

Sagardighi Thermal Power Project

1x660 MW Unit No. 5, Phase - III

OF

West Bengal Power Development Corporation Limited

TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

SPECIFICATION NO.: PE-TS-445-555-A001



BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA (INDIA)



1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5

COMPRESSED AIR SYSTEM

SPECIFICATION NO: PE-TS-445-555-A001

VOLUME: II B & III

REV: 00

DATE: Mar. 21

SHEET: 1 OF 1

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1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5

COMPRESSED AIR SYSTEM

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SECTION-A

INTENT OF SPECIFICATION



1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5

COMPRESSED AIR SYSTEM

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1.0 INTENT OF SPECIFICATION

- 1.1 The specification is intended to cover design, engineering, manufacture, inspection and testing at vendor's/ sub-vendor's works, painting, forwarding, proper packing and shipment and delivery at site, unloading, handling & transportation at site, Erection & Commissioning, minor civil works as required on FOR site basis, Performance and guarantee testing and handing over of Compressed Air System as per details in different sections / volumes of this specification for **1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5** .
- 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 of Compressed Air System within quoted price.
- 1.3 It is not the intent to specify herein all the details of design and manufacturing. However, the equipment shall conform in all respects to highest 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. Similarly, the extent of supply also includes all items required for completion of the system and not withstanding that they may have been omitted in drawings / specifications or schedules.
- 1.5 The general term and conditions, instructions to tenderers 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 Vol-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



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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 schedule; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification.
- 1.9 In case all above requirements are not complied with, the offer may be considered as incomplete and would become liable for rejection.
- 1.10 Unless specified otherwise in GCC, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or NTPC including their consultant as interpreted by BHEL in the relevant context.

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SECTION: B

PROJECT INFORMATION WITH WIND AND SEISMIC DESIGN CRITERIA



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SECTION-III

PROJECT SYNOPSIS AND GENERAL INFORMATION

1.00.00 INTRODUCTION

The West Bengal Power Development Corporation Limited (WBPDC) proposes to extend their on-going Phase-II extension project of 2x500 MW at Sagardighi by adding one super critical unit of 660 MW as Phase-III extension unit. Sagardighi TPS is located in the village Manigram in Murshidabad district of West Bengal, India. The West Bengal Power Development Corporation Limited, a Company fully owned by the Government of West Bengal formed in the year 1985, have commissioned 2x300 MW Thermal Power Plant together with all other infrastructure at Sagardighi Thermal Power Project. Presently WBPDC is also working on their under-construction Phase- II extension project of 2x500 MW at Sagardighi.

The Bidder shall acquaint himself, by visiting the site, with the conditions prevailing at site. The information given here in under is for general guidance only.

2.00.00 APPROACH TO SITE

Sagardighi Super Thermal Power Station site is located at Manigram village, 13 KM north of Sagardighi town by the side of the SMGR (Sagardighi-Manigram-Gankar-Raghunathganj) Road at a distance 20 KM from National Highway 34 in Murshidabad District, West Bengal and around 240 KM from Kolkata, India. The nearest rail station is Manigram adjacent to the site on Bandel - Barhawara branch line and 6.5 KM from Sagardighi Railway Station on Sainthia - Azimgunj line of Eastern Railway. From Sagardighi railway station a railway line will branch off to the site for material unloading and coal marshalling. The equipment will be normally transported by rail only and under exceptional cases by road. The material consignments shall be as per the restrictions of rail and road transportation prevailing in the country.

Nearest Airport – Kolkata.

Nearest Seaport –Haldia.

3.00.00 LAND

The total land available for the Power Station and Plant auxiliaries will be generally as per the Site Location Plan (12A05-DWG-M-002) enclosed and flexibility will remain to make the final equipment layout based on equipment sizes.

All construction material, heavy equipment, over dimensioned consignments (ODC) for the station during construction may be transported through road/rail access. During operation stage, coal would be transported through rail access.





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The total land, approximately 706 hectares, has already been acquired for the present and proposed extension. The locations of various facilities and plant auxiliaries for Unit 1 & 2 under Phase-I and Units 3 & 4 in Phase-II and the space provision for extension unit no. 5 (660 MW) will be as per the General Layout enclosed. About 456 acre of land has been kept for disposal of ash. The Bidder shall accommodate equipment offered under this specification generally within the spaces allocated for such equipment in the General Layout. Specific approval from Owner/Consultant shall be taken by the contractor prior to any revision or relocation.

Except where stated otherwise, the plinth levels of all buildings shall be 300 mm above the corresponding developed grade level and the road level shall be 150 mm above the developed grade.

4.00.00

SOURCE OF COAL

The Power plant shall receive coal from ECL mines. Coal is planned to be transported in rake loads through the existing Pakur- Tildanga-Dhulian-Monigram broad gauge line or through Pakur- Nalhati (proposed)-Takipara-Gosaingram-Poradanga-Monigram broad gauge line. The coal would be carried in rake loads of BOBR/BOX-N wagons.

It is considered that coal would be received from the same source as the plant under Phase-I and Phase-II station with similar characteristics and a new mine at Pachwara (north) in Jharkhand being developed by WBPDC. These sources being connected by B.G. rail track, coal would be transported by rail only. For coal unloading, crushing and storage facility it is proposed that a new Wagon tippler along with crusher houses, conveyors will be installed in addition to existing coal handling plant of Phase-II station with suitable extension from the end of Transfer Point (TP-19).

5.00.00

SOURCE OF WATER

The source of water for this project is the River Bhagirathi (5 km) through the proposed intake pump house under implementation for Phase-II station. The water from the River Bhagirathi will be transferred and stored in the five (5) nos. Plant Raw Water Reservoirs by augmentation of the Intake water transportation system for phase - II for meeting the requirement of Phase-III Sagardighi TPS.

The Power station will operate on semi open recirculating condenser cooling system using cooling towers. In addition all water conservation and recycling measures will be adopted to minimize requirement of make up water. The proposed project will adopt zero effluent discharge philosophy.

6.00.00

ASH DISPOSAL AREA

Bottom Ash (BA) shall be extraction in wet form and conveyed to the disposal area in lean slurry form. Whereas Fly Ash (FA) shall be extracted in dry form and stored in dry form for onward usage. However, arrangement shall be also





made to dispose fly ash in lean slurry form to ash dump yard located within 1 km from Plant boundary under exigency..

7.00.00 DETAILS OF EXISTING FACILITIES OF PHASE-II

INTRODUCTION

The proposed phase-III, Unit No. 5 is an extension project with many auxiliary systems being common and shared with the Phase-II units (Unit Nos. 3 & 4). It is not the intent to describe all systems in details. Facilities being shared by both Phase-II & Phase-III units and which have a common terminating and control philosophy are outlined below:

MAIN & AUXILIARY COOLING WATER SYSTEMS & ACCESSORIES

Condenser cooling water and auxiliary cooling water system of Phase-III will be independent of Phase-II. Separate pump house and pumping system shall be installed for Phase-III. Only CT make-up system of Phase-II will be shared for Phase-III. However, DMCW system of boiler of Phase-II has excess capacity, which can be utilized for phase-III. The detail of excess cooling water capacity is furnished below:

Provision kept of miscellaneous BOP coolers in DMCW (SG) pump capacity of Phase-II:

- i) AHP compressor coolers – $2 \times 300 = 600 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- ii) MRS compressor coolers - $2 \times 30 = 60 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- iii) Plant air compressor coolers - $2 \times 175 = 350 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)

Cooling water consumption for miscellaneous BOP coolers (both working and standby) of Phase-II:

- i) AHP compressor coolers $158 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- ii) Fluid Coupling of Ash slurry pumps = $40 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- iii) BA overflow pumps = $30 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- iv) MRS compressor coolers - $30 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)
- v) Plant air compressor coolers - = $185 \text{ m}^3/\text{hr}$ (for $2 \times 500 \text{ MW}$ units)

The following excess capacity of DMCW(SG) system of Phase-II is available, which can be shared by miscellaneous BOP coolers of Phase-III (except BAOF pump and vacuum pumps), by suitable extension of existing supply and return header of Phase-II :

- i) AHP system coolers- $372 \text{ m}^3/\text{hr}$
- ii) MRS compressor coolers - $30 \text{ m}^3/\text{hr}$
- iii) Plant air compressor coolers - = $165 \text{ m}^3/\text{hr}$

Bidder to check and confirm that excess available capacity of DMCW (SG) system of Phase-II would be adequate for satisfactory operation of the above mentioned BOP systems of Phase-III. With this consideration, the capacity of DMCW (SG) can be optimized for Phase-III.





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For details and disposition of existing equipments of Phase-II and space provision for proposed equipment of phase-III, please refer layout compressor house (Dwg. No. PE-V0-373-160-505).

Cooling water requirements for conveying air compressor shall be met from existing DMCCW system. The supply and return lines shall be connected at the tie in points from the existing DMCCW system.

PLANT COMPRESSED AIR SYSTEM

Plant air compressor house will be common for Phase-II & III. Instrument air and service air compressors, dryer, receivers and interconnecting piping system for phase-II are installed in the compressor house. Provision of one (1) no. Instrument air Compressor and one (1) no. Service air Compressor, with dryer, receivers and interconnecting piping system are kept in the compressor house for Phase-III. The brief details of existing facilities of Phase-II are indicated below:

- a) Instrument Air Compressors- Three (3) nos. (2W+1S) Motor driven oil free screw compressors with air dryer, each of capacity 36 Nm³/min (FAD-46.53 m³/min) and discharge pressure of 8.0 kg/cm²(g)at after cooler outlet at rated capacity.
- b) Service Air Compressors- Two (2) nos. (2W+0S) Motor driven oil free screw compressors with air dryer, each of capacity 36 Nm³/min (FAD-46.53 m³/min) and discharge pressure of 8.0 kg/cm²(g)at after cooler outlet at rated capacity.
- c) Air Receivers- Five (5) nos., each of capacity 10m³.

For details and disposition of existing equipment of Phase-II and space provision for proposed equipment of phase-III, please refer P&ID & layout Compressor house of Phase-II (Dwg. no. PE-V0-373-555-A002 & PE-V0-373-555-A001 respectively).

The proposed compressors of Phase-III shall be selected and interconnected such that the aggregate compressed air capacity of Phase-II & III can be shared by all the units of both Phase-II & III.

FIRE PROTECTION SYSTEM

Two (02) nos. inter-connections with isolation valves for hydrant system and Two (02) nos. inter-connections with isolation valves for spray system shall be considered at site for proposed integration with the hydrant and spray network of Phase-III with Phase – II. Please refer Composite piping layout of hydrant and spray network of Phase-II (Dwg. no. PE-V0-373-522-A0013) for locations of inter connection points.

LP PIPING (PIPE RACK)

Existing pipe rack of Phase-II shall be utilized to carry pipe lines from new pumps/ compressors of Phase-III to be installed in existing pump/compressors



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houses of Phase-II. Suitable augmentation/ modification/strengthening of existing pipe racks of Phase-II shall be carried out by the bidder.

FUEL OIL HANDLING SYSTEM

No further extension of unloading and storage capacity is envisaged for installed fuel oil handling system, which is sufficient for requirement of Phase-I, II & III units.

Pressurizing pumps will supply oil from the HFO/LDO storage tanks to the burner. Three (3) nos. HFO (2 W+ 1S) & two (2) nos. LDO (1W +1S) pressurizing pumps (each having capacity equivalent of 2X500 MW units) are installed under Phase-II system.

There is provision for one additional HFO pressurizing pump along with HFO Heater to be installed in pressurizing pump house to cater the requirement of Phase-III. Installed LDO forwarding pumps of Phase-II can also cater requirement of Phase-III. HFO & LDO Pressurizing pump discharge lines, which has been extended up to Unit #4 of Phase-II, shall be further extended by bidder to feed Phase-III.

HFO supply and return lines to and from boiler of phase-III to be extended from existing HFO supply and return header respectively (terminated with isolation valve) of Phase-II. Similarly, LDO supply line to boiler of phase-III to be extended from existing LDO supply header (terminated with isolation valve) of phase-II.

The proposed HFO pressurizing pump with heater of Phase-III shall be of identical capacity with the existing equipment to utilize existing equipment foundations at site.

ELECTRICAL EQUIPMENT & ACCESSORIES

Necessary power supply for Phase-III Fuel oil pump will be arranged from existing FO Switchboard. Accordingly existing FO switchboard shall be modified as specified elsewhere.

If the new equipment of Phase-III 400kV air insulated switchyard can be accommodated in the existing switchyard control building, same needs to be modified if required.

For further details regarding the existing facilities of Phase – II, please refer Volume – II F1 and F2: Technical Specifications for Electrical Equipment and accessories.

CONTROL & INSTRUMENTATION

The following are the existing Stage-II facilities which shall be used for Unit #5 C&I works.





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- | | System | Existing Facilities to be used |
|----|--|---|
| a) | Fuel Oil Pressurizing & Heating System | Existing spare I/O cards and spare I/O slots of Unit #3 & Unit #4 DCS [Stage-II] shall be used for augmentation of the new Fuel Oil Pressurizing & Heating System of Unit#5 of Stage-III. Relevant control shall be implemented in the existing DCS processors. |
| b) | Compressed Air System | <p>New Instrument Air Compressor and Service Air Compressor shall share the existing serial network of Compressors of Unit#3 & Unit#4 DCS [Stage-II] for DCS soft communication.</p> <p>The new Instrument Air Compressor shall also be interfaced with the existing electronic sequencer module (ES-6) provided for the existing Instrument Air compressors of Unit#3 & Unit#4 DCS [Stage-II] for group interlocks.</p> |
| c) | Mill Reject Handling System | <p>The control shall be implemented in the existing MRHS PLC of Unit#3 & Unit#4 [Stage-II], located in the existing CPU regeneration Area control room. The new MRH System shall use the existing processor of the PLC. New IO panel for additional IO cards for the new system shall be installed in the assigned location of the existing control room for Future IO Panel.</p> <p>The UPS for the new MRH system PLC IO Panel shall be derived from the existing UPS ACDB located in the existing CPU Regeneration Building Control Room (Stage-II).</p> |
| d) | Ash Handling System | <p>The operation and control of new Unit#5 AHP facilities shall be through the existing PLC of Stage-II (located in the Compressor House Control room).</p> <p>Existing PLC processor (PLC-1), shall cater to the control of the common systems including Ash Water & Ash Slurry System, Fly Ash Unloading System, Instrument Air System & various sump draining systems.</p> <p>Additional IO panels shall be installed in the locations assigned for future IO panels in the Compressor House Control Room, Ash Water Pump House RIO Room and Silo Utility Building RIO Room of Stage-II units.</p> |





One new redundant processor shall be installed in the existing Processor Panel located in the Compressor House Control room to cater the new Unit#5 Bottom Ash & Fly Ash Evacuation System. Extended RIO of the new processor shall be procured for the Unit#5 systems.

For new PLC CPU/ IO at existing (Stage-II) Compressor House Control Room, existing UPS system in the Existing [Stage-II] Compressor House Control Room shall be considered.

New Energy Meter, Numerical Relays, Air Compressor etc. shall share the existing serial network for interface with existing PLC for Unit#3 & Unit#4 [Stage-II].

e) Coal Handling System

Spare IOs cards at Remote IO Unit of existing Stage-II CHP PLC near TP-17 of Stage-II shall be used for the augmentation of new CHP system of Unit#5 (Stage-III). The control shall be implemented in the existing PLC processor.

However, for Wagon Tippler & Crusher separate new PLC based system with connectivity with existing PLC at HMI network level shall be envisaged.

Existing “3D Level Mapping Software” loaded in the CHP PLC for Unit#3 & #4 of Stage-II shall be used for the new Unit#5 Bunker Level indication System. The existing Fiber Optic network for CHP PLC interface with Bunker Level indication System of Stage-II shall also be used by the new Bunker Level indication System for CHP PLC interface.

f) GPS Master Clock System

All the microprocessor based control systems like DCS, PLC based systems, CCTV, TSI & Rotating machine condition monitoring system etc of unit#5 shall be time synchronized with the Existing GPS Master clock of Phase-II.

g) Fire Alarm System

Existing Fire Alarm Panel at Fire Station of phase II shall be used to display parameters / Alarms of new Fire Alarm System of unit#5. Main FAP of unit#5 shall be connected to the phase II FAP located at existing fire station.





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CIVIL, STRUCTURAL AND ARCHITECTURAL WORK (BUILDINGS CONSTRUCTED WITH SPACE FOR PHASE III)

Necessary Walkway connection between operating floors of Power House of Phase – II (Existing) and Phase – III shall be considered by Bidder.

Few civil foundations have already been constructed for future equipment. Such existing foundation details including bolts, inserts etc. to be studied in detail before procurement of specific equipment for respective purposes so that the same can safely be placed over the existing foundations complying all technical compatibility. In case this is not at all possible, new foundations need to be constructed after complete demolition of existing foundations.

For further details regarding the existing facilities of Phase – II, please refer Volume – II G1, G2 and G2: Technical Specifications for Civil, Structural and Architectural..

8.00.00 SALIENT DESIGN DATA

8.01.00 For implementation of the project, the Bidder shall consider the following Site and Meteorological data:-

- | | | | |
|----|-------------------------|---|--|
| a) | Location | : | Manigram village, Sagardighi, Raghunathganj sub-division, Murshidabad District, West Bengal. |
| b) | Latitude and Longitude | : | 24 ⁰ 22' 13.7" N, 88 ⁰ 6' 15.8" E
(Topo sheet No.78/D/3) |
| c) | Nearest Towns | : | Ajimganj, Jangipur, Raghunathganj. |
| d) | District Head Quarters | : | Berhampore - 40 km. |
| e) | Approach Road | : | 20 km from National Highway (NH-34) |
| f) | Nearest Railhead | : | Manigram railway station on Bandel-Barhawara branch line 1 km from site. |
| g) | Source of Water | : | Bhagirathi River - 5 km |
| h) | Source of Coal | : | Pachwara (North) mine block in Jharkhand. |
| i) | Fuel Transportation | : | By rail in rake loads of BOBR/BOX-N wagons. |
| j) | Surrounding Habitations | : | Villages - Manigram, Chhamugram, Karaia, Thakurpara on the south; Bhumhar, Khasittor, Ekrakhi on the west; |





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Dhalo, Bagpara, Santoshpur on the north and Harirampur, Chandparam, Dogachhi on the east.

- k) Level : Within 34.5 m contour. Land is above HFL (highest flood level) of the area.
- l) Soil : Less fertile alluvial soil.
- m) Land Use : Within existing plant boundary of WBPDC.

Meteorological data of site is given below:

- a) Design ambient dry bulb temperature : 50 °C maximum
5 °C minimum
- b) Highest wet bulb temp : 26.9 °C
- c) Maximum relative humidity : 84%
- d) Average relative humidity : 73%
- e) Average annual Rainfall : 1389 mm
- f) Wind load : In accordance with IS-875 for a basic wind speed of 47 m/sec, up to a height of 10 metres above mean ground level.
- g) Seismic Zone : Zone III as per IS: 1893 latest edition.
- h) Altitude : 34M above MSL



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TECHNICAL SPECIFICATIONS

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SPECIFIC TECHNICAL REQUIREMENT

	1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5 COMPRESSED AIR SYSTEM	SPECIFICATION No: PE-TS-445-555-A001	
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SECTION: C1

SCOPE OF SUPPLY & SRVICES, TERMINAL POINTS, EXCLUSIONS AND OTHER PROJECT SPECIFIC DETAILS

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1. 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, fill of lubricants & consumables, Mandatory spares along with spares for erection, start up and commissioning as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in-site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, preparation of layout drawings and carrying out Performance guarantee tests at site, training of customer/client and O&M staff and handover in flawless condition of the package to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification, amendment & agreements till placement of order for **1 X 660 MW Sagardighi TPS Extn. Unit#5.**

Items not specifically mentioned but deemed necessary by the Tenderer for making the system completely reliable and efficient shall also be considered as if included.

2. SCOPE OF SUPPLY:

Scope of supply by bidder shall include but not limited to the following:

2.1 Two (2) nos. of multi stage rotary oil free screw Compressors, One (1) compressors each for instrument air and service air respectively, each of minimum 36 NM3/Min capacity at 8.0 Kg/cm2 (g) discharge pressure, along with motor, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories, shall be provided. **The model no. of compressors shall be ZR 275 of M/s Atlas Copco make.** The Datasheet, GA drawing and the P&ID for the compressor is attached Section-5, Volume-III.

2.2 Two (2) numbers (one for service air & one for instrument air compressors) Heat of Compression (HOC) type air-drying plants (ADP) (Single rotary drum type) of min. 36 NM3/min. capacity, with all instruments, control panels & accessories as specified, suitable for connecting to individual instrument air compressor & service air compressor. **The model no. of ADP shall be MD 600W of M/s Atlas Copco make.** The Datasheet, GA drawing and the P&ID for the ADP is attached Section-5, Volume-III.

2.3 Two nos. receivers of capacity (10 m3 each) to be considered for the instrument air compressor, of which one no. IA receiver near compressor house and another in B-C bay of power house of capacity 10 m3 each to meet the requirement. Another SA receiver of capacity 10 m3 in addition to receiver near compressor house will be installed to meet the requirement of specification.

Additionally, one(1) instrument air receiver of 10 m3 effective capacity with all accessories is being provided for CWBD PT-UF-RO plant area & one(1) instrument air receiver of 2 m3 effective capacity with all accessories is being provided for FGD area.

Accordingly, Four (4) nos. instrument air receiver and two (2) nos. Service air receiver is being provided for the project. The volume mentioned (10 m3 & 2 m3) is the water filled volume.

2.4 Sequential panel for ensuring equal no. of running hours of each compressor – 1 Lot.

2.5 Online Electronic Dew point meter.

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2.6 Pipes & fittings for compressed air line, cooling water & drain line including hanger/supports, auxiliary structural members etc. inclusive of all fittings, flanges & Counter flanges, bolts, nuts, gaskets etc. at all piping terminals. 2.7 All airline valves, cooling water valves, drain valves etc.– 1 Lot. 2.8 Necessary instruments for control and interlocks, instruments indicated in the P&I Diagram for the compressed air system to be considered as a minimum. Any additional instrument / valves required for successful operation of the system, to the discretion of BHEL, shall be provided to BHEL by successful bidder without any price implication. 2.9 Access platform required for the maintenance of instruments/valves on the towers of HOC type air drier, air receiver shall be in bidder's scope of supply. 2.10 Maintenance tools and tackles, consumables, first fill of lubricants inclusive of packing – 1 Lot. 2.11 Commissioning spares with proper packing suitable for long duration storage – 1 Lot (refer Annexure-VI). 2.12 Mandatory Spares as specified in the price schedule inclusive of proper packing for long duration storage purpose – 1 Lot. 2.13 Compressor & Dryer mounted local control panel. 2.14 Erection, start up and commissioning consumable & spares as required for completing these activities. 2.15 All flanges, fasteners and counter flanges at all TPs. 2.16 Pipe supporting structure over the insert plate for pedestal supported pipe, wall supported pipe, insert plate and supporting structure for floor supported pipe. 2.17 All MS structures for cross overs, valve, instrument, equipment operating and maintenance platform; approach ladder for access to pit/ trench. 2.18 All Equipment base plate, foundation anchor bolts. 2.19 Grout for civil work grouting below base plate for all structures/equipment & for grouting of foundation / anchor bolt. 2.20 Paint required for painting of all items under the package for corrosion protection and to meet color coding required by customer. 2.21 Hoses for O&M purpose etc and other accessories as required - 1 no. 2.22 Any other item mentioned under Customer specification and enclosed under Section SECTION-C2 of this Specification. 2.23 Any other item covered under the price format. 2.24 Electrical scope as per details furnished under Section – C3: TECHNICAL SPECIFICATION (ELECTRICAL PORTION). 2.25 Instrumentation & control System including instruments, interlocking & protection devices with bare minimum instrumentation as shown in P&I Diagram of Compressed Air System (Refer			

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Section-5, Volume-III) and the System Architecture (Refer Section-5, Volume-III). Further any other instruments required for safe, efficient and reliable operation of the system and to be read in conjunction with C&I portion of specification (Refer Section – C4).

- 2.26 Any other item required for making the installation complete in all respect and for satisfactory operation of the system, meet layout and accessibility & operability requirements for the scope within the terminal point, for compliance to GTR (General Technical Requirement), GCC (General Condition of Contract), SCC (Special Condition of Contract), ECC (Erection condition of contract) as relevant to Compressed Air System as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of supply.

3. SCOPE OF SERVICES:

Scope of services by bidder shall include but not necessarily limited to the following:

- 3.1 Erection & Commissioning of Compressed Air System.
- 3.2 Unloading, Storage, handling and transportation at site (Pl. refer Section-E, Annexure - IV).
- 3.3 Minor civil work like requirement of wall opening (if applicable), grouting below base plate for all structures, equipment, grouting of anchor bolts wherever these are not placed in the foundation during casting of foundation itself.
- 3.4 Pre- Commissioning work such as flushing, hydraulic testing etc. Necessary consumables and instrumentation as required for inspection and testing at works as well as at site including pre-commissioning activities shall be arranged by the successful bidder at their own cost.
- 3.5 Performance Guarantee test (Refer Section C2-C).
- 3.6 Painting of all items within bidder's scope of supply equipment within the battery limit.
- 3.7 Electrical scope as per enclosure elsewhere in the specification.
- 3.8 Preparation of drawing showing common facilities, if any, between BHEL & Vendor supplied equipment.
- 3.9 Supply of temporary equipment and services for Erection, commissioning and test etc. as applicable.
- 3.10 Making good/ repairing/ replacement of any damage done by the bidder to adjacent structures, pipes, etc. while erecting and commissioning equipment related to Compressed Air System
- 3.11 Site support during DCS commissioning.
- 3.12 The compressors along with driers shall be located in the existing compressor house (Refer Section-5, Volume-III). Further the existing EOT crane in the compressor house can be allowed during erection purpose, provided Vendor undertakes that :
 - a. Any damage to the existing EOT crane during erection if found, will be rectified by Vendor and handed over to the Owner in working condition.
 - b. Similarly, any repair if required for erection by the existing EOT crane, will be under Vendor's scope.
 - c. Also any erection issue originating from the use of existing EOT during erection will be under Vendor's risk and cost.

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3.13 Any other services mentioned under Customer specification and enclosed under SECTION-C2 of this Specification.

3.14 Any other service covered under the price format.

3.15 Preparation of civil assignment drawings i.e. pedestals details, insert plates / embedment's plates required for supporting pipes and equipment etc. and review of civil drawing prepared by customer based on civil assignment drawing of bidder. In case any modification is required in the civil work already done based on civil inputs given by vendor, rework shall be done at the cost and risk of the vendor.

3.16 Training of plant Owner's personnel, O&M operators' personnel on plant and Equipment operation and maintenance.

3.17 Any other services required for making the installation complete in all respect and for satisfactory operation of the system, meet layout and accessibility & operability requirements for the scope within the terminal point, for compliance to GTR (General Technical Requirement), GCC (General Condition of Contract), SCC (Special Condition of Contract), ECC (Erection condition of contract) as relevant to Compressed Air System as well as to meet any statutory requirement relevant to the package, unless specifically EXCLUDED from scope of supply.

4. EQUIPMENT SELECTION & DESIGN CRITERIA

The minimum design criteria/ technical details to be followed for various equipment shall be as per Data Sheets / Design criteria under Section – C2 including customer specification and other details placed elsewhere in the specification. In case of any contradictory requirement for specification of particular equipment, and clarifications not having been sought by the bidders, the most stringent requirement as per interpretation of the BHEL will prevail. Successful bidder will furnish detailed data sheets/ specifications / design calculations for various equipment for customer's/ consultant's approval during detail engineering. For items for which specific technical specification is not enclosed, data sheet / dwgs / design calculations for such items shall be subject to customer/ consultant approval during detail engineering. All comments made by customer/ consultant shall be incorporated by the successful bidder without any commercial and delivery implication.

5. TERMINAL POINTS:

5.1 Bidder shall terminate the common header for IA and SA (both 150 NB) at 5M from the air receiver outlet (Refer P&ID for compressed air system, Section-5, Volume-III).

5.2 Cooling water supply will be provided by the BHEL outside the compressor house (5m within vicinity of Compressor house). The return hot water shall be terminated by the contractor at the same location. Parameters at T.P. shall be as below:

INLET TEMP. TO PHE :39 °C

DESIGN PRESSURE = 10 KG/SQ.CM(G)

Pipe Size at cooling water T.P. = 150 NB (both for inlet & outlet)

5.3 All the drains shall be terminated to plant garland drain outside compressor house by bidder.

6. EXCLUSIONS:

6.1 MCC / Switchgear for power supply to Air Compressors and other drives and panels.

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6.2 Civil works like construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe/cable trenches. However, grouting required for the equipments shall be in bidder's scope.

6.3 Lighting and ventilation of compressor house.

6.4 Fire protection & Detection system of Compressor House.

6.5 Monorail with Electric Hoists as necessary for handling of equipment after erection.

6.6 DCS control. However, all logic for implementation of control and monitoring from DCS shall be provided by successful bidder during detail engineering.

6.7 Relevant exclusion as per GTR, GCC, SCC & ECC.

6.8 Exclusions, if any, indicated in Electrical and C&I portion of the technical specification.

7. SERVICES TO BE PROVIDED BY THE CUSTOMER

Relevant services as per GCC, SCC & ECC.

8. PERFORMANCE GUARANTEES

Performance test for CAS shall be carried as per Section – C2-C.

All consumable and instruments required during PG Test will be arranged by the bidder. Instruments will be duly calibrated from customer authorised/ approved laboratory.

9. QUALITY ASSURANCE, QUALITY PLANS, INSPECTION & TESTING PROCEDURE

For Quality assurance, Quality Plans and Inspection & Testing, pl. refer Section – C2-D. The quality requirements specified are only indicative, any additional test, as required by Customer/WBPDCL shall be provided by bidder without any commercial and delivery implication to BHEL.

10. SUB-VENDOR ITEMS

The make of Sub-vendor items shall be generally as per enclosed sub vendor list, which is subject to customer approval during detail engineering (Refer).

The tentative make of Sub-vendor items shall be generally as per Section-E, Annexure-I enclosed which is subject to customer approval during detail engineering. Make of any unlisted items shall be subject to Customer approval during detail engineering. For such items, bidder to furnish list of sub-vendors during detail engineering stage for BHEL's review and approval. Bidder shall furnish the following supporting documentation within 1 month of placement of LOI. Thereafter no request for additional sub-vendor shall be entertained.

- Documentation to show that the equipment /system has been supplied for a plant of similar or higher capacity.
- Documentation in the form of certificate that the equipment/system has been operating satisfactorily for one year.

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The successful bidder will get the makes of all items approved from Customer/ Consultant during detail engineering within two months of placement of LOI. The complete list of sub vendors will necessarily be submitted by the successful bidder within one month of placement of LOI.

Bidder to assess the capability of their proposed sub-vendors in terms of preparation of drawings, calculations, documents, quality assurance, supply of material etc. as per project schedule before placing the order on them.

Dealers are not acceptable for any item of the package. Bidder shall procure all items including plates, structural, flanges, counter flanges etc. from approved sub vendor only.

11. DRAWINGS AND DOCUMENTS TO BE SUBMITTED WITH THE BID

The drawings and documents to be submitted with the bid shall strictly be as mentioned under Volume III (section-1). Any documents other than those indicated in Volume III (Section-1) will not be reviewed and will not form part of contract.

12. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

Tentative list of drawing / document required during detail engineering is attached in Volume-II (Refer Section-E, Annexure-III). Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.

13. DRAWINGS DISTRIBUTION SCHEDULE

Vendor needs to submit drawing/document during detail engineering along with editable soft copy of the same (Refer Section C2-B).

14. DRAWINGS ENCLOSED WITH THE SPECIFICATION

Following drawings enclosed will form part of the specification.

- Pl. refer section 5, Vol.-III.

The P&I diagrams are indicative and show the minimum requirement to be followed including minimum requirement of instruments. Any other item and instruments required (within the terminal points) to make the system complete in all respect and for satisfactory operation of the system shall also deemed to have been included by the bidder in their scope. The detailed P&I diagrams for compressed air system in line with specification requirement shall be developed by the vendor during detail engineering for customer's approval and without any commercial implication to customer. Bidder to note that the while preparing PIDs after placement of order, successful bidder shall incorporate line numbers Instrument tag nos., KKS Numbering, equipment no, Line Spec, Line MOCs, legend / symbol chart, equipment capacity, relief valve capacity and set pressure, control valve capacity, range, fail position etc. in these drawing and same are subject to the customer approval.

15. ADDITIONAL POINTS TO BE NOTED BY BIDDER

15.1 Compressed Air system shall be offered as turnkey basis meeting specification requirements.

15.2 Basis of design, all calculations, equipment selection criterion, layout drawings/schemes/G.A. drg. and documents like data sheet/Technical particulars etc. are subject to Customer & BHEL approval during detail engineering stage.

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15.3 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.

15.4 Performance test for compressors shall be carried out at shops with job motor only.

15.5 Compressor and air dryer shall be designed for cooling water (passivated DM water) with inlet temp of thermal 39 deg C (max.). Further the temperature of the air at the outlet of after cooler shall be limited to 10deg.C above cooling water inlet temperature i.e. outlet air temperature from air dryer in any case shall not be more than 45 deg. C. The Compressors coolers, dryer's coolers & / or after coolers shall be designed to withstand 12 kg/cm² i.e., shutoff head of BHEL DM cooling water pumps. The pressure drop across the complete cooling water circuit shall be 10 MWC. Successful bidder shall furnish break-up of pressure drop for individual components and compressors as a whole in the datasheet to be submitted for approval at the time of detail engineering.

15.6 Corrosion allowance of 2.5 mm shall be provided for air receiver.

15.7 Only KKS tagging shall be used in all document/drawings and in the field for all items/equipment/signals etc. No other tagging method is acceptable. The successful bidder shall provide detailed drawing with KKS only. Operational write up of the system should strictly contain KKS code for identification and description.

15.8 Packaging of items / equipment and mandatory spares (Pl. refer Section-E, Annexure - V).

15.9 Inspection & testing (Refer Section C2-D).

16. LAYOUT CONSIDERATIONS

16.1 The compressed air system equipments shall be located in the existing compressor house (Refer Section-5, Volume-III).

16.2 The air receivers will be located outdoors adjacent to the compressor room and at locations specified in the P&ID for the compressed air system (Refer Section-5, Volume-III).

17. CONTROL AND INSTRUMENTATION

Compressor control systems of unit#5 shall be interfaced with the unit # 3&4 DCS. Since, the compressors of unit #5 will be connected to existing compressed air header, any loss of header pressure for what so ever reason including failure of unit#5 compressors, will automatically start the standby compressor with the help of existing control system of units #3&4.

Unit#5 IAC and Unit#3,4 IAC shall be connected to existing ES- 6 controller & Mark V Gateway. Unit#5 SAC and Unit#3,4 SAC shall be connected to Optimizer along with Mark V Gateway.

The hardwire signals consisting of Status of the compressors of U#3&4 are terminated in U#3&4 DCS and Status of the compressors of U#5 are terminated in U#5 DCS.

The following Minimum Indication/ Annunciation signals shall be indicated in DCS:

- Status of each compressor
- Instrument air pressure Low / High
- Service air pressure Low / High
- Dew point of compressed air

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- e) Status of each ADP
- f) Compressor header pressure
- g) Receiver Pressure
- h) Instrument Air Flow
- i) Service Air Flow

The System Architecture for the above mentioned control philosophy has been indicated in Section-5, Volume-III.

For further details, please refer C&I Specification Section-C4, Volume-IIB.

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CUSTOMER SPECIFICATIONS

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SECTION: C2-A

CUSTOMER SPECIFICATION: TECHNICAL REQUIREMENT



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VOLUME: II-J1**SECTION: II****TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

Development Consultants Pvt. Ltd.

Volume: II-J1
Section: II
Compressed Air System



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SECTION-II

COMPRESSED AIR SYSTEM

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacture's works, Packing, Transportation, Delivery, Receipt, Unloading, Storage and handling at site, supervision of Erection, Testing, Commissioning and Field Acceptance/ Performance Guarantee test of compressed air plant consisting of air compressors, receivers and air drier units with all associated accessories and auxiliaries as specified herein after and as required for safe trouble free operation and maintenance for 1 x 660 MW Sagardighi Thermal Power Station, Phase-III, Unit-5 for The West Bengal Power Development Corporation Ltd. (WBPDC) at Sagardighi, Murshidabad District, West Bengal.

1.02.00 It is not intended to specify completely herein, all details of design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation up to the vendor's guarantee in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work of material which in his judgment is not in full accordance therewith.

1.03.00 The compressed air system shall be comprised of SA & IA systems required for the following areas:

- i) Turbine Generator (TG) and Auxiliaries.
- ii) Steam Generator (SG) and Auxiliaries.
- iii) Flue Gas De-Sulphurisation System.
- iv) Various pump house area
- v) Laboratory
- vi) Plant I & C area

2.00.00 GENERAL INFORMATION

2.01.01 The compressed air plant (Compressors and Air Dryers) shall be located in Plant Air Compressor house of Phase-II. The air receivers shall be located outdoor. All equipment, electrical, instruments to be supplied under this





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specification shall be suitable for their respective location. For technical requirements of electrical equipment and accessories relevant sections of the Electrical Specification, Volume-II-F/1 & F/2 shall be referred.

- 2.01.02 One(1) service air compressors and One(1) instrument air compressors of capacity 36 Nm³/min at pressure 8.5 kg/cm² (g) will be used to cater the service and instrument air requirement respectively.
- 2.01.03 Air drying plant of capacity and number equal to that of each instrument and service air compressor shall be installed in order to supply moisture free instrument air for the power plant.
- 2.01.04 Instrument and Service Air Receiver of number equal to that of each instrument and service air compressor respectively shall be provided to store instrument and service air. Another instrument air unit receiver of capacity 10 m³ shall be installed in B-C bay of power house. In addition to this one (1) no. instrument air receiver of capacity 2m³ shall be installed to cater IA requirement of FGD area.
- 2.01.05 All the piping works including all accessories.

3.00.00 **SYSTEM DESCRIPTION**

- 3.01.00 Plant air compressor house will be common for Phase-II & III. Instrument air and service air compressors, dryer, receivers and interconnecting piping system for phase-II are installed in the compressor house. Provision of one (1) no. Instrument air Compressor and one (1) no. Service air Compressor, with dryer, receivers and interconnecting piping system are kept in the compressor house for Phase-III. For details of existing facilities, please refer section-III of volume-IIA.
- 3.02.00 To meet the requirement of instrument air and service air, Two (2) nos. of multi stage rotary screw Compressors, One (1) compressors each for instrument air and service air respectively shall be provided.
- 3.03.00 One (1) No. of Air drying plants for IA & SA compressor each of HOC type air dryer with continuous and fully automatic operation shall be provided to ensure dry moisture free Instrument quality air for both instrument and service air system. The schematic arrangement of Compressed Air System has been shown in Drawing No.: 12A05-DWG-M-001S.
- 3.04.00 Compressors, after coolers and intercoolers shall be of water cooled type and shall utilize Passivated Demineralised water (DMCW) for cooling purposes from DMCW system.

The compressors and coolers shall also be connected with ACW system for cooling at the time of commissioning and during emergency.





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4.00.00 CODES AND STANDARDS

4.01.00 The equipments to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations as applicable, including all its latest amendments subsequent to the year of publication as mentioned below :

- | | | | |
|---------|-------------------------|---|--|
| 4.01.01 | IS-2825/1969 | : | Code for unfired pressure vessels. |
| 4.01.02 | IS-4503/1967 | : | Shell and Tube Type Heat Exchanger |
| 4.01.03 | IS-5456/1985 | : | Code of Practice for testing of positive displacement type air compressors and exhausters. |
| 4.01.04 | IS-5727/1981 | : | Glossary of terms relating to compressors and exhausters. |
| 4.01.05 | IS-1239
Part-1/1990 | : | Mild Steel tubes, tubulars and other wrought steel pipes. |
| | IS-1239
Part-2/1992 | : | Mild steel tubes, tubulars and other wrought steel fittings. |
| 4.01.06 | IS-6206/1985 | : | Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bars. |
| 4.01.07 | ANSI-B16.5
(1988) | : | Steel Pipes Flanges and Fittings. |
| 4.01.08 | IS-7938/1976 | : | Air Receivers for Compressed Air Installations. |
| 4.01.09 | IS-10431
Part-I/1983 | : | Measurement of Air Flow of Compressor and Exhausters by nozzles. |
| 4.01.10 | ASME PTC-9 | : | Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers. |
| 4.01.11 | BS-5169/1975 | : | Fusion Welded Steel Air Receiver. |
| 4.01.12 | IS-11989 | : | Specification air dryer. |
| 4.01.13 | ISO-7183 | : | Compressed Air Dryers - Specification and Testing |
| | ISO-7183
(Part-II) | : | Compressed Air Dryers - Performance rating |
| 4.01.14 | API 619 | : | Rotary Type Positive Displacement Compressors |





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- 4.02.00 In case of any contradiction with the aforesaid standards and the stipulations as per this Section and Attachments/Annexures of this section, the stipulations of this Section and its Annexures shall prevail. In case of any contradiction between this Section and Attachments/Annexures, stipulations of Attachments/Annexures shall prevail.
- 5.00.00 **SPECIFIC DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS**
- 5.01.00 The Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis for the 1 x 660 MW Unit. It consists of two sub systems namely,
- Instrument Air (IA) for Instrumentation and Control purposes for the station.
 - Service Air (SA) for some boiler equipment, general house cleaning and other miscellaneous usage.
- 5.02.00 The normal pressure of Service air and Instrument air supply, at the outlet of Air Dryer shall be $7.5 \text{ Kg/cm}^2 \text{ (g)}$ and shall not be lower than $7.0 \text{ Kg/cm}^2 \text{ (g)}$ under any circumstances. Corresponding to the above pressure at the outlet, the rated discharge pressure of each compressor shall be worked out by the system supplier allowing for pressure drops in system piping, equipment and all other accessories.
- The rated discharge pressure shall be as computed above or $8.0 \text{ Kg/cm}^2 \text{ (g)}$, whichever is higher. The maximum expected pressure in the system should be computed by considering 10% overpressure over and above the rated discharge pressure of compressor, as computed above.
- 5.03.00 However, since service and instrument air are of same quality (instrument air) and the headers are interconnected, there will be adequate supply of instrument air. Thus the instrument air compressor capacity for Phase-III shall be same as Phase-II i.e. $36 \text{ Nm}^3/\text{min}$, which will also ensure the interchangeability. Again, foundations of both IA & SA compressors and dryer of Phase-III are already constructed at site considering existing models of compressor and dryer of Phase-II. Hence, identical compressors shall be considered to ensure utilization of already constructed foundations at site.
- 5.04.00 Each Service Air Compressor shall have free air delivery capacity identical to that of each IA compressor.
- 5.05.00 FAD capacity of both instrument and service air compressor shall be calculated considering ambient temp. as 50°C and 100% RH. The site is located at 34.0 M above mean sea level.
- 5.06.00 IA group shall consist of 1X100% (i.e. One (1) working and no standby, standby compressor of Phase-II shall be shared if required) compressor with





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necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel and supplemented by 1X100% HOC type Air Drying plant. There shall be one (1) Air Receiver for each IA compressor.

- 5.07.00 SA group shall consist of 1X100% (i.e. One (1) working and no standby, standby compressor of Phase-II shall be shared if required) compressors for each unit with necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel and supplemented by 1x100% HOC type Air Drying plant. There shall be one (1) Air Receiver for each SA compressor.
- 5.08.00 Suitable interconnections shall be kept between SA and IA compressors before Air Dryers for each unit with normally closed motorized isolation valves.
- 5.09.00 Equipment operating on Instrument Air and Service Air System shall be designed for a pressure range of 5.5 Kg/cm² (g) to 110% of rated discharge pressure of each air compressor, as computed in accordance with clause no. 5.02.00 above.
- 5.10.00 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 Microns.
- 5.11.00 Compressed air system equipment requiring DMCW cooling water shall be capable of operation at design capacity with cooling water inlet temperature subject to a maximum of 36°C in DMCW system. The above equipment shall also be capable to withstand a pressure not less than the shut off head of each DMCW pump.
- 5.12.00 The temperature of air at outlet from after cooler shall not exceed 10°C above the cooling water inlet temperature.
- 5.13.00 Air Compressors shall be identical and shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Annexure-A enclosed with this section.
- 5.14.00 The power rating of the driver shall be selected such that a minimum margin of 15% is available over the power required to deliver rated capacity against rated discharge pressure. When the driver is not directly coupled to the compressor, due account should be made for losses in power transmission, in addition to the above margin.
- 5.15.00 As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, keeping noise level within permissible limits for a number of compressors working simultaneously.





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- 5.16.00 Each Air Receiver shall be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver shall not fall below 5.5 kg/cm² (g) within 45 seconds of such stoppage, while maintaining an out flow of air at a rate equal to the rated capacity of a single compressor, during the aforesaid period. In no case, the size of each Air Receiver shall be less than that arrived from IS 7938.

The capacity of each Air Receiver shall be determined in accordance with the following guidelines:

$$V_{AR} = \frac{T \times C \times P_A}{P_{MAX} - P_{MIN}} \times E, \text{ where}$$

- V_{AR} = Volume of each Air Receiver in M³.
- T = Bleed down time in minutes, shall be taken as 45 seconds (minimum)
- P_A = Atmospheric pressure, shall be taken as 1 Kg/Sq.cm (absolute).
- P_{MAX} = Maximum system pressure in Kg/Sq.cm absolute, shall be taken as 110 percent of rated compressor delivery pressure.
- P_{MIN} = Minimum system pressure in Kg/Sq.cm absolute, shall be taken as 6.5 Kg/Sq.cm absolute.
- C = Free air delivery capacity of each Air compressor for IA system or free air delivery capacity of each SA compressor for SA system, M³.
- E = 1.15, considering 15 percent minimum margin to account for peak requirements.

The water filled volume of each Air Receiver shall be calculated in accordance with the guidelines specified above or 10M³, whichever is higher.

- 5.17.00 The drying capacity of each Air Drying Plant (ADP) shall be provided to match the corresponding capacity of each compressor with required margin.
- 5.18.00 The air drying plants receiving compressed air saturated with moisture shall be capable of operating continuously to provide reliable moisture free compressed air. Dew point of the outlet air measured at the stated operating pressure shall be as mentioned in Annexure-B or lower throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 100% & 150°C respectively.
- 5.19.00 The drying process shall employ HOC type air drying unit to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air to following quality:





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- a) Dew point at atmospheric pressure (-) 40 degree.
- b) Oil content 0.01 ppm (maximum tolerable) or oil free.
- c) Dust – Practically dust free but maximum particle size 1 micron.

Air quality after air drying plant shall be in accordance with above stipulations or as per ISA – S7.3 (Instrument society of America) quality standards for instrument air, whichever is stringent.

5.20.00 Driers shall be suitable for part load operation while maintaining the outlet air dew point as specified above. Necessary instruments and controls shall be provided to ensure that the specified dew point is maintained irrespective of input variations.

5.21.00 The successful Bidder shall assume full responsibility in the operation of the air drying plant as a whole.

5.22.00 For the air drying capacity and all other relevant details pertaining to Air Drying Plant, Annexure-B shall be referred to.

6.00.00 SCOPE OF SUPPLY AND WORKS

6.01.00 Scope of Supply

The detailed scope of supply under this section shall be as below and as indicated in relevant tender drawings. Items not specifically mentioned but deemed necessary to make the system completely reliable and efficient shall also be included.

6.01.01 1x100% IA compressors and 1X100% SA compressors for 1x660 MW unit. There shall be one (1) Air Receiver for each IA compressor and one (1) Air receiver for each SA compressor. Additionally, one (1) IA receiver shall be installed in BC bay of power house.

Each Air Compressor shall be complete with Intake Air filter cum Silencer, Intercooler, after cooler, Moisture Separator, interconnecting piping, valves, drive motors, instruments and all other accessories.

6.01.02 One (1) no. Microprocessor based control panel in built with each IA and SA compressors as well as for each Air Drying Plant shall be provided. Each built-in control system for the compressors & air dryers shall be complete with necessary Hardware and Software, push buttons, annunciations as needed to make the system completely reliable and efficient.

6.01.03 All Cooling water piping, control air and interconnecting air piping, valves, supports and hangers, instruments as indicated in tender drawings and as required for smooth, reliable and efficient functioning of the system.





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- 6.01.04 One (1) no. air drying plant for each IA & SA compressor shall be provided by the Bidder. Each air drying plant shall be complete with the following accessories:
- i) Air Ejector as applicable.
 - ii) Filters and coolers, as required.
 - iii) Moisture separator with auto drain trap.
 - iv) Rotor drum/Tower loaded with desiccant and drive motor, as required.
 - v) Dryer container/tower.
 - vi) Regeneration line control valve
 - vii) Regeneration air cooler.
 - viii) All inter-connecting/integral piping, valves, trap stations with by-pass valves at drains, fittings, flanges, gaskets, etc.
 - ix) Instrument and controls.
 - x) Interconnecting wiring.
 - xi) Differential pressure indicator.
 - xii) One (1) dew point indicator.
- 6.01.05 Supporting structures, base plates, support plates, foundation/ anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts, etc. as needed for efficient installation and handling of equipment.
- 6.01.06 All interconnecting piping, instrument air and service air distribution piping, valves, supports and hangers, drains, instruments etc. as indicated in the tender drawing nos. 12A05-DWG-M-001S, 12A05-DWG-M-001L and 12A05-DWG-M-001M.
- 7.00.00 **DESIGN AND CONSTRUCTION**
- 7.01.00 The Compressors shall be designed to deliver the nominal capacity at the required delivery pressure as mentioned in Annexure-A of this section.
- 7.02.00 The design shall be such as to ensure trouble free operation with least vibration and noise. Suitable acoustical treatment will be provided to ensure the noise level within permissible limits as specified in Vol-IIA. Different parts of the compressor and accessories shall be arranged neatly in a compact manner. Due consideration shall be given for easy accessibility and maintenance of the compressors.





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- 7.03.00 The compressors shall be non-lubricated, oil free, horizontal, multi-stage water cooled, electric motor driven screw type, heavy duty and rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.
- 7.04.00 Unless inconsistent with this section, equipment from the standard range of manufacture of the Bidder shall be preferred.
- 7.05.00 Compressor components shall be interchangeable as far as possible. Material of construction shall be suitable for the service.
- 7.06.00 Design capacity, outlet pressure and the material of construction for various parts of the compressor and accessories shall be as specified in Annexure-A enclosed with this section.
- 7.07.00 **Compressor casing, rotor and shaft**
- 7.07.01 Compression chamber wall thickness shall be such that to withstand maximum design pressure.
- 7.07.02 During maintenance of compressor suitable arrangement for cleaning of the cooling water jackets shall be provided.
- 7.07.03 Dynamically balanced, one-piece Rotor construction with a symmetric profile to keep leakage loss to a minimum and ensure high efficiency.
- 7.07.04 Rotor shaft mounted, highly precise timing gears shall be designed to counter the axial forces incurred in compression.
- 7.07.05 The rotor and shaft shall be of single piece construction, made of forged steel with suitable corrosion resistant coated material to minimize leakage and wear (AISI C1141 or equivalent). The stator (casing) shall be of Cast-Iron Construction with corrosion resistant material and with integral jacket cooling.
- 7.07.06 The shaft sealing and retainers shall be free for radial self-adjustment on the rotor shafts.
- 7.07.07 The seal rings and retainers shall be of stainless steel construction. The seals shall prevent air and oil leakage along the shaft. Air vented from second stage discharge end seals shall provide buffer air to the other seals to prevent migration of oil towards the compression chamber under all operating conditions.
- 7.07.08 The gaskets shall be of asbestos free material.
- 7.07.09 Use of Oil lubricated anti friction type bearings to be at least 8000 running hours.





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7.08.00 Lubrication System

7.08.01 The compressor package shall include a lubricant management system which shall lubricate the bearings and seal. By the design, the compressor chamber (screw rotor housing) is totally separated from bearing / gear chamber.

7.08.02 The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided if required by the manufacturer to supply pre-start and shut down system. All lube oil pumps shall be of rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system will be protected by a relief valve.

7.08.03 The heat exchanger for lube oil cooler shall be water cooled. The heat exchanger shall be located within the enclosed compressor skid.

7.08.04 The fouling factor shall be considered as per the recommendation of TEMA.

7.08.05 The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors.

7.08.06 The cooler shall be designed in accordance with the requirement of IS-2825.

7.08.07 Due consideration for the differential expansion of shell and tube shall be given in the design of the coolers.

7.09.00 Gear Box

7.09.01 Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position. Gears shall have a rating of AGMA-12 or equivalent.

7.10.00 Inter Cooler, After Cooler and Moisture Separator

7.10.01 Inter-cooler shall be located between the low and high-pressure stages, if required, to reduce overall power consumption. Design performance shall be in accordance with Manufacturer's Standard and wall thickness of tubes and expansion joints shall ensure maximum trouble-free service for long period.

7.10.02 Design of intercooler and after cooler shall be such as to keep the Cooling Water pressure drop within limits and complete leak tight condition for long period of service time.

7.10.03 After-cooler at each compressor discharge shall be water cooled and supplied by the Bidder. It shall be located after compressor discharge to bring the outlet temperature of the compressed air within 10°C, of the cooling water inlet temperature. The moisture separator to be provided on after cooler air outlet shall have suitable internal baffling for removal of moisture and oil. Necessary safety valves shall be provided on inter coolers and after coolers.





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- 7.10.04 Inter-cooler, After-cooler and Moisture Separator shall be provided with Auto trap stations including strainer, bypass and double isolating valves for the traps. A level gauge glass with isolating cock shall be provided near the bottom of moisture separator. Automatic traps shall be of reputed make and shall be of float type suitable for intended services. Y-strainer of 20 mesh screen of stainless steel shall be placed before each trap.
- 7.10.05 The water cooled after coolers and intercoolers shall be shell and tube type. The intercooler shall have air in shell side and water in tube side to add surge volume for reducing air pulsation before the second stage.
- 7.10.06 The shell, tubes, tube sheets and expansion joints with tube sheets particularly at flange portion etc. of the heat exchangers shall be designed to withstand the maximum working pressures encountered. Necessary allowance for corrosion shall be provided.
- 7.10.07 The tube nest shall be removable type to facilitate cleaning and maintenance.
- 7.10.08 Intercoolers/After coolers shall be provided with supports, which are designed to avoid undue stress or deflection in support or body of the equipment.
- 7.10.09 Due consideration for the differential expansion of shell and tube shall be given in the design of coolers.
- 7.10.10 Necessary drain and vent nozzles shall be provided for intercooler and after cooler.
- 7.11.00 **Air Receiver**
- 7.11.01 Air receiver(s) shall be in accordance with IS-2825 or ASME Sections-VIII Div.I and IS-7938.
- 7.11.02 The design pressure, capacity and other parameters shall be as specified in Annexure-A of this section.
- 7.11.03 The air receiver shall be vertical self-supporting cylindrical vessel with torispherical dished ends and with supporting stand for resting on the Civil foundation in accordance with Annexure-A enclosed with this section.
- 7.11.04 Receivers shall be of welded construction with minimum number of joints. Longitudinal seams in adjacent sections of shell shall not be in the same line.
- 7.11.05 All welding shall be performed in accordance with relevant codes. Filler material that will deposit weld metal with a composition and structure as near as that of the material being welded shall be used. The electrodes shall be dried in oven immediately before use to ensure freedom from porosity.
- 7.11.06 Receivers shall be provided with required number of nozzles, the orientations of which shall be subject to approval by the Purchaser. At least two gasketed inspection holes shall be provided for receivers up to 600 mm diameter. For larger diameter manhole of minimum 450 mm diameter shall be provided.





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All openings shall be placed as far as possible from welded seams and in no instance shall pierce the seam.

- 7.11.07 Receivers shall be provided with one or more safety relief valves of proper capacity so that the maximum working pressure of the system is not exceeded under any circumstance. Unless otherwise mentioned, each receiver shall be provided with at least one pressure gauge and one temperature gauge of proper range and required number of pressure switches for compressor control purposes.
- 7.11.08 Each air receiver drain connection shall be provided with automatic no air loss type drain valve for automatic removal of drain consisting of valve, strainer, double isolation and bypass valves.
- Each Air Receiver should have air release vents at the top to facilitate statutory hydraulic tests as per IS-7938.
- 7.11.09 Receiver shall be heat-treated in accordance with BS-5169.
- 7.12.00 **Intake Air Filter and Silencer**
- 7.12.01 Filters with multiple elements and quick removal type for easy cleaning to be provided at suction of each air compressor and shall also be of heavy-duty dry type. Oil bath type shall not be acceptable for non-lubricated compressors.
- 7.12.02 The filters shall be complete with integral silencers and all other accessories. The filtering elements shall be easily removable for cleaning or for replacement.
- 7.12.03 The filters shall be designed for an efficiency of not less than 95% for particles 1 microns and larger.
- 7.12.04 The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirements in Volume-IIA.
- 7.12.05 Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold.
- 7.12.06 If filter after receiver is specified in Attachments/Annexures, the same shall be provided to remove the bulk of moisture and other contaminants entrained in the air stream.
- 7.13.00 **Drive Unit**
- 7.13.01 The compressors shall be driven by constant speed squirrel cage induction motor unless otherwise specified in Annexure-A of this section. For determining the output rating of driver, general guidelines as indicated in Cl. no. 5.14.00 of this section and Volume II-F/1 & F/2 of this specification shall be followed.





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- 7.13.02 For other types of connection between drive unit and compressor, suitable flexible coupling shall be provided.
- 7.13.03 Necessary guard shall cover all exposed moving parts.
- 7.13.04 Motor speed torque curve shall match with that of the compressor for trouble free start up.
- 7.13.05 Motor shall be suitable for eight (8) equally spreaded starts per hour.
- 7.14.00 **Moisture Separator**
- Moisture separator shall be of high efficiency design & no air loss type and provided with vent nozzle and auto drain trap system.
- 7.15.00 **Air- Drying Plant**
- 7.15.01 Air-drying plant shall be of heat of compression desiccant type, drying by adsorption method.
- 7.15.02 Reactivation shall be done by Heat of compression method without any air purge loss. Hot unsaturated compressed air shall be used for regeneration of exhausted desiccant in ADP.
- 7.15.03 Air dryer shall be Indoor located.
- 7.15.04 All pressure vessels shall be designed as per IS: 2825 or equivalent code.
- 7.15.05 All vessels shall be included with required manholes/hand holes.
- 7.15.06 All hot vessels & pipelines to be insulated to restrict the outside temperature within 60°C with mineral wool (or equivalent).
- 7.15.07 Quantity of desiccant to be calculated taking into account residual moisture content at the end of regeneration cycle. Design calculation with curves shall be submitted for approval of Owner.
- 7.15.08 Desiccant filling and removal connections shall be provided.
- 7.15.09 Complete ADP equipments shall be preferably mounted on a skid.
- 7.15.10 Required sample connections in piping shall be provided for sampling of air at desired locations.
- 7.16.00 **Pressure Vessels**
- 7.16.01 All pressure vessels shall be designed as per IS : 2825 or approved equal.





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- 7.16.02 The vessels shall be of self supporting construction. All welding materials and procedures shall be as per IS: 2825 or approved equal.
- 7.16.03 Each vessel shall be provided with suitable air-tight manhole and other connections as required.
- 7.16.04 Relief valves of adequate capacity shall be provided for each vessel. Relief valves shall be provided with hand lever. The valves shall be of stainless steel construction.
- 7.16.05 Internal surfaces of all the vessels shall be suitably protected against corrosion and rusting. Corrosion allowance of 2.5 mm shall also be provided on shell and dished end thickness.
- 7.16.06 Draining trap station complete with Auto drain trap, isolation and by-pass valves and Y-strainer shall be provided for the moisture separator.
- 7.17.00 **Solenoid Valves and Multiway Valves**
- 7.17.01 The solenoid valve shall be of approved make. The solenoid valves shall have heavy duty, double impregnated tropicalized coils (Single or double solenoid as required) and shall be suitable for the operating temperature and for operation continuously energised, in a tropical climate.
- 7.17.02 The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy moulded type, Class-F. The enclosure shall conform to NEMA-4X standard.
- 7.18.00 **Drives and Mounting**
- 7.18.01 All relevant details pertaining to drives shall generally comply with the stipulations laid in Volume II-F/1 & F/2.
- 7.18.02 All the components of the Air Drying plant including the strainers, filter, interconnecting piping, valves, fittings, control panels, etc. shall be mounted on a common fabricated steel base frame to form a self contained unit.
- 7.19.00 **Interconnecting Piping, Valves and Fittings**
- 7.19.01 Pipelines shall be selected as per IS-6206/equivalent standard. Piping in airlines and cooling water lines up to 50 NB shall be socket welded and 65 NB and above shall be butt-welded and flanged type.
- All interconnected air piping and cooling water piping etc., as indicated in tender drawings shall be furnished by the Contractor, complete with valves, fittings, pipe supports as necessary. The piping shall be as per the Codes/ Standards specified in Annexure-A enclosed with this section.





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- 7.19.02 The air discharge piping shall be full size of compressor outlet or larger, short and direct with minimum number of fittings. Only long radius elbows shall be used where bends are unavoidable. The velocity of compressed air in pipe shall be limited within 20 to 30 m/sec.
- Any pocket in compressed air and interconnecting air piping shall be provided with drain connection complete with automatic trap station.
- Long runs of vertical piping at compressor discharge shall not be acceptable.
- The layout shall be such as to prevent resonance. Provision of thermal expansion of hot pipes shall be made.
- All pipe connections with equipment shall be flanged type. All pressure gauges/switches shall be complete with root valves and all temperature elements shall be mounted in a proper thermowell.
- All instruments, safety valves etc. as shown in tender drawings shall be furnished on the piping.
- 7.19.03 For water cooled compressors, cooling water shall normally be piped through the intercooler and after cooler in parallel. From the intercooler, the water shall be taken to cylinder jackets. A solenoid valve shall be provided on the water inlet line for interlocked starting of compressors. Where provision for automatic water flow regulation by thermostatic valve has been made, a suitable bypass arrangement to the valve shall be made so that flow to the cylinder is ensured under all circumstances.
- The velocity in water pipes shall be limited to 2.0 Metres/Sec.
- Sight flow indicators shall be provided on water discharge from each cylinder, intercooler and after cooler.
- 7.19.04 Valves to be supplied for compressed air service and DMCCW service shall be as per Annexure-A.
- 7.19.05 All traps shall be float operated. All traps shall be of auto drain type to drain out moisture at regular intervals. The body and cover shall be of cast iron/solid steel construction and internals shall be of SS. Isolating valves shall be of stainless steel.
- 7.19.06 All strainers shall be Y-type with suitable blow-off plugs. The body material shall be cast iron. The screen shall be of stainless steel with 40 mesh openings.
- 7.19.07 Complete piping system shall be provided with adequate supporting arrangement to avoid undue forces and moments at the equipment terminals and vibration.





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7.19.08 All other pipes and equipment conveying hot air shall be properly insulated to limit outside surface temperature to 60°. The insulating material shall be glass or mineral wool as per IS-3690/IS-3677/equivalent with chicken wirenet and 22 gauge aluminium cladding.

7.20.00 Dew Point Indicator

Dew point indicator shall be digital type for spot measurement of dew point of air. The specification of the meter shall be as follows:

- a) Range : (-) 40 °C to (+) 20 °C
- b) Accuracy : ± 0.1 °C

Dew point monitoring facility shall also be provided in local Control Panel as well as in unit DCS operator work station.

7.21.00 Automatic Drain Valve

- i) Type : No air loss, electronically controlled level, controlled version.
- ii) Operation : Continuous
- iii) Air flow (free air delivery) : By Bidder
- iv) Air pressure : 8.5 bar g
- v) Ambient temperature (max.) : 50 Deg.C
- vi) Maximum pressure : 16 bar (g)
- vii) Drain connection : 1 inch from back side
- viii) Power supply : 230 V/single phase/50 Hz

8.00.00 CONTROL & INSTRUMENTATION

8.01.00 Control, protection & interlocking system for individual compressors shall be achieved through skid mounted proprietary microprocessor based controllers with colored Graphic User Interface (GUI) with LCD/ LED screen based display unit, control switches and other operational keys. The control system together with the power supplies and other accessories will be located within the local panel.

8.02.00 C&I system shall comprise of the following facilities:

8.02.01 Local push button switches for the compressors and cooling water line valves to start or stop manually, local load selector switch for selecting the base load





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compressor and standby compressor, ammeter, indicating lamps, bearing and winding temperature scanner for the compressor drivers, fault wise annunciation for each etc.

- 8.02.02 Compressor control systems of unit#5 shall be interfaced with the unit # 3&4 DCS. Since, the compressors of unit #5 will be connected to existing compressed air header, any loss of header pressure for what so ever reason including failure of unit#5 compressors, will automatically start the standby compressor with the help of existing control system of units #3&4. However, the status of all compressors including the same of unit#3&4 shall be available at unit#5 control room.
- 8.02.03 Each compressor shall be operated independently from its own microprocessor based control system having hardware/software interface with unit#3&4 DCS. However, provision shall be also made to operate & monitor the Compressors from the unit #5 DCS also.
- 8.02.04 Local control panel for air drying plant will house the start/stop push button switch of compressor, temperature indicator for dry air line and annunciation system.
- 8.02.05 Necessary & suitable instrumentation as required to achieve the operation philosophy as indicated here-in and as illustrated in the flow diagram and V.IIE/ Section-V of the specification shall be provided as minimum requirement for the system.
- 8.03.00 **Control Concept of Compressors**
- 8.03.01 Each compressor shall be controlled by dual control method to maintain receiver pressure within narrow limits. Dual control method permits the operation of a compressor in either of the two following ways:
- Continuous run load - unload control.
 - Automatic start/stop control.

One selector switch for each compressor shall be provided in the control panel to achieve any of the above controls. Each selector switch shall have three positions : "base duty" (Load-Unload control), "Standby duty" (Auto-start/stop control) and "Stop". Each compressor shall operate in 50% or 100% load under load/unload mode of control depending on system demand. The compressors shall be primarily controlled from local control panels and status indication of the same shall be provided on local control panel as well as on the operators' station in central control room (CCR). Other details of control concepts are elaborated in Volume II-E.

As the IA & SA compressors of Phase-II & III shall operate in parallel to feed the compressed air demand of units of both Phase-II & III, accidental trip of any compressor shall be sensed by low pressure in the header & accordingly common stand by compressor shall be started to meet the short fall.





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8.04.00 Control System Description

Please refer V.IIE/ Section-V of this specification.

8.05.00 Interfacing With Plant DCS

Individual proprietary control systems will be interfaced with existing phase II DCS through software link. Phase II DCS shall be interfaced with unit#5 DCS via Network Bridge. Hardwired signals of the new systems shall be terminated in the new Phase-III unit DCS.

8.06.00 Indication/ Annunciation System

8.06.01 The following Minimum signals shall be indicated in DCS:

- a) Status of each compressor
- b) Instrument air pressure Low / High
- c) Service air pressure Low / High
- d) Dew point of compressed air
- e) Status of each ADP
- f) Compressor header pressure
- g) Receiver Pressure
- h) Instrument Air Flow
- i) Service Air Flow

8.06.02 The following Trip / Annunciations shall be provided in individual compressor panel:

- a) Motor Overload
- b) Compressor Discharge Air Temperature High for each stage.
- c) Lube Oil Temperature High.
- d) Lube Oil Pressure Low.
- e) Control Supply Failure.
- f) Compressor Cooling Water Flow Low.
- g) Compressor Motor Winding Temperature High / High High.
- h) Compressor Motor Bearing Temperature High / High High.
- i) Compressor Tripped
- j) Compressor Emergency Stopped

8.06.03 Following minimum indication lamps shall be provided on the Dryer Control panel:





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- a) Power On.
- b) Dryer Trouble.
- c) Power Supply Failure.

8.07.00 **Interlock**

8.07.01 The following safety interlocks shall be provided for the compressed air system:

- a) Compressor trip on low lube oil pressure.
- b) Compressor trip on high air temperature at compressor discharge.
- c) Compressor trip on high cylinder jacket water temperature (for water cooled compressors).
- d) Compressor start only after coolant flow is established.
- e) Compressor trip due to low cooling water flow.
- f) Any other interlock as required for safe and reliable operation of the system.

8.07.02 All pressure and temperature conditions used for tripping the compressor shall be provided with pre-trip annunciation in the local control panel.

9.00.00 **INSPECTION AND TESTING**

9.01.00 The Successful Bidder shall carry out the following specific tests and inspections to ensure that the equipment furnished shall conform to the requirements of this section and in accordance with relevant codes and standards.

9.02.00 Material identification of compression chambers, rotor, rotor shaft, suction and delivery valves constituting the compressors and all parts of intercoolers, aftercoolers, moisture separators, air receivers, strainers, filters, all interconnecting air and water piping with valves and all other parts and accessories that could not spelt out in this clause.

9.03.00 Hydrostatic testing of compressor, intercoolers, after coolers, moisture separators, air receivers, strainers, filters, all interconnecting air and water piping with valves and all other applicable pressure parts that could not be spelt out in this clause. Hydrostatic testing shall be carried out at 150% of the design pressure for at least one (1) hour, unless contradicted by the relevant test code.

9.04.00 Specific tests to be carried out for each compressor





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- 9.04.01 Non-destructive testing of rotors, rotor shaft and all other applicable parts.
- 9.04.02 Type test/Routine tests for all the air compressors as per IS-5456. All performance tests for compressors shall be carried out with actual motor being furnished. Routine tests shall include the following tests and measurements :
- a) Capacity (Free Air delivery)
 - b) Speed
 - c) Specific power consumption
 - d) Volumetric and overall efficiency of machine
 - e) Test of loading and unloading mechanism
 - f) Any other test deemed necessary for the system
- 9.04.03 Dynamic balancing of all rotating components and assembly of each air compressor including all drive motors in the compressed air system.
- 9.04.04 Tests for capacity, pressure drop and efficiency of each Intake Air Filter with silencer shall be as Manufacturer's standard. These tests shall be conducted along with performance testing of each compressor.
- 9.05.00 Dew Point tests to be carried out on each Air Drying Plant.
- 9.06.00 Spot radiography of all weld parts shall be tested for all pressure parts and vessels.
- 9.07.00 Testing of all drive motors and control panels in the compressed air system shall be as outlined under Volume V of this specification.
- 9.08.00 Any other test deemed necessary for the system.





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- 10.00.00 **DRAWINGS/DOCUMENTS, DATA & INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH THE TECHNICAL OFFER**
- 10.01.00 The Bidder shall furnish along with his proposal following specific drawings/documents/data as asked for in this section.
- 10.01.01 P&I Diagram.
- 10.01.02 Preliminary Layout drawing.
- 10.01.03 Calculations establishing the rated pressure, FAD capacity of compressors and characteristic curves showing efficiency against capacity, capacity of Air Receivers and ADPs.
- 11.00.00 **DRAWINGS/DOCUMENT, DATA, AND MANUALS TO BE FURNISHED AFTER AWARD OF CONTRACT**
- 11.01.00 Final version of all drawings/data/information asked for in clause 10.00.00 above (for approval purpose except characteristic curves).
- 11.02.00 Certified dimensioned general arrangement drawing; detailed cross-sectional drawing with parts list and details of material; piping layout drawings for Compressed Air System.
- 11.03.00 Foundation drawings with dead load, operating load and other design data.
- 11.04.00 Functional logic diagram showing operational philosophy, inter lock and protection for the compressed air system.
- 11.05.00 Complete design calculations for heat exchangers, moisture separator, air receiver, etc.
- 11.06.00 Local panel layout and complete electrical schematic drawings for instrumentation and control.
- 11.07.00 Detailed list of Instruments showing make, size, range, tag nos. etc.
- 11.08.00 Bill of material indicating tag nos., type, sizes, working pressure, material of construction, quantity etc. of the following:
- a) Pipe
 - b) Valves and
 - c) Fittings
- 11.09.00 Detailed test reports, certified performance curves as required for all the applicable equipment in Compressed Air System.
- 11.10.00 Quality assurance plan, datasheet, flow diagram and final layout drawing (for approval purpose).





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ANNEXURE-A

SCREW TYPE AIR COMPRESSOR AND AUXILIARIES

A. Performance Data

Free Air Delivery	: 36 Nm ³ /min.
Discharge Pressure	: 8.5 kg/cm ² (g)
Noise level near compressors	: 85 dBA (Maximum)
Vibration limit	: 40 microns
Guaranteed Power consumption at motor input terminals at rated condition	: Bidder to indicate

B. Construction Features

Location	: Indoor
No. of compressors	: One (1) No. of IA compressor + One(1) Nos. of SA compressor.
Type	: Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw compressors.
Service	: Instrument Air and Service Air
Duty	: Continuous
Type of Drive	: Electric Motor
Design ambient for drive	: 50°C
Number of starts per hour	: 8 (equally spreaded)
Type of transmission	: Gear
Anti-vibration arrangement required	: Yes
Maximum temperature for any step during the cycle	: Bidder to indicate
Type of control	: Dual i.e., both load-unload and auto start/stop





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Type of Annunciation : Audio-visual
Flange standard : ANSI B-16.5/equivalent

C. Materials of Construction

Compressor chamber : Cast iron coated with corrosion resistant material
Rotors : Forged carbon steel coated with corrosion resistant material
Bearing : As per manufacturing standard. (Antifriction Bearing)
Timing Gear : Low alloy steel
Base Plate : MS
Inlet throttle valve & housing : Aluminium
Shaft seals : High Alloy Steel
Safety valves : Brass
Water separator : Cast Iron
Blow off valve : Stainless Steel
Unloading Cylinder header : Aluminium
Tube of oil cooler : SS-304
Outer casing of coolers : Carbon Steel
Gear Box : Cast Iron GGG 40 (DIN 1693)
Gears : Alloy Steel

D. Supply of Accessories and Service

Intake air filters with silencers : Yes
Intercoolers : Yes
After coolers with moisture separators : Yes
All instruments as specified, as shown : Yes



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in tender drawing and as required for safe and trouble-free operation of the system

Coupling guards : Yes

Air receivers : Yes

Base plates : Yes

Foundation bolts, nuts, sleeves, inserts etc. : Yes

All interconnecting air and cooling water piping, complete with valves, fittings as shown in relevant tender drawings and as required for reliable and smooth operation of the system : Yes

Eye bolts, lifting tackle, tools, etc. : Yes

Control panels complete with all accessories : Yes

Instrument gauge panels complete with all accessories : Yes

E. DM Cooling Water Data

Quality : Passivated DM Water

Design inlet temperature : 36 °C (normal), 39°C (maximum).

Maximum Allowable temp. rise : 5.5°C

Design pressure : Bidder to indicate. Shall not be less than the shut off head of DMCCW pump.

Normal inlet pressure : Bidder to indicate.

Maximum pressure drop allowable between inlet and outlet points : 7.0 MWC

F. Testing And Inspection

Material Testing and identification : Required

Dye Penetration test : Yes





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Type of performance test to be conducted : Routine test/Type test as per Clause No. 9.04.02 of this section.

Bend Test as per BS 5169 : Yes

Field performance test : Yes

MPI and UT tests : Yes

Spot Radiography for all circumferential and longitudinal butt joints : Yes

All other specific tests as specified in Clause No. 9.00.00 of this section : Yes

G. Drive Motor

Drive motor for compressor shall comply with the requirements of Clause No. 7.13.00 of this section and Volume II-F/1 & F/2 of this Specification.

H. Compressor Accessories

a) Intake Air Filter

Numbers required : One (1) no. with each compressor

Location : Indoor/At the suction of each air compressor

Type : Dry type

Silencer : Yes

Air flow rate : To suit compressor rating

Particle removing efficiency : 99.9% up to particle size of 1 Micron

Maximum allowable pressure drop at stated air flow rate in new condition of filter (viscosity of air at normal ambient temperature) : 150 mm WG

Test requirement : No separate test. Compressor performance testing will include the filters in test set up. Capacity, pressure drop and efficiency shall be measured.





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b) **Air Receiver**

Numbers required	: One (1) for each IA compressor + (1) for each SA compressor+ One (1) IA receiver in B-C bay of power house
Installation	: Outdoor
Type	: Vertical cylindrical with torispherical dished ends.
Design pressure	: 10 Kg/Sq.cm(g)
Hydraulic test Pressure	: 15 Kg/Sq cm(g)
Design code	: IS-2825/IS-7938/ Approved equal
Capacity of each air receiver	: Bidder to compute in accordance with clause no. 5.16.00 of this section. However the water filled volume shall not be less than 10 M ³ under any circumstances.
Material of construction of shell	: IS-2062-Gr. B
Material of construction of dished ends	: IS-2062 Gr. B
Material of construction of flanges	: IS-2062 Gr. B
Supply of Accessories & Services	:
Flanges with nuts, bolts and gaskets	: Yes
Pressure gauge with snubber	: Yes
Pressure switch	: Yes
Temperature indicator	: Yes
Relief valve	: Yes, set pressure shall be at least 10% above working pressure.
Trap station	: Yes
Level gauge	: Yes
Vent valve/plug	: Yes





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Supporting stand with necessary : Yes
foundation bolts, nuts, sleeves,
etc

Eye bolts, lifting tackle etc. : Yes

Painting

i) External : Two coats of red-oxide primer and two
finish coats of synthetic enamel paints.

ii) Internal : Shop painted as per manufacturer's
standard.

Inspection and Testing

Material testing and identification : Yes

Bend test as per BS-5169 : Yes

Spot radiography of circumferential : Yes
and longitudinal butt welds

Field performance test : Yes

D.P. test where radiography : Yes
cannot be done

Hydraulic Test : Yes

Other specific tests as specified in : Yes
Clause No. 9.00.00 of this
specification

c) **Intercooler, After cooler,
Moisture Separator, Piping,
Valves etc. :**

i) After cooler :

Installation : Indoor

Type : Shell and Tube

Relief Valve : Yes

Moisture Separator : Yes



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Trap Station : Yes

Temperature Indicator : Yes

Temperature Switch : Yes

Level Gauge : Yes

ii) Intercooler :

Installation : Indoor

Type : Shell and Tube

Relief Valve : Yes

Trap Station : Yes

Pressure Gauge : Yes

Temperature Indicator : Yes

Temperature Switch : Yes

Moisture Separator : Yes

iii) Supply of Accessories and Services :

Supporting stands with bolts, nuts and gaskets : Yes

Eye bolts, lifting tackle etc with tools and tackle : Yes

Flanged connections for supply and return of cooling water : Yes

iv) Material of Construction :

Tube : Stainless steel

Shell : Mild Steel

Tube Sheet : IS 2002 Gr 2A

Baffles : IS 2062

Flanges : IS 2062

v) Cooling Water Data : Same as mentioned earlier



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vi) Piping, Valves and Fittings for
Compressed Air System :

Pipes for cooling water line, : Stainless steel as per ASTM-A312
compressed air line & GR.304. Size – as per ANSI-B36.19.
interconnecting lines Thickness as per schedule 10S for pipe
sizes up to 50 NB and as per schedule
10S for sizes equal to & greater than 65
NB.

Fittings

Fittings for Cooling water, : Stainless steel as per ASTM-A-351-CF8
compressed air piping & for size 65 NB and above
interconnecting piping

ASTM A-182 F304 for sizes upto 50 NB

Valves for air line : Stainless Steel, SS-304

Valves for cooling water line : Stainless Steel, SS-304
Pipes for cooling water line, : Stainless steel as per ASTM-A312
compressed air line & GR.304. Size – as per ANSI-B36.19.
interconnecting lines Thickness as per schedule 10S for pipe
sizes up to 50 NB and as per schedule
10S for sizes equal to & greater than 65
NB.

Fittings

Fittings for Cooling water, : Stainless steel as per ASTM-A-351-CF8
compressed air piping & for size 65 NB and above
interconnecting piping

ASTM A-182 F304 for sizes upto 50 NB

Valves for air line : Stainless Steel, SS-304

vii) Testing and inspection : As per clause No. 9.00.00 of this section.





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ANNEXURE-B

AIR DRYING PLANT AND AUXILIARIES

A. General Information

Numbers of Air drying Plant	: Two (2) nos. [2W + 0S]
Duty	: Continuous
Operation	: Fully Automatic
Service	: Instrument & Service Air
Installation	: Indoor
Type of Drying	: Adsorption
Type of Reactivation	: Heat of compression type
Outlet dew point	: At least (-) 40°C at 1 atm pressure.
Annunciation	: Local and remote
Location	: Indoor skid mounted

B. Performance Specification

Air drying capacity	: To suit the compressor capacity
Pressure dew point (constant) at prevailing pressure	: By Bidder
Inlet air pressure	: To suit compressor rating
Air flow (Free Air delivery)	: To suit compressor rating
Inlet air temperature	: To be indicated by Bidder
Maximum allowable air pressure drop	: 0.5 kg/sq.cm
Design Requirement	: At least (-) 40°C dew point at outlet (at atm. Pressure). Dust laden not more than 1 ppm, oil free





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C Material

Absorber vessels and its internal	: SS-304
Regeneration air cooler shell & tube sheet	: SA-285 Gr. C or equivalent
Relief valves	: Brass or SS
Tube of Heat exchanger	: SS
Desiccant	: Activated Alumina/Silica Gel.

D Supply of accessories And Services For Each ADP

Pre-filters and After Filters	: 2 x 100% with automatic drain trap filter arrangement & with ceramic candle type
Dew point indicator	: Yes
Instruments as per specification, Tender drawing and as required for safe and trouble free operation	: Yes
Control panel with accessories	: Yes
Tools and tackle	: Yes
Spare parts	: Yes
All interconnecting piping complete with fittings, valves etc	: Yes
Insulation	: Yes
Base frame, foundation bolts, nuts, sleeves etc.	: Yes
Vessel internal point	: Anti-corrosive
Shop painting	
i) Internal	: Anti-corrosive heat resistant paint
ii) External	: 2 coats of red-oxide primer





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E Inspection And Testing

Non destructive material test	: Yes
Hydrostatic test	: Yes
Performance tests at shop	: Yes
Performance tests at site	: Yes
Spot Radiography of welds parts to be tested	: All pressure parts and vessels
Dye Penetration test	: Yes



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SECTION: VIII

**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS AND VALVES**



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SECTION - VIII

PIPING, FITTINGS & VALVES

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacturing, inspection, shop testing, erection, testing and commissioning at site of all the piping, fittings, valves and all other accessories as specified and as further required.

2. 00.00 SCOPE

The items & materials to be supplied shall include but not be limited to the following:

- 2. 01.00 Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.
- 2. 02.00 Gaskets, ring joint, backing rings, jointing material etc. as required.
- 2. 03.00 Instrument tapping connection, stub and thermowells.
- 2. 04.00 Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary.
- 2. 05.00 Valves and Isolation Gates, to start/stop and control / regulate flow.
- 2. 06.00 Strainers.
- 2. 07.00 Anchor blocks (for buried / over ground piping), support brackets, clamps, support trestles, hangers, vibration dampener etc. for the piping under the scope of contract.
- 2. 08.00 Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points.
- 2. 09.00 Steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for underground / above ground pipes.
- 2. 10.00 Painting, anti-corrosive coatings, etc. inside and outside of pipes as necessary and as specified.
- 2. 11.00 All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the Bidder.



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3. 00.00

CODE & STANDARDS

The design, manufacture, fabrication shop testing & inspection, erection, testing and commissioning of piping fittings and valves shall conform to the latest revisions of the following Indian / International codes / standards and other applicable statutory codes / ordinances, rules, regulations as well as safety codes, in addition to other codes / standards if any as addressed elsewhere in the Tender Specification.

Other National / International Standards may also be considered acceptable (subject to specific approval by Purchaser) with reference to any specific situation / requirement provided they are recognized to be equivalent or superior to the Standards as stipulated in the Tender Specification.

ANSI	- B 16.5	: Steel pipe flanges and flanged fittings.
ANSI	- B 16.9	: Wrought steel Butt welding fittings
ANSI	- B 16.11	: Forged steel socket welding and screwed fittings
ANSI	- B 16.21	: Non Metallic Gaskets for Pipe Flanges
ANSI	- B 16.25	: Butt welding ends
ANSI	- B 16.28	: Wrought Steel Butt Welding short radius elbows and returns
ANSI	- B 31.1	: Power Piping code.
ANSI	- B 36.10	: Welded & seamless wrought steel pipe
ANSI	- B 36.19	: Stainless steel pipe
API	- 5L	: Specification for Line Pipe
ASME	- Section II	: Ferrous Materials Specification
ASTM	- A 53	: Seamless carbon steel.
ASTM	- A 106	: Grade C Seamless carbon steel pipe.
ASTM	- F441 / F441M - 09	: Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM	- F439 - 11	: Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
AWWA	- C-203	: Coal tar protective coatings and linings for steel water pipe lines - Enamel and Tape - Hot Applied



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AWWA	-	C-208	: Dimensions for Steel Water pipe fittings
AWWA	-	C-504	: Standard for butterfly valve.
BS	-	1868	: Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
BS	-	5158	: Specification for cast iron plug valves
BS	-	5353	: Specification for steel plug valves
BS EN	-	593	: Industrial valves. Metallic butterfly valves
BS EN	-	1796	: Plastics piping systems for water supply with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)
BS EN	-	13397	: Industrial valves. Diaphragm valves made of metallic materials
BS EN	-	13789	: Industrial valves. Cast iron globe valves
BS EN	-	14364	: Plastics piping systems for drainage and sewerage with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints
BS EN ISO	-	16138	: Industrial valves. Diaphragm valves of thermoplastics materials
DIN	-	16966	: Glass fibre reinforced polyester resin (UP-GRP) pipe fittings and joint assemblies - Requirements for and testing of bushes, flanges, and flanged and laminated joints
IS	-	210	: Grey Iron Castings
IS	-	318	: Lead Tin Bronze Ingots and Castings
IS	-	458	: Precast Concrete Pipes (with and without reinforcement).
IS	-	554	: Pipe Threads where Pressure Tight-Joints are made on the Threads – Dimensions, Tolerances and Designation.
IS	-	778	: Copper Alloy Gate, Globe and Check Valves for Waterworks Purposes.
IS	-	783	: Code of Practice for Laying of Concrete Pipes.





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IS	- 1239 Part 1	: Steel Tubes, Tubulars and other Wrought Steel Fittings - Specification Part 1 Steel Tubes
IS	- 1239 Part 2	: Specification Steel Tubes, Tubulars and other Steel Fittings Part 2 Steel Sockets Tubular and other Steel Pipe Fittings
IS	- 1363	: Hexagon Head Bolts, Screws and Nuts of Product Grade C.
IS	- 1364	: Hexagon Head Bolts, Screws and Nuts of Product Grades A and B.
IS	- 1367	: Technical Supply Conditions for Threaded Steel Fasteners.
IS	- 1536	: Indian Standard for Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage.
IS	- 1537	: Vertically Cast Iron Pressure Pipes for Water Gas and Sewage.
IS	- 1538	: Cast Iron Fittings for Pressure Pipes for Water, Gas and Sewage.
IS	- 1703	: Water Fittings - Copper Alloy Float Valves (Horizontal Plunger type)
IS	- 1879	: Malleable Cast Iron Fittings
IS	- 2016	: Plain washers
IS	- 2062	: Hot Rolled Low, Medium and High Tensile Structural Steel.
IS	- 2629	: Recommended practice for Hot dip galvanising of iron and steel
IS	- 2633	: Method for testing uniformity of coating on zinc coated articles.
IS	- 2379	: Colour Code for Identification of Pipe Lines.
IS	- 2685	: Code of Practice for Selection, Installation and Maintenance of Sluice Valves.
IS	- 2712	: Gaskets and Packings- Compressed Asbestos Fibre Jointing.





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IS	- 2825	: Code for Unfired Pressure Vessels.
IS	- 3006	: Chemically Resistant Glazed Stoneware Pipes and Fittings.
IS	- 3042	: Single Faced Sluice Gates (200 to 1200 mm size).
IS	- 3114	: Code of Practice for Laying of Cast Iron Pipes.
IS	- 3589	: Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter).
IS	- 4038	: Foot Valves for Waterworks Purposes.
IS	- 4682 (Part I)	: Code of practice for lining of vessels and equipment for chemical - rubber lining.
IS	- 4736	: Hot-dip Zinc Coatings on Mild Steel Tubes.
IS	- 4984	: High Density Polyethylene Pipes for Potable Water Supplies.
IS	- 4985	: Unplasticized PVC Pipes for Potable Water Supplies.
IS	- 5312	: Swing Check Type Reflux (non-return) Valves for Water Works Purpose.
IS	- 5822	: Code of practice for laying of electrically welded steel pipes for Water supply.
IS	- 8062	: Code of practice for cathodic protection (Part-II) of steel structure
IS	- 10221	: Code of practice for coating and wrapping of underground mild steel pipes
IS	- 14846	: Sluice Valve for Water Works Purposes (50 to 1200 mm Size).

4. 00.00 DESIGN, MANUFACTURE, FABRICATION AND ERECTION

4.01.00 The piping system, fittings and accessories supplied shall conform to high standards of engineering, design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to Purchaser.

4.02.00 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years and shall withstand the operating parameter fluctuations and cycle variations which can be normally expected during this period.





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4.03.00 Material of construction for pipes under different services shall be as below:

Service	Recommended Material of Construction
River Water	Carbon Steel
Clarified Water	Carbon Steel
Filtered Water	Carbon Steel (inside rubber lined)
Degassed Water	Carbon Steel (inside rubber lined)
Demineralised Water	Carbon Steel (inside rubber lined)
Service Air	Galvanized Steel
Instrument Air	Stainless Steel (schedule 40)
Potable Water	Galvanized Steel
Chlorine (liquid under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine (dry gaseous under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine under vacuum	CPVC (schedule 80)
Chlorine in water	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Sodium Hydroxide Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Alum Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Lime Solution	Galvanized Steel
Polyelectrolyte Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Hydrochloric Acid (concentrated)	Carbon Steel (inside rubber lined)
Hydrochloric Acid (dilute)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (concentrated)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (dilute)	Carbon Steel (inside rubber lined)
Sulfuric Acid Solution (concentrated)	Carbon Steel
Sulfuric Acid Solution (dilute)	Carbon Steel (inside rubber lined)



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Service	Recommended Material of Construction
Scale Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Corrosion Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Biocide Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Filter Backwash Wastewater	Carbon Steel
Ammonia Solution	Seamless Stainless Steel (304 grade)
Hydrazine Solution	Seamless Stainless Steel (304 grade)
Oxygen Line	Aluminum
Crude Condensate	Carbon Steel (inside rubber lined)
Treated Condensate	Carbon Steel (inside rubber lined)
Demineralized Water with ion exchange resins	Stainless Steel (304 grade)
Non Oily Sludge	Cast Iron (underground) Carbon Steel (overground)
Neutralized Wastewater	Carbon Steel (inside rubber lined)
Cooling Tower Blowdown	Carbon Steel
Boiler Blowdown	Carbon Steel
Crude Oily Wastewater	Seamless Carbon Steel
Treated Oily Wastewater	Seamless Carbon Steel
Rainfall Runoff	Carbon Steel
Equalized Wastewater	Carbon Steel
Oily Sludge	Seamless Carbon Steel

The portion of pipe lines at the downstream of isolation valves, conveying flushing water shall be of the material & type same as those of the pipelines which are being flushed.





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4.04.00 Material & Dimensional Standards for Piping and Fittings

4.04.01 The welded Carbon Steel Pipes shall conform to the following codes / standards:

Pipes	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 80.	IS-1239 Part-1. Plain ends for Socket Welding.
65 mm to 150 mm NB	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-1239 Part-1. Bevelled ends for Butt Welding.
200 mm to 450 mm NB	Mild Steel, ERW, IS-3589 Grade Fe 410 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-3589. Bevelled ends for Butt Welding.
500 mm NB and above	Rolled and Butt Welded from IS-2062 Grade A plates or SA-285 Grade C or Equivalent (subject to approval by Purchaser). / Spiral Welded pipes.	IS-3589. Bevelled ends for Butt Welding.
Elbows (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Forged carbon steel from ASME-SA 105 / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm to 350 mm NB	ASME SA-234 Grade WPB	BW ends to ANSI-B 16.9 / IS-1239 Part-2.



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Mitre Bends (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
400 mm NB and above	Fabricated from parent pipe.	ANSI-B 31.1 / AWWA-C 208. 90° - 3 cut, 4 piece constructions. 45° - 2 cut, 3 piece constructions.
Tees	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged Carbon Steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type).	ANSI-B 16.9
Reducers	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged carbon steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type)	ANSI-B 16.9



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Slip On Flanges / Blind Flanges	Material Code / Standard	Dimension Code / Standard
All sizes	IS-226 / IS-2062 Grade A / ASME-SA 105 / ASTM-A 216 Grade WCB. Flanges shall be either machined or forged from plate / casting.	Dimensions / Drilling as per ANSI-B 16.5, Pressure rating 150# / 300# or otherwise as applicable, generally Flat face.
Bolts & Nuts	Material Code / Standard	Dimension Code / Standard
All sizes	IS -1367 Cl 4.6 for bolts IS-1367 Cl 4 for nuts	IS -1367
Gaskets	Material Code / Standard	Dimension Code / Standard
All sizes	3 mm thick wire reinforced rubber. Material shall contain no asbestos.	ANSI-B 16.21.

- 4.04.02 Seamless Carbon Steel Pipe shall conform to ASTM-A 106 Grade C (Schedule 80) / ASTM-A 53 / API 5L. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.03 Galvanized Steel Pipes and Fittings shall conform to the clause 4.02.01 above and be galvanized to IS-4736. Ends of all fittings will however be screwed as per IS-554. Mitre Bends shall not be used. Pipe joints shall be screwed for lower size and flanged for higher size. No hot work on G.I. pipes shall be done. Flanges shall be screwed and hot dipped galvanized.
- 4.04.04 Pipes and Fittings which shall be rubber lined, need to conform the clause 4.02.01 above. The inside surfaces of the items shall be completely debaded and made suitable for lining. The items will be inside rubber lined with 3 mm thick (minimum) natural rubber in two layers as per IS-4682. Flanges shall be flat face as per ANSI-B 16.5 and full face rubber lined. Pipe to Pipe joint will be flanged only. For small size fittings, SS-316 fittings shall be used if rubber lined carbon steel fittings are not available.



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- 4.04.05 Stainless Steel Pipe shall conform to ASTM-A 312 of specified grade (Schedule 40) with dimensions as per ANSI-B 16.39. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe. Mitre Bends shall not be used. Elbows / Tees / Reducers shall be of Forged Stainless Steel (ASME-SA 182) with SW ends to ANSI-B 16.11 (3000#).
- 4.04.06 Cast Iron pipes shall conform to IS-1536. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.07 PVC Pipes shall conform to IS-4984 Class 4. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.08 High density Polyethylene Pipes shall conform to IS-4984 Class 5. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.09 CPVC pipe (Schedule 80) shall be produced from compounds which conform to and are specified in ASTM-D 1784. CPVC Pipe shall be manufactured in strict compliance with ASTM-F 441. Pressure-Rated CPVC Pipe shall be manufactured in strict compliance with ASTM-F 442. All CPVC piping shall be manufactured from NSF approved compounds and NSF Listed for potable water use. CPVC Fittings (Schedule 80) shall be as per ASTM-F 437 and F 439.
- 4.04.10 Pipe lines carrying water, chemicals, air etc. shall be sized generally based on the following ranges of velocities. However pipe size if any for any particular service is addressed in the Tender Drawings / Data Sheets, the selected size for the applicable service shall not be less than the specified size.

Pipe Size	Velocity in m/sec		
	Below 50 mm	50 mm - 150 mm	200 mm & above
Pump Suction for Water		1.2 - 1.5	1.2 - 1.8
Pump Discharge for Water	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
Header		1.5 - 2.4	2.1 - 2.4
Compressed air below 2 Kg/cm ² (g)	15 - 20	20 - 30	25 - 35



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Pipe Size	Velocity in m/sec		
	Below 50 mm	50 mm - 150 mm	200 mm & above
Compressed air 2 Kg/cm ² & above	20 - 30	25 - 40	35 - 45
Suction to compressor/ Blowers		7 - 8	
Pump Suction for Chemical Solution	1.0 - 1.2	1.1 - 1.3	
Pump Discharge for Chemical Solution	1.2 - 1.4	1.3 - 1.5	

4.05.00 Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

4.06.00 The following "C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping and fittings.

i)	Carbon Steel Pipe	:	100
ii)	C.I Pipe	:	100
iii)	Carbon Steel Pipe (inside rubber lined)	:	120
iv)	PVC / HDPE / GRP / CPVC pipes	:	140

For calculating the pump head, at least 10% margin shall be taken over the pipe friction losses.

4.07.00 Piping Layout

4.07.01 Piping shall be grouped together as far as practicable and routed to present a neat appearance and orientation. All piping shall generally be installed perpendicular or parallel to the major equipment, building structure and floor. Pipe routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of other equipment. Piping shall be routed to avoid interferences with other pipes, hangers, structures, equipment electrical trays, HVAC ducts etc. Convenient



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supporting points, adequate flexibility for thermal expansion and neat appearance shall be considered in piping layout work.

- 4.07.02 Provision shall be made while preparing piping layout to accommodate all system accessories such as valves/ expansion bellows/instrument stubs/instruments/ specialties as per P&ID.
- 4.07.03 All local instruments on the pipeline shall be located such that the reading can be observed without inconvenience.
- 4.07.04 Overhead indoor piping shall have a vertical clearance of minimum 3.0 m above finished floor level of working areas / walkways. Overhead outdoor piping shall have a vertical clearance of minimum 4.0 m above finished ground level and minimum 7.5 m above finished road level unless addressed otherwise elsewhere in this specification. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.
- 4.07.05 In specific cases (subject to instruction by Purchaser for any site specific reason), pipes may be routed overground on RCC pedestals with bottom of pipes minimum 300 mm above finished ground level.
- 4.07.06 Pipe, when specifically addressed, shall be laid in trenches or buried. All buried pipes in general shall be laid with the top of the pipe 1.2 m to 1.5 m below the finished ground level unless mentioned otherwise. Full length of buried piping shall be provided with 100 mm thick sand bed.
- 4.07.07 Openings provided to accommodate pipelines must be closed with bricks and mortar with 10 mm to 12 mm clearance between brick work and pipe. The clear space must be filled with felt or approved filling compound. The details of wall sealing arrangement shall be approved by Purchaser.
- 4.07.08 Drains shall be provided at low points and at pockets in piping such that complete drainage of system is possible. Vent connections shall be provided at high points where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vents shall not be less than 15 mm size. Plugs / cocks required for vent/drain system shall form part of the piping system and shall be supplied by Bidder as per finalized flow diagram. All vent valves & drain valves shall be arranged with easy reach of operation. All pipelines shall be given proper slope towards the drain points.
- 4.07.09 To facilitate dismantling of piping at the valves and equipment, break up flange/unions shall be provided. The location shall be decided as per the system requirement during detailed engineering.



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4.08.00 **Line Joints**

Line Joints shall be envisaged as follows:

CS and SS pipes	:	Welded (socket welded for 50 mm NB & below & butt welded for 65 mm NB and above)
Galvanized Pipes	:	Screwed
Rubberlined Pipes	:	Flanged

4.08.01 **Welded joints**

For making welded joints (socket weld or butt weld) the welding shall be performed by manual shielded metal arc process. Any welder employed for carrying out welding shall be qualified as per ASME-Section IX for the type of joints to be welded. Jointing by butt weld or socket weld shall depend upon the respective piping material specification.

For Stainless Steel piping atleast the root run shall be welded with Tungsten Inert Gas (TIG).

Butt welding edge preparation shall be done as per ANSI-B 16.25.

All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

4.08.02 **Screwed joints**

Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI-B 2.1 (taper) NPT / IS 554, unless specified otherwise.

Teflon tapes shall be used to seal screwed joints and it shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease (with appropriate solvent if necessary) and dried before applying the sealant. Pipe ends shall be reamed or filed out to size of bore and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe as well as the flange shall be refaced accurately.

4.08.03 **Flanged joints**

All flanges and flange drilling shall be to ANSI-B 16.5 of applicable pressure/temperature class. However in case of interface with the pipe of Purchaser, the flange/interconnection details shall be designed to match the applicable interface piping and concerned details.





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When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

Drilling of flanges on piping must match with the drilling of flanges on the valves / equipments to which the piping is to be connected.

While fitting the mating flanges, care shall be taken to properly align the pipes and to check the flanges to trueness so that the faces of the flanges can be pulled up together without producing any stress on the adjacent pipes and equipment flanges.

Flanges shall be generally Slip-On / Blind Flat Face type. The packing ring or gasket of the flanged joint shall be of full face type. Flanged joints shall not be buried.

4.08.04 With reference to maintenance for carbon steel pipes, three piece socket welded unions for sizes 50 mm NB and below shall be used. For higher sizes, flanged joints shall be used.

4.09.00 **Fabrication of Pipes**

4.09.01 **General Requirements**

The Bidder shall prepare necessary fabrication drawings based on approved piping layouts.

Flanges and their contact surfaces shall be concentric with the pipe axis and shall be accurately machined and drilled true to template.

Where welded pipe and fittings are used, the longitudinal weld seams of adjoining sections shall be staggered by 90 degree.

Prefabrication shall be carried out in the fabrication shop to ensure quality of work and to minimize work on the field.

Where fabricated reducers have been specified, they shall be fabricated from parent pipes by the 'cut and shut' method.

All bends, tees and reducers shall be fabricated as per the latest edition of power piping code, ANSI-B 31.1 or approved equivalent. Reinforcement wherever required, shall be provided.

Only shop fabricated mitre bends or mitre fittings shall be acceptable. Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes 400 mm NB and above, the mitre bends shall conform to BS-534.



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For easy handling & removal of equipment, valves etc. and for maintenance purpose, break up flanges shall be provided for 65 mm NB and above. For flanged joints of 50 mm NB and below, suitable type of compression flexible coupling shall be provided.

4.09.02 **Rolled and Welded /Spiral Welded Pipes**

Pipes of larger diameter shall be fabricated from steel plates conforming to IS-2062 by rolling and welding or spiral welded pipes shall be used.

Where pipe lengths need to be erected before the circumferential joints are welded, the pipe ends at these joints shall be beveled so that the top half is welded mostly from outside and the bottom half mostly from inside of pipe.

Beveled (single V / double V) ends shall be provided for butt welding as per Welding Procedure Specification.

4.09.03 **Fabrication of flanges for large diameter pipes (sizes 600 mm NB and above)**

Flanges fabricated from plates shall conform to AWWA-C 207 / BS-4504 / ANSI-B 16.47.

All welds in fabricated flanges shall be subjected to 10% radiographic examination.

Flanges shall be flat faced machined to 10 microns surface finish. Back face of the flanges shall also be machined to 25 microns surface finish.

Inspection holes shall be provided at suitable locations for pipes 800 mm NB and above as required for periodic observations and inspection purposes.

4.09.04 **Rubber Lined Pipes**

All rubber lined pipes shall be seamless or bead removed ERW pipes. Inside surface of the pipes shall be completely cleaned and made suitable for lining.

All rubber lined pipes shall have flanged joints. Pipes shall be welded with flanges before rubber lining.

For rubber lined pipe, natural rubber lining should be applied in two (2) layers on the inside surface of pipes, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 + 5 Shore A class.

4.09.05 **Welding**

Welding shall be carried out by manual shielded metal arc and Tungsten Inert Gas Welding process. Electrodes used shall be of Purchaser approved make. Electrodes shall be kept dry and electrode containers shall be protected against moisture. Electrodes that show sign of deterioration or damage shall not be used. Automatic or semiautomatic welding shall be done with the specific approval of Purchaser.



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The Bidder shall submit procedures for welding, stress relieving, dye penetrant testing radiography etc. for prior approval of the Purchaser.

Weld shall not be made in pipe bends.

4.10.00 **Supports for Overground Pipe**

4.10.01 Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor pipes shall run on steel trestles wherever required. All the steel structure for the pipe rack and the supporting posts/trestles along with all necessary hangers, clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.

4.10.02 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the Purchaser.

4.10.03 The supports shall meet the general guidelines indicated in the following code / standards:

MSS-SP 58 : Pipe hangers & supports - Materials, design and manufacture.

MSS-SP 69 : Pipe hangers & supports Selection and application.

ANSI-B 31.1 : Power Piping Codes

4.10.04 Bidder shall locate, design, fabricate, supply and erect all supports, restraints and anchors required for supporting of over ground portion of piping under this contract

4.10.05 Support drawings for piping shall be got approved from the Purchaser. BOM for each support shall also be submitted.

4.10.06 All material for supports shall be of tested quality.

4.10.07 All structural steel required for supports shall be provided by the Bidder at no extra cost to the Purchaser.

4.10.08 All pipe supporting element, guides, sliding support, beams, channel section, attachment to supports, beam clamps etc. shall be provided by the Bidder.



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- 4.10.09 Support locations will be shown in the layout drawing to be submitted by the Bidder.
- 4.10.10 Fabrication, supply and installation of brackets, pipe shoes, saddles etc. shall be included in the scope of Bidder and the same shall be carried out as per approved drawings.
- 4.10.11 If an outdoor saddle support is assumed to permit sliding movement of piping over the support, consideration shall be given in selection of supporting material at the interface so that no rust formation takes place and the actual sliding movement is feasible in practice.
- 4.10.12 All pipe supports shall be designed to fully sustain the pipe in normal operating position, allow free and ample expansion or contraction except where anchored and prevent excessive stress.
- 4.10.13 Sway braces, cushioned clamps or other vibration control equipment shall be used in order to prevent unwanted movements of the piping due to vibration, shock or other causes. These shall be of such design as to protect piping against these movements regardless of direction.
- 4.10.14 The supports shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 4.10.15 All piping supports shall be designed to avoid interference with other piping hangers, electrical conduits equipment and structures etc.
- 4.10.16 Saddles, supports etc. shall be capable of carrying the sum of all concurrent acting loads and shall be fabricated from plates/pipes sections conforming to SA 53 / IS-2062 or equivalent. They shall be designed to provide the requirement of supporting effects and allow pipe line movements as necessary. The structural work shall be as per IS-800 / BS-4360.
- 4.10.17 The maximum spans of the supports of straight lengths shall not exceed the recommended values indicated in ANSI-B 31.1. The spans shall be suitably reduced considering the following:
- a) Point loads due to valves and specialties, branch lines etc.
 - b) Pipe bends
 - c) Structural Steel beams.
 - d) Facilities for maintenance of flanged joints.
 - e) Minimum loads on equipment.
- 4.10.18 All vertical lines shall be properly supported on the vertical run and additionally provided with adequate number of lateral-restraints where the length of vertical run exceeds 5M.



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- 4.10.19 At all sliding surfaces of restraints and supports Bidder shall provide a teflon lining to minimize sliding friction.
- 4.10.20 Pipe clamps shall have a minimum thickness of 5 mm for indoor piping and 6 mm for outdoor piping.
- 4.11.00 **Erection**
- 4.11.01 The Bidder shall coordinate the erection of the piping system as required with the erection schedule of other concerned systems. The sequence of work shall be carefully planned to minimize interference with other groups working in the same area. The actual sequence to be followed shall be to the approval of Purchaser who may at any time, direct the Bidder to reschedule his work as per the status of work site
- 4.11.02 Prior to making interface connections with equipment / system supplied by others, the Bidder shall obtain the approval of the concerned authority.
- 4.11.03 All workmanship shall be accomplished using accepted methods and procedures of the highest recognized fabrication and erection code / standards. Workmanship not conforming to the intent of this specification shall be liable to rejection by the Purchaser at any time, during the progress of work. The Bidder shall correct the workmanship immediately at no extra cost to the Purchaser.
- 4.11.04 The Bidder shall make all interface joints of the piping system, covered under this specification at the connecting points with equipment/piping supplied by others.
- 4.11.05 It is the responsibility of the Bidder to ensure correct orientation of all valves, instrument stubs etc. in line with final piping drawings.
- 4.11.06 The Bidder shall utilize the existing structures if any, to support the piping as far as practicable. All auxiliary steels required shall be supplied by the Bidder.
- 4.11.07 Before performing any welding, all corrosion products, dust, grease and other foreign material shall be cleaned from the surfaces to be joined.
- 4.11.08 Piping on both sides of the joint shall be adequately supported during all welding. Temporary supports, if used shall be so designed that no stress due to pipe weight comes on the joints during the joining.
- 4.11.09 All pipes shall be located and laid in accordance with the approved layout drawings. No deviation will be allowed unless written consent is issued by Purchaser in specific case(s).
- 4.11.10 Before laying the pipes, the coordinates and levels of the pipes shall be checked by the Bidder. Any discrepancies between the execution and approved drawings shall be brought to the notice of the Purchaser and corrections shall be carried out as per his instructions.





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- 4.11.11 During erection of piping, the Bidder shall provide proper number and size of bolts and nuts as per drawings and specification. The Bidder shall provide approved quality of grease mixed with graphite powder thoroughly on all the bolts, nuts and washers immediately after erection and when the flange joints are dismantled for flushing, testing and alignment of equipment etc. to prevent rusting of nuts, bolts and gaskets. The grease and graphite powder shall be supplied by the Bidder

4.12.00 **Cleaning and Flushing**

The exterior and interior surface of all piping shall be thoroughly cleaned of all sand, mill scale, grease, oils, dirt and other foreign materials. After cleaning, the interior surfaces of all piping shall be thoroughly blown dry and protected with a completely water soluble preventive coating.

Flange faces shall be coated with an easily removable rust preventive coating.

Machined surface shall be coated with rust preventive paint. The paint shall be consumable in the welding process.

- 4.13.00 Pipes and Fittings if any, coming under purview of IBR, should meet its requirements and getting the approval from IBR in respect of the same shall be under the scope of the Bidder.

4.14.00 **Valves & Isolation Gates**

Valves will be used to start/stop or control flow.

All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. The valves shall be of standard pressure rating as per the applicable code/ standard. The pressure rating of diaphragm valves shall be selected considering the maximum expected operating differential pressure. Sample valves will be used in sample collection lines.

Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too.

For location and type of Valves / Isolation Gates, Bidder need to refer to the P&I drawings enclosed with this specification.

- 4.14.01 Sluice / Gate Valves (for river water / clarified water / filtered water / similar application)

Sluice / Gate valve shall conform to IS-14846 PN1.6 minimum. Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS-14846. Valves shall be of outside screw and rising stem type. Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.



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Sluice / Gate valves for sizes 50 mm NB and below shall conform to IS-778 Class-2 / ANSI-B 16.34 straight, rising stem; with outside screw.

Sluice / Gate valves shall be provided with the following accessories in addition to the standard items.

- a) Hand wheel
- b) Gear Reduction Unit Operator for valves 250 mm NB and above.
- c) Bypass valve for valve of sizes 300 mm NB and above.
- d) Draining / Flushing arrangement wherever required.
- e) Arrow indicating flow direction.
- f) Position indicator.

Sluice / Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

For lower sizes, the gate valves will be screwed bonnet with outside screw rising stem as per IS-778. The material of construction will be gun metal body, with brass stem and trim. Ends will be screwed to ANSI-B 2.1.

Gate valve on galvanized iron pipe shall be gun metal construction as per IS-778 Class 2. Ends will be screwed to ANSI-B 2.1.

4.14.02 Butterfly Valves (for river water / clarified water / filtered water / similar application)

Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate conforming to AWWA-C 504 class 150 (min.) or BS-5155 PN 10 / class 150 (minimum)

The various components of butterfly valves shall be of the following:

- i) Body : Cast Iron – ASTM-A 48 Cl.40;
 BS-1452 Grade220
 SG Iron – BS-2789.
 Cast Iron IS-210 Grade FG 260
 Cast Steel – ASTM-A 216 Grade WCB;
 BS- 1504 or Equivalent grade (subject to approval by Purchaser).
- ii) Disc : Cast Iron – ASTM-A 48 Cl.40;
 BS-1452 Grade220
 SG Iron – BS-2789.
 Cast Iron IS-210 Grade FG 260
 Cast Steel – ASTM-A 216 Grade WCB;
 BS-1504 or Equivalent grade (subject to approval by Purchaser).





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- iii) Shaft : ASTM-A 296 Grade CF 8M / AISI 316;
AISI-420;
BS-970 Grade 316;
BS-970 Grade 420 S45.
- iv) Seat rings : Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon.

Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 mm NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

All the butterfly valves shall be provided with Hand wheel or lever/wrench operated as per the requirements.

The use of lever operators shall be limited to valves requiring a maximum of 90 degree stem rotation from full open to full closed position. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions

For larger sizes i.e. 150 mm NB and above, hand wheel shall be provided.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 mm NB and above. Valve provided with motorised or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Handwheel or Gear reduction unit or Motor actuator etc.) shall be designed as per applicable International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc. Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

4.14.03 Butterfly Valves (for decationized water / deanionized water / demineralized water / desalinated water / similar application)

The butterfly valves shall conform to the requirements addressed under Cl. No. 4.14.02 above along with the requirements delineated below:

- a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.
- b) Disc shall be either lined with PVDF, polypropylene, or natural rubber or shall conform to ASME-SA 479 Grade 316.



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4.14.04 Ball Valves (for river water / clarified water / filtered water / similar application)

Ball valves may be used for sizes 40 mm NB and below. Ball valves shall conform to the following technical specifications:

- a) Design Standard BS:5351
- b) Type Screwed / Welded / Flanged ends; Full Bore: Split Body & Seat supported construction
- c) Material of Construction
 - Body Carbon Steel to ASME-216 WCB / Cast Iron to IS-210 Grade 220 or better.
 - Ball Stainless steel ASME-SA 479 Grade 316 or 410.
 - Seat ring PTFE
 - Stem Stainless steel ASME-SA 479 Grade 304 or 316 or 410.
 - Seats Nitrile rubber; PTFE
- d) Valves shall be designed to be directly operable by a wrench / hand lever.
- e) Suitable stops shall be provided for both the fully open & close condition.
- f) All the valves shall be provided with an indicator for showing the position of the ball port.
- g) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

4.14.05 Globe Valves (for river water / clarified water / filtered water / similar application)

Globe valves shall conform to the following technical specifications:

For sizes 50 mm NB and below

- i) Design Standard : IS-778 Class-2 / BS-1873
- ii) Type : Straight, rising stem, with outside screw.





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iii) Material of Construction

i)	Body, Bonnet, Stuffing Box & seat rings	Leaded Tin Bronze con forming IS-318 Grade 2
ii)	Stem	Stainless Steel, AISI-316
iii)	Disc	IS-318 Grade 2/AISI-316

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which are being flushed by the line.

For sizes above 50 mm NB

- i) Design Standard : BS-13789 PN 10 (minimum).
- ii) Type : Double Flanged or wafer body, outside screw and rising stem type.
- iii) Material of construction
 - a) Body : Cast iron: IS-210 Grade FG260 / BS-1452 Grade14.
 - b) Stem : Stainless steel AISI-410 / 13% chrome steel.
 - c) Disc : Cast iron IS-210 Grade 260 / BS-1452 Grade 14.
 - d) Packing : PTFE
 - e) Seat & seat rings : 13% chromium steel
 - f) Gland & gland nut : AISI-420
 - g) Hand wheel : Cast Iron or Malleable Iron
- iv) Back seat shall be provided on the stem or on the disc.
- v) Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer.



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- vi) Disc of globe valve may be provided with renewable rubber seating ring.
- vii) Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

Globe valve on galvanized iron pipe shall be gun metal construction as per IS-778 class 2. Ends will be screwed to ANSI-B 2.1.

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

4.14.06 Diaphragm Valves (for river water / clarified water / filtered water / similar application)

Metallic Unlined Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The Metallic Unlined Diaphragm valves shall conform to the requirements addressed under Cl. No. 4.14.07 below except the requirements with reference to lining for body and integral flanges.

4.14.07 Diaphragm Valves (for decationized water / deionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

Metallic Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The metallic diaphragm valves shall conform to the following requirements.

- a) Design Standard : BS EN-13397 or Equivalent (subject to approval by Purchaser) of required rating/class. (minimum rating of valves should be PN 10).
- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.





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c) **Material of Construction**

Body/Bonnet	:	Cast Iron IS-210 Grade FG.260 or Equivalent (subject to approval by Purchaser).
		Cast steel ASTM-A 216 Grade WCB.
Body lining	:	Soft Natural rubber - 3 mm thick as per IS-4682 (hardness 85-90 on shore A), Ebonite polypropylene, PVDF.
Diaphragm	:	Reinforced rubber, Hypalon
Handwheel	:	Cast Iron
Compressor	:	Stainless Steel
Stem & Bush	:	Stainless Steel

d) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (min.) piping flanges, full face rubber lined and shall be cast / integral with the body.

e) Handwheels shall be marked with the direction of closure.

f) Valves shall be provided with a position indicator to show the open and closed condition.

g) Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per applicable International Standard.

h) The testing of valves will be as per BS EN-13397 and rubber lining will be tested as per IS-4682.

Note: For valves which may come in contact with concentrated acid/ alkali, the material of construction of diaphragm shall be as follows:

Diaphragm shall be of reinforced Teflon, EPDM for acid services and reinforced Neoprene / Hypalon for alkali services.

Use of Nonmetallic Diaphragm Valves for any specific / critical application shall be subject to approval by Purchaser and shall conform to the requirements of BS EN ISO 16138 - Industrial valves. Diaphragm valves of thermoplastics materials.



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4.14.08 Plug Valves (for lime solution / sludge / similar application)

The plug valves shall conform to the following requirements.

a)	Design Standard	BS-5158 or Equivalent (subject to approval by Purchaser)
b)	Type	Flanged and non lubricated, regular pattern, plug valves.
c)	Material of Construction	
	Body	Cast Iron IS-210 Grade FG 260 or Equivalent (subject to approval by Purchaser)
	Plug	Stainless Steel AISI-316
	Body Sleeve or Seat	PTFE
	Seat	PTFE
	Gland	AISI-304 / AISI-316
	Cover	Cast Steel ASTM-A 216 Grade WCB
	Gland Nut	AISI-304 / AISI-316

- d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.
- e) All valves shall be provided with an indicator for the position of the plug part.
- f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.
- g) Valves of size of 250 mm NB and above shall be provided with a suitable reduction gear unit.
- h) Ends will be flanged and compatible with AISI-16.5 Cl. 150 (minimum) piping flanges.



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4.14.09 Non Return or Check Valve (for river water / clarified water / filtered water / similar application)

Non return valves shall be of swing check (reflux) type or dual plate type.

The valves shall conform to the following specifications.

- i) Design Standard : IS-5312, BS-1868, BS-5153, API-594 / API-60 or equivalent (subject to approval by Purchaser)
- ii) Type : Swing check Type and Flanged ends.
- iii) Material of Construction:

a)	Body & Cover Hinge Disk/Door	Cast iron IS-210 Grade FG 260 / Cast Iron BS-1452 Grade 220 or equivalent (subject to approval by Purchaser)
b)	Hinge Pin and Door / Disc Pin	Cast steel ASTM-A 216 Grade WCB High tensile Brass IS-320 HT 2 or BS-2872 equivalent (subject to approval by Purchaser)
c)	Disc facing ring	Stainless steel
d)	Body Seat ring	Stainless steel
e)	Bearing bushes	Leaded Tin Bronze IS-318 Grade 2
f)	Bolts	Carbon Steel

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.

For sizes 50 mm NB and below, check valves shall be gun metal body swing type as per IS-778. Ends will be screwed type to ANSI-B 2.1.



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- 4.14.10 Non Return Valve (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

The valves shall conform to Cl. No. 4.09.00 above along with the following requirements:

- a) The body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Equivalent (subject to approval by Purchaser) material (subject to approval by Purchaser). Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI-316).
- b) For only acid services Non- Return valves shall be of lined construction & Flap type.
- c) For alkali services, the complete valve shall be stainless steel construction (AISI-316) or of lined construction as specified above.

4.14.11 Valves for Sampling / Instrument Isolation Service

Each sampling valve / instrument isolation valve shall be full bore ball type.

Ball valves shall conform to the requirements stipulated under Cl.4.04.00 above. However, Body material shall be Stainless Steel (AISI-316).

4.14.12 Valves for Air Service

For Air services globe valves or Ball valves may be used for sizes 50 mm NB and below.

For sizes higher than 50 mm NB, either Butterfly valve or Ball valves shall be used.

Globe valves shall generally conform to Cl. 4.05. 00 above.

Ball valves shall conform to the requirements stipulated in Cl.4.04.00 above. However, Body material shall be leaded Tin Bronze (IS-318 Grade2) or stainless steel (AISI-304 / 316).

Butterfly valves shall conform to the Cl.4.03.05 to 4.03.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI-304 / 316).





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4.14.13 Safety / Relief Valves

The safety valves / relief valves at the downstream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.

4.14.14 Valves for Resin Transfer Line

In resin transfer line two way eccentric plug valve shall be used. The valves, shall have type 316 stainless steel body and bearings, resilient faced plug and flanged ends.

4.14.15 Isolation Gates

Design standard for gates shall be IS-3042 or Equivalent (subject to approval by Purchaser).

The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS-3042.

Material of Construction

i.	Frame and Door	Cast Iron IS-210 Grade 20
ii.	Spindles, bolts & nuts	M.S. to IS-2062
iii.	Face & seat rings	Gun metal (as per IS-3042).

All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.

Each of the gates shall be provided with handwheel, and a position indicator.

The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

4.15.00 Strainers

4.15.01 Basket Strainers

a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.

i. Body Fabricated mild steel : IS-2062 (Tested quality)





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- ii. Strainers Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
- iii. Drain Plug / Nuts Gun metal
- b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.
- c) Suitable Vent and drain valves shall be provided for the strainers.
- d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- e) Pressure drop in clean condition shall not be more than 1.0 mwc at full flow.
- f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness $65 \pm 5^\circ\text{A}$).

4.15.02 Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials:
 - i. Body Cast Iron IS-210 Grade FG 260
 - ii. Strainers Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
 - iii. Drain Plug / Nuts Gun metal (threaded construction)
- b) Y-Type strainers shall also conform to Cl. 4.15.01 (b), (c), (d), (e) and (f).
- c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS-210 Grade FG 260) and lined with soft or hard rubber to a thickness of 3 mm.

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- d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

4.16.00 **Resin Traps**

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

- 4.16.01 The body shall be of mild steel (IS-2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI-316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process.
- 4.16.02 The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.
- 4.17.00 General Requirements for Valves, Gates, Strainers and Resin traps
- 4.17.01 All the items shall be suitable for service conditions i.e. flow, temperature and pressure to which they may be subjected to.
- 4.17.02 All the items shall be of proven design for the duty conditions and the Bidder or manufacturer shall have sufficient experience in using the above equipment in water treatment application in the plants supplied earlier by them.
- 4.17.03 In case Purchaser desires, the experience list/feedback from the users shall be made available to Purchaser for any or all the equipments during the detailed engineering phase.
- 4.17.04 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.
- 4.17.05 All valves shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the applicable design code / standard. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed.



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- 4.17.06 Valves pressure classes, sizes, types, body materials, and end preparation shall generally be as described herein, unless mentioned otherwise elsewhere in Bid Specification. All valves shall conform to the requirements of the governing codes, and the requirements specified.
- 4.17.07 Valves (including safety, relief and control valves) body materials shall be compatible with the piping with which they are used. If the body material is not of the same type as the material of the connecting pipe work, the valves shall be fitted with suitable welding nozzles to avoid dissimilar butt welds at site.
- 4.17.08 Each modulating control valve shall be provided with isolation valves. Manual bypass valve shall be provided for each modulating control valve to achieve safe and reliable manual operation.
- 4.17.09 All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.
- 4.17.10 Valve bodies and bonnets shall be designed to support the valve operators (handwheel, gear, or motor) with the valve in any position without external support.
- 4.17.11 Valve ends and size limitations are as follows:
- a) 50mm NB and smaller valves - Class 800 minimum with socket weld ends. (For instruments connections/ isolation valves screwed ends may be acceptable)
 - b) 65mm NB and larger size valves - Class 150 minimum (butt-weld ends or flanged or wafer style).
 - c) Flanged steel butterfly valves - 750mm and larger size; pressure class per AWWA / BS-5155.
- 4.17.12 Gate, globe and angle valves shall be outside stem and yoke construction.
- 4.17.13 Valves sizes 65 mm NB and larger shall have a non-rising handwheel.
- 4.17.14 All the actuator operated valves shall be fitted with handwheel for manual operation. The pneumatic actuators shall be selected based on the available air pressure and operating air pressure (maximum and minimum). The supporting calculations for selection of actuators shall be furnished for Purchaser's approval before finalization of all the actuators.
- 4.17.15 Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the Bidder.
- 4.17.16 Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.





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- 4.17.17 The various items shall be installed such so that they are easily approachable for the operating and maintenance personnel. All valves shall be accessible without chain pulls, as far as possible. Generally Valves shall be located about 1.2 meter to 1.5 meter 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.
- 4.17.18 All valves shall be provided with hand wheels. Wherever necessary, chain operator shall be provided so that the valve may be operated from the ground floor.
- 4.17.19 All valves shall be provided with cast heat marks on casting of Body and Bonnet.
- 4.17.20 Whenever screwed valves will be installed in a pipe line, it will always be followed by screwed three piece union of same material as that of pipe.
- 4.17.21 Short pieces used for welding of different pipe fittings and valves shall not be less than 80 mm in length.
- 4.17.22 However valves which are provided (in the buried 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.
- 4.17.23 All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as 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.
- 4.18.00 **Rubber Expansion Joint**
- 4.18.01 The inner cover (i.e. the tube) and also the outer cover shall be made up of natural or synthetic rubber of adequate thickness. The carcass between the tube and the cover shall be made up of high quality cotton and rayon cord having suitable number of plies and impregnated with rubber or synthetic compounds. Moreover, to ensure adequate strength, reinforcements consisting of metal rings embedded in the carcass, shall be provided.
- 4.18.02 In all cases, the expansion joints shall be integral flanges at both ends complete with split retaining rings.





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- 4.18.03 Each of the expansion joint shall be provided with adequate number of limit rod assemblies which shall be tightened after erection of the entire suction branch of the pumps, in order to avoid transmittal of undue pressure thrust on to the pump foundation. Each of these limit rod assemblies shall consist of a long bolt and two connecting plates which are, in turn securely bolted to opposite flanges. Each plate is to be drilled with three holes, two for bolting to the flange, the third for passage of the stretcher belt. Rubber washers backed with metal washer shall be placed under the head of the bolt and under the nut.

4.19.00 **Protective Lining and Painting**

The supply and application of Protective Lining and Painting with reference to Piping, Fittings and Valves need to be as per **Sub Section: Section-XIII of V.III-C- Technical Specification for Protective Lining and Painting**, attached herewith.

5.00.00 **TESTS AND INSPECTION**

5.01.00 **Tests & Inspection for Pipes and Fittings**

5.01.01 **Shop Tests**

Shop test shall include all tests to be carried out at supplier's work, works of sub suppliers and at works where raw materials supplied for manufacture of equipment are produced. The supplier shall carryout a comprehensive inspection and testing program during manufacture at works. Necessary Manufacturing and Field Quality Plans shall be prepared by supplier and submitted for approval by Purchaser for all checks conducted on raw materials, fabrication etc.

Calibrated instruments required for measuring / testing of pipes shall be arranged by manufacturer at their works during inspection.

Purchaser shall be given full access to all tests. The manufacturer shall inform Purchaser of the testing well in advance so that Purchaser at own option may witness the test.

All the test certificates and reports shall be submitted to Purchaser for approval.

All the mechanical and chemical tests including optional tests if any as per the applicable codes / standards shall be carried out and the test certificates for the same shall be submitted for approval by Purchaser. Material Certificate shall be furnished for each grade / lot of pipes. All material test certificates shall carry material specification, size, class, length, chemical composition, physical properties and heat number or other acceptable reference to enable correlation of the certificate with the pipe. IBR / CCE / TAC approval certificates / any other statutory approval certificates as required shall be furnished.



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Welding procedure and welder performance qualifications shall be carried out. Mechanical and chemical tests shall be carried out as per code. Spot radiography check shall be carried out for all butt welds. D.P.T shall be carried out for all root run welds. Segmented flanges exceeding 30 mm thickness shall be stress relieved. Tensile test, eddy current test, bend test, flattening test and dimensional checks as per applicable code shall be carried out.

All rubber lining is to be subjected to the following tests as per IS-4682 Part I:

- a) Adhesion test.
- b) Tests to check resistance to bleeding.
- c) Measurement of thickness of lining.
- d) Shore hardness test.
- e) Spark test at High voltage 5 KV / mm of thickness.

Galvanizing shall be carried out as per IS-4736 / IS-2629 and tested as per IS-2633 / BS- 729. The test shall include weight of coating, uniformity of thickness and adhesion test.

All pipes and fittings shall be subjected to hydraulic tests as per applicable code / standard. When rubber lined, hydraulic tests shall be carried out before and after rubber lining.

Buried pipes where wrapping and coating is done, material for wrapping and coating shall be tested as per applicable code. Procedure for wrapping and coating and its testing shall be submitted for approval by Purchaser. Entire wrapping and coating shall be checked for thickness and Holiday test. Peel test shall be done to ensure proper bonding of coating to surface.

5.01.02 **Site Test**

Hydraulic tests of the piping system at 1.5 times the design pressure or twice the working pressure whichever is higher shall be carried out for a period of minimum 30 minutes. However, if the Code / standard of supplied piping specifies more stringent requirements than the above criteria, then the hydraulic tests shall be conducted as per the applicable piping code / standard.

Pneumatic tests shall be carried out for air pressure piping that shall not be subjected to water filling.

The Bidder shall make all temporary closures/connections as required for hydrostatic/pneumatic testing and clean/remove the same after successful completion of the test.

The procedure for hydro test and pneumatic test shall be submitted by the Bidder for review and approval by Purchaser.



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All tests as indicated in FQP approved

by Purchaser shall also be carried out.

5.02.00 **Tests & Inspection for Valves / Gates / Strainers**

5.02.01 **Shop Tests**

Chemical composition of all material, castings, forgings, etc. shall be tested for various components of the valves, gates, strainers and test certificates shall be submitted for approval by Purchaser.

Mechanical tests including optional tests if any shall be performed as per the applicable code / standard and the test certificates for the same shall be submitted for approval by Purchaser. The performance requirements of the valves shall also be tested as per the applicable code / standard.

Elastomer wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per applicable code / standard and the test certificates shall be furnished for approval by Purchaser.

Rubber lining on Valves / Gates / Strainers / Resin Traps shall be checked in accordance with IS-4682 Part I including Spark Testing at high voltage (5 KV/mm of thickness).

All the valves shall be hydraulically tested for the body, seat, back seat and all valves shall be pneumatically tested for seat as per the applicable code / standard to which these are designed irrespective of the working pressure for which valves are selected.

Wherever specifically required, pressure drop across each type and each size of the valve at various flows shall be conducted, and test reports shall be submitted for approval by Purchaser. Type test report for this test (if already carried out by the manufacturer) may be submitted to fulfill this requirement.

Gates shall be tested against leakage and strength as required in the code / standard.

Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.

5.02.02 **Site Tests**

All valves, gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of 120 minutes.

All valves / gates (Manual / Automatic) shall be operated throughout 100% of the travel manually and as well as from control panel and these should function without any trouble whatsoever.





KAHALGAON TPS – FGD

COMPRESSED AIR SYSTEM

SPECIFICATION No: PE-TS-481-555-A001

VOLUME: II B

SECTION : C2-B

REV. 00

DATE: Nov. 20

SHEET: 1 OF 1

SECTION: C2-B

PROJECT SPECIFIC GENERAL REQUIREMENTS

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SECTION-V

GENERAL TECHNICAL REQUIREMENTS

**Development Consultants Pvt. Ltd.**

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General Technical Requirements



SECTION-V

GENERAL TECHNICAL REQUIREMENTS

1.00.00 CODES AND STANDARDS

1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.

1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.

1.03.00 Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Electricity Rules, Indian Explosives Act, Factories Act etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Successful Bidder.

1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.

1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the Successful Bidder proceeds with manufacturing the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Successful Bidder to advise Owner of the resulting effect.

2.00.00 RESPONSIBILITY FOR DESIGN

2.01.00 The Bidder shall assume full responsibility for the design of the whole and every portion of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Successful Bidder was directly involved in the design work.

2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.

2.03.00 The Bidder shall carry out optimization studies for selection of pipe size and equipment wherever required. The result of such studies shall be included as part of bid proposal.





The successful Bidder shall have to carry out surge analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.

- 2.04.00 The Bid shall include a detailed discussion on the development status of and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.
- 2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feedback, etc. are to be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternatives offered. In case of each alternative offer, its implications on the performance, guaranteed efficiency, auxiliary power consumptions, etc. shall be clearly brought out to the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with the specifications i.e. Base offer shall be as per the technical specifications and the same will be considered for techno-commercial evaluation.
- 3.00.00 **NAME PLATES (RATING PLATES)**
- 3.01.00 Instruction plates, nameplates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.
- 3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.
- 3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.
- 3.04.00 The size and location of nameplates shall be subject to Approval of the Owner/Owner's Engineer.
- 4.00.00 **SAFETY AND SECURITY**
- 4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.
- 4.02.00 Ready and safe access with clear headroom shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.



4.03.00 Escape routes and clear ways shall be provided to allow speedy evacuation of the plant in the event of fire or explosion, and the plant layout shall allow for ease of access to all parts of the Works by rescue and fire fighting teams. The Plant layout shall be designed to localize and minimise the effects of any fire or explosion. The recommendations of NFPA, OSHA, and TAC etc. as necessary shall be followed in all respects.

4.04.00 The use of corrosive, explosive, toxic or otherwise hazardous materials shall be kept to a minimum during construction and the design of the plant shall minimise the requirement for such materials during operation and maintenance. Where such materials must be used, all necessary precautions shall be taken in the design, manufacture and layout of equipment to minimise the resulting hazard, and all equipment necessary for the protection and first-aid treatment of personnel in the event of accidents shall be provided. Particular attention is drawn to avoid the use of materials containing asbestos in any form.

5.00.00 **GUARDS**

5.01.00 Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.

5.02.00 Mesh guards which allow visual inspection of equipment with the guard in place are generally preferable. The guards shall be constructed of mesh attached to a rigid framework of mild steel rod, tube, or angle and the whole galvanised to prevent loss of strength by rusting or corrosion. The guards shall be designed to facilitate removal and replacement during maintenance.

5.03.00 All drive belts, couplings, gears, sharp metallic edges and chains must be safely guarded. Any lubricating nipple requiring attention during normal running must be positioned where they can be reached without moving the guards.

5.04.00 Guards for couplings and rotating shafts shall be in accordance with BS 5304-1975 or similar approved standard. All rotating shafts and parts of shafts must be covered.

5.05.00 Suitable fencing shall be provided to enclose all openings or doorways used for the hoisting and lowering of machinery etc. This fencing must be securely fixed but quickly detachable when required. A secure handhold must be provided on each side of the opening or doorway.

6.00.00 **LOCATION AND LAYOUT REQUIREMENTS**

The majority of plant and equipment shall all be of indoor installation. A broad list of buildings housing such equipment is given In Vol-II-G2 Section I. Layout shall facilitate access for operation-maintenance and inspection of any one or more equipment/components at a time without disturbing the operation or installation of rest of the plant. Further, Bidder should comply with the criteria given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings enclosed in Vol-II-L show the location of major installations and auxiliary buildings. The Bidder



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shall try to retain these locations as far as practicable. The layout of equipment within the power house as shown in the tender drawings is indicative. The Bidder may, subject to Owner's acceptance alter the same to suit the space requirement of the equipment offered.

While developing the layout of buildings the following criteria shall be given effect:

- a) The minimum width of clear access corridors around equipment shall be 1.2 meters.
- b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as required.
- c) The plinth level with respect to the existing grade level shall be as indicated elsewhere in Vol-II-A Section-V/Annexure-II.
- d) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.2 meters shall be maintained between the floor and any overhead piping/cables or other obstruction. Adequate provision for natural ventilation and illumination shall be made as per good engineering practices.
- e) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.
- f) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces shall be as specified in Vol-II-A Section-V/Annexure-II.
- g) All rail/road crossings for pipe/cable racks shall be constructed with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II of this section.
- h) Cubicle for operating personnel shall be located at safe place near the equipment.
- i) Pipe rack, cable rack and Pipe cum Cable rack shall have hand railings (not less than 1200 mm high) in walkways (min. 800 mm wide) on both sides at appropriate heights.



7.00.00 OPERATION AND MAINTENANCE CONSIDERATIONS

7.01.00 Space for ease of operation and maintenance including equipment removal, tube bundle/cartridge/rotor pulling etc. shall be provided. All valves, gates, dampers and other devices shall be located and oriented in such a way that they are accessible from operating floor levels. Where this cannot be adhered to, platforms and walkways with access ladders shall be provided to facilitate operation and maintenance.

7.02.00 Lifting devices i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling of any equipment and/or part having weight in excess of 100 Kg during erection and maintenance activities. Suitable beams, hooks etc. for this purpose shall be provided in the buildings and clear space provided below to a platform or floor which will allow normal risk free transport means to be used.

Lifting tackles, slings, etc. to be connected to hook of the hoist/crane shall also be provided by the Bidder for lifting the various equipments and accessories covered under this specification.

7.03.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 MATERIALS

8.01.00 In selecting materials of construction of equipment, the Bidder shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled.

All materials shall be new and shall be of the quality most suited to the proposed application.

8.02.00 Materials used for various components shall be those which have already proven operating experience in similar type of applications.

8.03.00 All parts which could deteriorate or corrode under the influence of the atmospheric, meteorological or soil conditions at the Site, or under the influence of the working conditions shall be suitably and effectively protected so that such deterioration or corrosion is a minimum over the life of the plant.

8.04.00 Prohibited Materials

The use of the following materials is prohibited:

- a) High alumina cement in structural elements
- b) Wood wool slabs in permanent framework to concrete
- c) Calcium chloride in mixtures for use in concrete works

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- d) Naturally occurring aggregate for use in reinforced concrete that does not comply with the applicable codes and standards.
- e) Cast iron for any oil service
- f) Carcinogenic material and suspected carcinogenic materials by World Health Organization.
- g) Asbestos or any other fibrous form of hydrated magnesium silicate
- h) Any other material generally known to be deleterious if used or incorporated in such project like the facility.

9.00.00 LUBRICATION

- 9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.
- 9.02.00 Non ferrous capillary tubing shall be used throughout.
- 9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.
- 9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant, which may drop, from operating parts.
- 9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.
- 9.06.00 The Bidder shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 LUBRICANTS, SERVO FLUIDS AND CHEMICALS

- 10.01.00 The Bidder shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Successful Bidder for initial commissioning, first fill and till completion of facilities and handing over of respective units.
- 10.02.00 The Bidder shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Successful Bidder shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognized standards and shall be easily





obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.

10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **PLANT LIFE AND MODE OF OPERATION**

The complete plant including all the equipment and systems individually and collectively shall be designed for continuous operation for an economic service life of thirty (30) years under the prevailing site conditions and for the type of duty as specified in relevant sections of the specification.

The critical components of the Steam Generator, Turbine-Generator and Auxiliary equipment, the life of which is limited by time and temperature dependent mechanisms such as thermal stress, creep and low cycle fatigue, are to be designed considering expected (hot, warm and cold) start-up, shut-down and cyclic load variations. (Details are specified in the Volume IIB – Specification of Steam Generator and Auxiliaries and Volume IIC – Specification of Steam Turbine and Auxiliaries and)

The units would be operated on base load with cyclic load variation. The load variation is expected to be as per schedule depending on power demand.

12.00.00 **PACKAGING & MARKING**

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. While packing the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Bidder shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

Bidder shall conduct his own route survey and transportation logistics for transportation of the equipments to project site by road/rail/sea and indicate the same in his proposal.

Each package shall have 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 Bidder 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 Bidder, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

13.00.00 **PROTECTION**

Equipment having antifriction or sleeve bearings shall be protected by weather-tight enclosures. Coated surfaces shall be protected against impact, abrasion, discoloration and other damages. Surfaces that are damaged shall be repainted.





Electrical equipment, controls and insulations shall be protected against moisture and water damages. All external gasket surfaces and flange faces, couplings, rotating equipment shafts, bearings and like items shall be thoroughly cleaned and coated with rust preventive compound as specified above and protected with suitable wood, metal or other suitable covering to ensure their full protection. All exposed threaded parts shall be greased and protected with metallic or other suitable protectors.

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs shall be sealed and taped. Male threaded openings shall be closed with rough usage covers or plugs shall be sealed and taped. Female threaded openings shall be closed with forged steel plugs.

Returnable containers and special shipping devices shall be returned by the Bidder.

14.00.00 **PAINTING**

14.01.00 **General**

All exposed metallic and wooden surfaces subject to corrosion shall be protected by shop application of suitable coatings. Surfaces not easily accessible after shop assembly shall be treated before-hand and protected for life of the equipment. Surfaces to be finish painted after installation shall be shop painted with at least two (2) coats of primer. Steel surfaces, which are not to be painted, shall be coated with suitable rust preventive compound subject to the acceptance of the Owner.

All paints shall be used in accordance with the manufacturer's instructions. No thinners or other substance shall be added to the coating material without the prior notification and specific acceptance of the Owner. The quality and vendor of the paints shall require acceptance of the Owner.

Procedure for painting of any item, if not indicated in the relevant specification, shall be developed by the Bidder. This procedure and quality of paint shall be subject to Owner's acceptance

All paints shall be applied in a normal full coat, shall be free from runs, sags, wrinkles, patchiness, brush marks or other defects.

All primers shall be properly applied on to the surface and the first priming coat shall be applied as soon as possible after cleaning, within four hours maximum. The paint shall be applied by brush, roller or airless spray, according to the manufacturer's instructions. Spray painting shall be carried out by operators trained and thoroughly experienced in the use of the spray painting equipment.

If the drying interval between successive coats of paint or primer exceeds the manufacturer's recommendations, the paint already applied shall be completely and uniformly abraded with fine abrasive paper before putting on the next coat.



Paint spraying on large surfaces shall not be done indoors, without the prior notification and specific acceptance of the Owner. Spray guns shall not be used outdoors in windy weather nor near unprotected surfaces of a contrasting colour and under no circumstances shall spray guns be used where spray may be carried into or onto exposed electrical equipment or unprotected humans.

The Bidder shall provide suitable protection for adjacent plants from air borne materials during cleaning and spraying to the satisfaction of Owner

Paint containers shall not be opened until required and the paint shall be mechanically mixed thoroughly before use, and agitated occasionally during use.

Electrical equipment shall be shop finished with one or more coats of primer and two coats of high-grade oil resistant enamel. The interior of all panels' cabinets and enclosures shall be finished with gloss white enamel. For detail please refer relevant electrical sub-section Volume II F1 & F2.

The Bidder shall furnish sufficient touch-up paint for one complete finish coat on all exterior factory surfaces of each item of equipment. The touch-up paint shall be of the same type and colour as the factory applied paint and shall be carefully packed to avoid damage during shipment. Complete painting instructions shall be furnished.

Shop primer for steel and iron surfaces which will have a continuous operating temperature below 35°C shall be selected by the Bidder, in accordance to the relevant standard. Special high temperature primer shall be used on surface exposed to operating temperature above 35°C.

The colour scheme shall be submitted during execution of contract for acceptance by the Owner.

14.02.00 Surface Preparation

The grade of surface preparation shall be classified as indicated in Annexure-I of this section.

Sl. No.	Type of Preparation	Reference Standards		
		SSPC	SIS	BS 4232
1.	Solvent cleaning	SP1	-	-
2.	Hand Tool Cleaning	SP2	St-2	-
3.	Power Tool Cleaning	SP3	St-3	-
4.	Flame cleaning of new steel	SP4	-	-
5.	White metal blast cleaning	SP5	Sa-3	First Quality
6.	Commercial blast cleaning	SP6	Sa-2	Third Quality
7.	Brush-off blast cleaning	SP7	Sa-1	-
8.	Pickling	SP8	-	-



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9.	Weathering followed by blast cleaning	SP9	-	-
10.	Near white blast cleaning	SP10	Sa-2.5	Second Quality

Oil and grease shall be removed from the surface by washing with a suitable detergent, rinsing with clean water, and drying.

The abrasive to be used shall be metal grit.

The surface preparation of all steel surfaces to be coated shall be free from all mill scales, rust corrosion products, oxides, paints, oil or other foreign matter.

All welded areas and appurtenances shall be given special attention for removal of welding flux in crevices. Welding splatter, slivers, laminations and underlying mill scale exposed during shot blasting shall be removed or repaired.

No acid/solvents/other cleaning solutions shall be used on surfaces after they have been blasted.

14.03.00 Application of Primer and Paint

Primer shall be applied immediately after surface preparation has been completed.

Brushing, spraying, roller coating or other suitable method shall be adopted for application of primer and paint and the work shall be carried out strictly as per the recommendation given by the paint manufacturer.

Primerized surfaces shall be faultless and shall not have mudcracking, dripping over thickness and dry sprays.

Before application of paint/primer, the following shall be particularly checked for conformance to this specification and recommendation of the paint manufacturer:

- Surface preparation profile.
- Catalysis ratio for two component paints.
- Pot life.
- Minimum and maximum top coating times.
- Type and quantity of thinners (if required)
- Viscosity
- Soundness of previous coating.
- Ambient conditions (temperature, humidity, etc)





Depending on the degree of contamination by foreign matters, the surfaces primed at shop shall be washed as follows to the satisfaction of the Owner:

- a) With clean water under a pressure of a least 7 Kg/cm² (g) using suitable nozzles. During washing broom or corn brushes shall be used.
- b) With suitable solvents, (such as Carbon Tetrachloride, Trichloroethylene etc.) if necessary, to remove traces of grease, oil etc.

Coated parts shall be carefully handled using hemp ropes, cloth belts, pendulum conveyors or suitable means as instructed by the Owner.

Surfaces which cannot be painted after fabrication shall be primed and provided with suitable rust preventive oil before boxing up.

Paints shall be stored in well-ventilated rooms, far away from heat sources, open flames, sparks and protected from sun. Outdoor storage is not permitted. Storage life shall be clearly indicated on the container. Paints, which have thickened or gelled or contained in non-original containers or in unsealed containers shall not be used. Owner's decision in this regard shall be final and binding.

The requirements for the dry film thickness (DFT) of paint and the materials to be used shall be as per Table I & II of this section.

For detail painting on building & structural steel elements refer Section-II/G/1 & II/G/2 of this specification.

14.04.00 **Damaged Paintwork**

Any damaged paintwork shall be made good as follows:

- a) The damaged area, together with an area extending 25mm around its boundary, shall be cleaned down to bare metal.
- b) A priming coat shall be immediately applied, followed by a full paint finish equal to that originally applied and extending 50mm around the perimeter of the original damage.
- c) The repainted surface shall present a smooth surface. This shall be obtained by carefully chamfering the paint edges before and after priming.

14.05.00 Surface preparation and painting work shall not be carried out under the following weather conditions:

- a) When the surface is wet or expected to become wet before the paint/primer has dried up due to impending rain, fog or mist.
- b) High winds.
- c) Ambient temperature below 5deg.C or surface temperature less than 3 deg.C above dew point.



- d) Relative Humidity is more than 85%.

14.06.00 Inspection and Testing of Painting

The following inspection and testing shall be performed during and on completion of paint systems.

- Shot blasting profile shall be checked using a suitable profile-meter. Acceptable profile shall be 25-30 microns.
- Check of time of top coating and drying, in accordance with the recommendation of paint manufacturer.
- Check of Dry Film thickness by suitable Non Destructive Equipment. The painting shall be rejected if any of the spot measurement shows thickness to be less than 80% of the specified thickness.
- Check of adhesion of Paint Material by "Chequering" or another suitable method.
- Check of porosity of coating for internals, by the use of a suitable instrument.
- Visual inspection of appearance and uniformity of the surfaces painted.

If during above inspection, painting defects are observed, the Bidder shall carry out rectification to bring the faulty surface to the acceptable degree.

The areas where defective or damaged coatings have been repaired or replaced shall be re-inspected to the original requirements.

Surface temperature and humidity readings shall be taken prior to application of each coat. The work shall not proceed if the ambient temperature parameters are outside the requirements of this specification. If more stringent, the coating manufacturer's requirement shall dictate.

The dry film thickness shall be tested with a micro test film gauge or an accepted equivalent. The testing method shall be in accordance with SSPC – PA 2.

15.00.00 COLOUR CO-ORDINATION & FINISH

15.01.00 Exterior surfaces throughout the plant shall be finished in colours and textures which will blend harmoniously together and with the surrounding landscape.

15.02.00 Interior surfaces throughout the plant shall be finished in colours and textures which will blend harmoniously together and which will be conducive to; the comfort, well-being and high productivity of the operators. Operating plant and services provided shall be colour coded for ease of identification.

15.03.00 All finishes shall be durable and as far as possible maintenance free. Finishes shall be easily cleaned.





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15.04.00 Final colours and finishes shall be to the acceptance of the Owner.

16.00.00 ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT

16.01.00 Environment Protection

The plant shall be designed for installation and operation in harmony with the surrounding environment and all measures of pollution control shall be ensured by the Bidder to restrict pollution from the liquid effluent and stack emission within the limits as given below with due consideration of Environment (Protection) Rules 1986 as amended till date.

The Plant shall be designed meeting the latest environmental requirement issued by MoEF, GOI. In the event of Ministry of Environment & Forest stipulate any other conditions not specified hereunder, the Bidder shall comply with those requirements.

16.01.01 Liquid Effluent Discharge

- a) Provision laid down in schedule-I for Thermal Power Plants and also in Schedule-VI. General Standards for discharge of Environmental pollutants Part-A: Effects of Environmental (protection) Rules 1986, as amended till date.
- b) Any specific requirement of State Pollution Authorities over and above the above stipulation.

16.01.02 Air Quality Emissions

- a) Suspended Particulate Matter at chimney outlet - Maximum 30 mg/Nm³
- b) Oxides of Nitrogen (NO_x) - 100 mg/Nm³.
- c) Sulphur di-Oxide(SO₂) - 100 mg/Nm³
- d) Mercury (Hg) - 0.03 mg/Nm³
- e) The Efflux velocity from boiler stack(s) shall not be less than 25 m/sec.
- g) Outlet dust emission level of bag filter installed in AHP and CHP shall be restricted to 30 mg/NM³.
- h) For The Coal Handling Plant, areas covered under Dry Fog Dust Suppression (DFDS) shall be designed to control the dust emission level in the working area measured at distance of 2m from the dust generation sources, over and above the atmosphere background dust level to shall be within 5 mg/NM³

The Bidder shall include in his scope all necessary equipment and measuring instruments to comply with above requirements. Location and accessibility of the instruments shall be properly coordinated.





16.02.00

Noise Level Requirement

The plant shall be designed, constructed and provided with suitable acoustic measures to ensure the noise level criteria as per the following stipulations.

- a) Maximum noise level shall not exceed 85 dB (A) when measured at 1.0M away from the noise emission source.
- b) Maximum noise level from its source within the premises shall not exceed 70 dB (A) as per Environment (Protection) Rules 1986, Schedule-III, 'Ambient Air Quality Standards' in respect of noise.
- c) Any statutory changes in stipulations regarding noise limitation that may occur in future according to State Pollution Control Board or Central pollution Control Board or Ministry of Environment & Forest regulation during tenure of the contract, the Successful Bidder shall comply with the requirement.

17.00.00

INSPECTION AND TESTING

17.01.00

Inspection and Tests during Manufacture

17.01.01

The method and techniques to be used by the Successful Bidder for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.

17.01.02

The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.

17.01.03

Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.

17.01.04

Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Successful Bidder may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Successful Bidder shall forthwith forward to the Owner's Engineer duly certified copies of the Test Certificates in Three (3) copies for approval.

17.01.05

Under no circumstances any repair or welding of castings be carried out without the consent of the Engineer. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Engineer.

17.01.06

All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.



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Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Successful Bidder shall allow for trial assembly prior to dispatch from place of manufacture.

- 17.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material.
- 17.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than one hour.
- 17.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.
- 17.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnuflux and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by the Successful Bidder. Successful Bidder's scope and responsibility shall also include preparation of all necessary documents in the specific formats stipulated by the statutory bodies, coordination and follow up for above approvals.
- 17.02.00 **Performance Tests at Site**
- 17.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Successful Bidder on site under normal operating conditions. The Successful Bidder shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.
- 17.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.
- 17.02.03 The Successful Bidder shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.
- 17.03.00 For details of specific tests required on individual equipment refers to respective section of this specification.





18.00.00

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TRAINING OF OWNER'S PERSONNEL

The Successful Bidder shall extend all possible assistance and co-operation to the Purchaser regarding the transfer of technology and developing expertise in the area of engineering operation and maintenance of the Plant.

Number of man-days of training as mentioned below shall be included in his Tender.

18.01.00

Training at Successful Bidder's Premises

The Successful Bidder shall conduct training of Sixty Five (65) engineers of the Purchaser on engineering, operation and maintenance of the Plant at the Successful Bidder's or Associates or Sub Vendor's premises where adequate training facilities are available during the design and manufacturing stage of the successful Bidder.

The total man-months for training of engineers shall be maximum sixty (60), having following indicative break-up:

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Discipline	No. of Engineers	No. of Man-month
Operation	25 heads	25
Maintenance Boiler, Turbine,	25 heads	25
Electrical Maintenance	5 heads	5
Control & Instrumentation	10 heads	5
	-----	-----
	65 heads	60
	-----	-----

However, the details of the training programme will be discussed and finalised with the successful Bidder.

The training may also be arranged by the Successful Bidder in any Plant where the equipment manufactured by the Successful Bidder or his Associates is under installation, operation or testing to enable the trainees to become familiar with the equipment being furnished by the Successful Bidder. All expenses inherently related to the training shall be borne by the Successful Bidder and shall include but not limited to travel expenses in case of off-shore training (international and inland fares), lodging and per diem charges as well as medical insurance, instructors fee, programme and miscellaneous cost to be incurred during the training.

The training programme shall be adequate for the trainees to acquire the necessary expertise and competence in the area of engineering, operation and maintenance and as trainers for in-house technology transfer programme of the Purchaser.

The Successful Bidder shall be responsible for the development of the Training Module and Programme Schedule, which shall be submitted to the Purchaser for approval.

The components of the training modules shall include but not be limited to the training procedures/methodology, instructional materials such as audio visual materials, CDs and slides and manuals for each trainee.

Three (3) sets of the materials included in the training modules shall be handed over to the Purchaser upon completion of the training. An evaluation shall be jointly undertaken by the Successful Bidder and the Purchaser's representative on the adequacy, appropriateness and relevance of the training and the programme effectiveness after the training. The training material shall be in English language only.

The content of the training programme shall include but not be limited to :

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.



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2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

Said training programme shall be submitted to the Purchaser for approval.

The timing of the training should be such that the participants will be conversant with sufficient know-how to participate in the pre-commissioning and commissioning tests of the Plant.

The Successful Bidder shall provide qualified English speaking instructors and training coordinator(s) during the tenure of the training programme.

18.02.00 Operation and Maintenance Training at Site

The Successful Bidder shall provide a comprehensive training programme related to design application, plant management, operation and maintenance, including trouble shooting, of the Successful Bidder's supplied system and equipment at the Site starting from Start of Commissioning and thereafter up to the Final hand over of the Unit..

The following instructors shall be at the Site continuously during the training :

- a) One (1) for Steam Generator and Auxiliaries
- b) One (1) for Turbine Generator and Auxiliaries
- c) One (1) for Electrical Works
- d) One (1) for Instrumentation and Control (Boiler and Auxiliaries)
- e) One (1) for Instrumentation and Control (Turbine and Auxiliaries)

18.03.00 On-the-Job Training

During the period of pre-commissioning, commissioning and trial operation, the Purchaser shall provide operation and maintenance personnel to assist the Successful Bidder in the operation and maintenance of his supply and work under the direction of the Successful Bidder for the purpose of on-the-job training.

The Purchaser shall have the right to send to the Site his employees later intended to operate and maintain the equipment supplied under this Contract. The successful Bidder shall, without additional cost, use his site staff to instruct these employees on the operation and maintenance of the equipment. All instructions shall be in the English language.



ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers (ASME).
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Performance Test Code (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).



- y) Standards of Manufacturer's Standardization Society (MSS).
- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Ministry of Environment & Forests, Govt. of India.
- hh) Central Board of Irrigation and Power (CBIP) Publications.
- ii) National Building Code (NBC).
- jj) Indian Road Congress (IRC).
- kk) Latest guidelines of Railway Authority.



CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

The guidelines shall be applied in general, unless otherwise stated in other technical Volumes. In addition to these guidelines, Bidder shall refer the attached Plot Plan, drawing no. **12A05-DWG-M-003A**, for tentative arrangement of the various facilities under this package.

ITEM	SPECIFICATION REQUIREMENT
A. Site conditions to be considered	
1. Prevalent wind direction during summer (for deciding Cooling Tower orientation)	Refer wind-rose in plot plan.
2. Prevalent wind direction(s) during dry seasons (for deciding the location of coal stock pile and ash dump/ unloading areas, minimising the pollution effect due to dust)	Refer wind-rose in plot plan
3. Location of:	
a) Water intake point.	Towards South.
b) Water discharge point.	-.
c) Plant drainage outfall point(s).	Towards East.
d) Railway entries & exits.	Towards South.
e) Road entries & exits.	Towards North & North-East.
f) Electrical power transmission grid system.	Towards East.
g) selected ash dump area.	Towards North.
h) Nearest residential area.	Towards South.



ITEM	SPECIFICATION REQUIREMENT
B. Layout Requirements	
1. Maximum permissible slope in	
a) Rail track	1 in 400
b) Road	1 in 30
c) Sides of unpaved embankment	1 in 2
2. Required road width	
a) Main roads	8.0 Metres with 2.5m wide shoulders on either side.
b) Auxiliary interconnections	4.0 Metres with 1.0m wide shoulders on either side.
c) Road to the power house unloading bay :	
• Only for entry to the unloading bay	Yes.
• To pass through the unloading bay	No.
3. Required minimum horizontal distance between the nearest points of	
a) Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b) Electrical transformer and any other	As per the Tariff Advisory building/facility Committee Rules.
c) Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee Rules.
d) Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code.
4. Required minimum vertical clearance	
a) Under pipes/cable racks at road crossings	8.0 Metres.
b) Soil coverage over underground pipes	1.0 Metre (minimum).
c) Pipe/Cable trench	No Trench. Pipe/Cable Racks shall be used exclusively.



ITEM	SPECIFICATION REQUIREMENT
5. Railway Wagon clearance	As per the rules of the Indian Railways.
6. Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres.
7. Required level, above the local developed grade level, of	
a) top of all roads	150 mm.
b) all outdoor paved areas	150 mm.
c) Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes.



BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

ITEM	SPECIFICATION REQUIREMENT
A. Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1. Horizontal, in all directions	
a) Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1200 mm.
b) Adjacent to any other plant facilities (including walls/structures)	1000 mm.
2. Vertical (head-room clearance)	
a) Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.2 Meters.
b) Under any other plant facilities (including structures, pipes etc.)	2.2 Meters.
3. For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment.
4. Minimum clear hand space required for	
a) The application of thermal insulation	100 mm
b) Welding work	150 mm
c) Bolt tightening	150 mm



B. Floors, platforms, staircase, ladders, walls, doors & windows

1. Statutory Requirement

As per the regulations of OSHA, Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.

2. Operation & Maintenance Requirement

- a) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.

Yes

- b) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.

Yes

3. **Plinth level** of all buildings, above the Finished Ground Level (FGL)

300 mm. However, 500 mm for power house building.

4. **Minimum access** opening required (with rolling shutter)

3.5 m wide x 4 m high or, more wherever entry of loaded truck is envisaged, depending upon the equipment size to be handled.

C. Other Maintenance Requirement

C. Other Maintenance Requirement

1. Generator stator handling

In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.

Yes





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2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, air compressors, blowers, heat exchangers, fuel oil pumps, filters etc. Shall be possible without disconnecting or dismantling any piping/ducting.
3. Overhauling and handling of the casings for the above items Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach

Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible. Yes
- D. Central Control Room

All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room. Yes

The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.

However, as a guide line, following features are given :
 - a) False ceiling and false flooring shall be provided.
 - b) Uniform height, colouring schemes for cabinets etc. shall be available.
 - c) The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.
 - d) No opening shall be provided from Boiler side.
 - e) Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.



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- f) Cable entry for the panels/consols shall be from bottom and suitable openings shall be provided.
- g) The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.
- h) Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.
- i) Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.

D. Toilet and drinking water facility

Required in all buildings and on all floors wherever operating personnel are to be deployed.



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SECTION-VI

PROJECT MANAGEMENT AND SITE SERVICES



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SECTION-VI

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

- a) Planning and Monitoring
- b) Owner's Engineering Management
- c) Contracts Management
- d) Quality Assurance, Inspection & Expediting
- e) Construction Management
- f) Spares Management
- g) Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The project management team shall be stationed at the organizational headquarter and headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. . He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters related to this contract.

1.02.02 Central Co-ordination Cell

The central coordination/ cell shall be based in Kolkata and shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or references made by Owner and his Consultants without having the need to refer to his headquarters each time.





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1.02.03 Site Organisation

The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.

1.02.04 Organisation Chart

The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.

1.03.00 Implementation Schedule

The following milestones shall be followed by the Contractor against each activity as detailed below:

1.	Letter of Award (LOA)	Zero Date
2.	Supply Completion	36 months from LOA
3.	Synchronization	38 months from LOA
4.	Completion of Trial Operation	42 months from LOA
5.	System & Completion of all facilities as per contract and handing over	45 months from LOA After rectifying all jobs as identified in the Punch List to the satisfaction of the Owner.
6.	P. G. Test	To be completed within three (3) months after Completion of all facilities and handling over.
7.	Guarantee/Warranty Period	For a period of 18 months from the date of completion of the facilities or twelve (12) months from the date of operation acceptance (or any part thereof), whichever occurs first and any suitable extension of time for completion of rectified job granted by Employer
8.	Final Acceptance	After the expiry of defect liability period



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1.03.01 Owner's Engineering Schedules

These schedules shall cover various design submissions indicating different Owner's Engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment/ item covered in the scope of this specification.

1.03.02 Manufacturing Schedule

The Contractor shall submit to the Owner's Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Award (LOA). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Owner's Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.

1.03.03 Erection Schedules

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules along with requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of Contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, Primavera.

1.04.00 Detailed Responsibilities

1.04.01 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network consisting of at least 500 activities.





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The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of Owner's Engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid, which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed package wise status of Owner's Engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.





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- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.04.02 Owner's Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of Owner's Engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for Owner's Engineering activities.

Based on (L-2) network, the Bidder shall further develop the Level-3 (L-3) network for Owner's Engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Award and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software.

The Owner's Engineering management team should also co-ordinate all interface Owner's Engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related Owner's Engineering documentation before the same is submitted to the Owner.

1.04.03 Contracts Management

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacturing can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks





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shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of bought out items, detailed shipping schedule and cash flow statement for Owner's approval.

1.04.04

Quality Assurance, Inspection and Expediting

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacturing is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior to placement of Letter of Award. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after six (6) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site up to erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

1.04.05

Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Award, the Contractor shall submit a programme of construction/erection/commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These





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programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in-charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

1.04.06 **Spares Management**

Along with the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

- a) Mandatory spares
- b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised within twelve (12) months thereafter.

1.05.00 **Project Progress Review Meetings**

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution in respect of Sagardighi Thermal Power Plant unit #5 will be held initially at least once in two (2) months at Kolkata/site. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.





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1.06.00 **Owner's Consultant**

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner/Owner's Consultant and Contractor/Contractor's project management team shall be finalised during contract negotiations.

1.07.00 **Commissioning Management**

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

- a) Commissioning Teams.
- b) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the following manner and submitted for Owner's approval :

- a) Paper of Principle

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

- i) Establish design data against which Plant Performance will be compared.
- ii) Set-out the testing objectives and proposals.
- iii) Define the documentation required.

- b) **Testing/Commissioning Schedule**

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

- c) **Standard Check Lists**

Standard checklists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.





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1.07.03 Test Reports

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-à-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

2.00.00 SITE SERVICES

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

- 2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.
- 2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/F.O.B. port of shipment by Contractor till receipt of the same at site.
- 2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Owner's Engineer a report detailing all the receipts during the week.
- 2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.
- 2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
- 2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

For Coal Handling Plant, satisfactory operation of the system, amongst others, shall consist of operation without spillage or choking anywhere even during monsoon.





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Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

- 2.07.00 Supply and application of the final paints lubricating oils and all consumable till completion of facilities and hand over..
- 2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :
- 2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to be rendered under this specification.
- 2.08.02 Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
- Supply of commissioning spares.
- 2.08.03 Supply of all chemicals and consumables, e.g. Regeneration chemicals, alum, lime, polyelectrolyte, resin, welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection commissioning work till completion of facilities and hand over, except those listed under exclusion elsewhere in this specification.
- 2.08.04 Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.
- 2.08.05 All structural steel fabrication and erection work as detailed elsewhere in the specification.
- 2.08.06 Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
- 2.08.07 Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives etc. for respective portions of work under the jurisdiction of such statutes or laws.
- 2.08.08 The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in this regard.





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2.09.00 Site Organisation

The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site.

On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.10.00 General Guidelines for Field Activities

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's Owner's Engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's Owner's Engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication to owner.

2.10.03 The Owner's Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Owner's Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner's Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Owner's Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall





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take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Owner's Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

- 2.10.05 The Owner's Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.
- 2.10.06 The works under execution shall be open to inspection & supervision by the Owner's Owner's Engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.
- 2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's Owner's Engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. The contractor shall engage maximum number of local unskilled and semi skilled labours for construction works. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general Owner's Engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Owner's Engineer.
- 2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Owner's Engineer, will have to be done by the Contractor.





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- 2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Owner's Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :
- a) Product groups under which these items are re-leased are not covered in the scope of this tender.
 - b) Items are supplied by an agency other than the Contractor.
- 2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub oil system, carryout the hydraulic test of oil coolers, etc.
- 2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Owner's Engineer, with all the necessary tools & tackles, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Owner's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.
- 2.10.16 Equipment and material, which are wrongly installed, shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.
- 2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.
- 2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.
- 2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No





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temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.

- 2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the safe operation of valves will be arranged by the Contractor.
- 2.10.21 For civil, structural and architectural works, volume IIG/1 & IIG/2 may be referred. For Instrumentation and Electrical works Vol. IIE and Vol. IIF1 & F2 may be referred.
- 2.11.00 Safety
- 2.11.01 Safety and overall cleanliness of work site shall be given top priority. The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.
- 2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.
- 2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.
- 2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.
- 2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be periodically done by the Contractor. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.





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- 2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.11.11 Adequate number of temporary toilets/urinals (men & women separate) shall be provided at work places with soak pits. Adequate drinking water facilities and rest rooms shall be provided for workers to take food and rest.
- 2.11.12 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.11.13 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
- 2.12.00 Taking Delivery & Storage
- 2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the materials so issued shall be submitted to the Owner.
- 2.12.02 The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.
- 2.12.03 All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.
- 2.13.00 Site Welding & Heat Treatment
- 2.13.01 Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.
- 2.13.02 All welders shall be tested and approved by Owner's Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Owner's Engineer shall be stamped by the welder on each joint done by them. The





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Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.

- 2.13.03 The Owner's Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Owner's Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.
- 2.13.04 All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.
- 2.13.05 All welded joints shall be subject to acceptance by Owner's Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.
- 2.13.06 Preheating/post-heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Owner's Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Owner's Engineer prior to the commencement of each cycle and handed over to Owner's Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.
- 2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Owner's Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.
- 2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.





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- 2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.
- 2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.
- Fillet weld shall be made by shielded metal arc process as per applicable codes.
- However, the Owner's Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.
- In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.
- 2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.
- 2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.
- 2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- 2.13.14 Each layer of welding shall have an even and smooth appearance.
- 2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.
- 2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surfaced to be welded are wet from any cause.
- 2.13.17 Following will be stages of inspection during welding:
- a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Owner's Engineer.
 - b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.





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- c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.

2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.

2.14.00 For further details on procedures of work at site on civil, architectural, electrical and instrumentation & control services, refer Volume: II-E, II-F1 & F2 and II-G/1 G/2 & G/3 of this specification.

3.00.00 PROTECTION AND CARE

3.01.00 All construction and erection activities for this project are to be carried out in the plant premises.

3.02.00 Generator Stator Lifting may be considered by either of the two options as mentioned below:

- a) With the help of two (2) nos. turbine room cranes.
- b) With the help of separate lifting arrangement to be provided by the Bidder from outside the TG building A-row column before the construction of A-row building wall.





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Annexure-I

“The Vendor list as included is not exhaustive and prepared from prior experience of WBPDCL. In case of items not covered in the list or if the bidder seeks additional vendor on the items already covered in the list, the same should be done with proper written request for approval from WBPDCL enclosing the vendor credentials. Maximum effort should be exercised to include only such proven vendors who are already registered in the Bidder's Vendor directory and the bidder has prior experience of supply items from such reputed vendors.”

Sl. No.	Item Description	Vendor Name	
1	SEVERE SERVICE CONTROL VALVE. (PRDS & SH/RH ATTEMPERATION APPLICATION)	1	CONTROL COMPONENTS INC
		2	DRESSER VALVE INDIA PVT.LTD.
2.	BFP RECIRCULATION CONTROL VALVE	1	CONTROL COMPONENTS INC
		2	DRESSER VALVE INDIA PVT.LTD.
3.	NORMAL SERVICE CONTROL VALVE	1	MIL CONTROLS LTD.
		2	FISHER SANMAR LTD.
		3	DRESSER VALVE INDIA PVT.LTD.
		4	CONTROL COMPONENTS INC
4.	OIL TRIP VALVES (FUEL OIL SYSTEM)	1	MIL CONTROLS LTD.
		2	KHUME ARMATUREN GMBH
		3	DRESSER VALVE INDIA PVT. LTD.
5.	STEEL GATE / GLOBE / NR VALVES	1	WEIR B.D.K VALVES INDIA PVT. LTD.
		2	KIRLOSKAR BROTHERS LTD.
		3	LEADER VALVES LTD.
		4	KSB VALVES
		5	FOURESS ENGG.INDIA LTD.
		6	VAG VALVES
		7	AUDCO INDIA
		8	DEWARANCE
6.	BALL VALVES	1	FLOW CHEM INDUSTRIES
		2	FISHER SANMAR LIMITED
		3	KIRLOSKAR BROS. LTD.
		4	LEADER VALVES LTD.
		5	KSB VALVES
		6	WEIR B.D.K VALVES INDIA PVT. LTD.
		7	VAG VALVES
7.	CAST IRON GATE /GLOBE/ NRV/ SAFETY RELIEF VALVES	1	H.SARKER & COMPANY
		2	G.M.DALUI & SONS PVT.LTD.
		3	KIRLOSKAR BROS. LTD.





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Sl. No.	Item Description	Vendor Name	
		4	LEADER VALVES LTD.
		5	VENUS PUMP & ENGG. WORKS
8.	GUN METAL VALVES	1	LEADER VALVES LTD.
		2	SANT VALVES PVT. LTD.
		3	VALTECH INDUSTRIES ,MUMBAI
		4	SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY,CHENNAI
		5	VAG VALVES
9	BUTTER FLY VALVES (STEAM SERVICE)	1	FOURESS ENGG.INDIA LTD.
		2	INSTRUMENTATION LTD.
		3	BDK PROCESS CONTL. HUBLI
10.	BUTTER FLY VALVES (WATER SERVICE)	1	WEIR B.D.K VALVES INDIA PVT. LTD.
		2	FOURESS ENGG.INDIA LTD.
		3	INSTRUMENTATION LTD.
		4	LARSEN & TOUBRO LTD.
		5	KIRLOSKAR BROS. LTD.
		6	VENUS PUMP & ENGG. WORKS
		7	TYCO VALVES & CONTROLS INDIA PVT.LTD.
11.	SPRING LOADED BYPASS VALVES	1	WEIR VALVES & CONTROLS M.E.
12.	PLUG VALVES	1	WEIR B.D.K VALVES INDIA PVT. LTD.
		2	FISHER SANMAR LIMITED
		3	LARSEN & TOUBRO LTD
		4	LEADER VALVES LTD.
13.	ANGLE DRAIN VALVES	1	REINEKE MEB-UND REGELTECHNIK GMBH
		2	SEMPELL AG, GERMANY
		3	VELAN INC.,CANADA
14.	AIR RELEASE VALVES	1	H.SARKER & COMPANY
		2	LEADER VALVES LTD.
		3	VENUS PUMP & ENGG. WORKS
		4	G.M.DALUI & SONS PVT.LTD.
15.	DUAL PLATE CHECK VALVES	1	VENUS PUMP & ENGG. WORKS
		2	FLUIDLINEVALVES COMPANY PRIVATE LTD.
		3	SURYA VALVES AND INSTRUMENTS MANUFACTURING COMPANY
		4	CHEMTECH INDUSTRIAL VALVES PVT.





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Sl. No.	Item Description	Vendor Name	
			LTD.
		5	ASIAN INDUSTRIAL VALVES & INSTRUMENTS,
16.	FLOAT VALVES	1	H.SARKER & COMPANY
		2	G.M.DALUI & SONS PVT.LTD.
		3	LEADER VALVES LTD.
17.	FUEL OIL PUMPS (POSITIVE DISPLACEMENT PUMPS)	1	TUSHACO PUMPS PVT. LTD.,
		2	ALEKTON ENGG.INDUSTRIES PVT.LTD.
		3	U.T.PUMPS & SYSTEMS (P) LTD.
18.	JACKING OIL PUMPS WITH MOTOR (SCREW TYPE)	1	TUSHACO PUMPS LIMITED
		2	ALLWEILER AG ,GERMANY
19.	AUX. OIL PUMP (AOP) & EMERGENCY OIL PUMP WITH MOTOR (EOP)	1	KSB PUMPS LIMITED
		2	MATHER & PLATT PUMPS
		3	KBL
20	VACUUM PUMPS	1	EDWARDS LIMITED, UK
		2	NI-TECH INC. USA
		3	NASH ELOM INDUSTRIES, GERMANY
21	LUB OIL TRANSFER PUMPS	1	MATZ PUMPS PVT.LTD.
		2	TUSHACO PUMPS PVT.LT
22	CONCRETE VOLUTE PUMP	1	KIRLOSKAR BROS. LTD.
		2	CLYDE UNION PUMPS
		3	FLOWERVE CORPORATION
23.	PUMPS (VERTICAL)	1	KIRLOSKAR BROS. LTD.
		2	KSB PUMPS LTD.
		3	SULZER PUMPS INDIA LTD.
		4	WEIR,UK
		5	WPIL LIMITED
		6	FLOWMORE
24.	PUMPS (HORIZONTAL)	1	KIRLOSKAR BROS. LTD.
		2	MATHER & PLATT PUMPS LTD.
		3	KSB PUMPS LTD.
		4	SULZER PUMPS INDIA LTD.
		5	WEIR,UK
25.	SUMP PUMPS / SUBMERSIBLE PUMPS/ SLUDGE PUMP	1	KISHOR PUMPS PVT.LTD
		2	KIRLOSKAR BROS. LTD.
		3	KSB PUMPS LTD.
		4	SAM TURBO
26.	LUBE OIL PUMPS	1	KSB PUMPS LTD.





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Sl. No.	Item Description	Vendor Name	
	(CENTRIFUGAL)FOR TDBFP	2	KIRLOSKAR EBARA, KIRLOSKARWADI
		3	SULZER, MUMBAI.
27.	LUBE OIL PUMPS (SCREW TYPE) FOR TDBFP	1	ALLWEILER, GERMANY
		2	IMO PUMP, USA
		3	TUSHACO, DAMAN
		4	LEISTRITZ (EMPIRE), GERMANY
28.	JACKING OIL PUMP TDBFP	1	TUSHACO, (DELTA CORP)
		2	HAGULLAND DENSION
29.	SCANNER AIR FAN	1	M/S.C.DOCTOR & CO.PVT.LTD.
		2	M/S PATELS AIRFLOW LTD.
		3	M/S.AIR CONTROL & CHEMICAL ENGG. CO.LTD.
30.	FLOW ELEMENTS	1	MICRO PRECISION PRODUCTS
		2	M/S ESPL KOLKATA
		3	IL PALGHAT
31.	OIL PURIFICATION UNIT (OIL CENTRIFUGE)/PORTABLE OIL PURIFIERS	1	PENNWALT LIMITED, INDIA
		2	ALFA LAVAL LIMITED, INDIA
		3	SERVIZ INDUSTRIAL, ITALY
32.	ELECTRICAL HOIST	1	AVON CRANES PVT.LTD.
		2	LIFTING EQUIPMENTS & ACCESSORIES
		3	REVA INDUSTRIES LTD
		4	CONSOLIDATED HOIST PVT LTD
		5	TUOBRO FURGUSON(INDIA)PVT.LTD
		6	HERCULES HOISTS LTD.
		7	DYNAMECH CRANES (P) LTD.
		8	UNIVERSAL HOIST – O- FABRIK
		9	ARMSEL MHE PVT.LTD
33.	CHAIN PULLEY BLOCK	1	ARMSEL MHE PVT LTD
		2	LIFTING EQUIPMENT & ACCESPROES
		3	UNIVERSAL HOIS –O-FABRIK
		4	HERCULES HOISTS LTD.
		5	TUOBRO FURGUSON(INDIA)PVT.LTD
34.	DOUBLE GIRDER EOT CRANE ABOVE 50T TO 150T (TG/GT HALL & OTHER AREAS)	1	HEAVY ENGG. CORPORATION LTD.
		2	MUKAND LIMITED,
		3	THE TATA IRON & STEEL CO.LTD
		4	UNIQUE INDUSTRIAL HANDLERS PVT.LTD
		5	WMI CRANES LTD.
		6	FURNACE & FOUNDRY EQUIPMENT





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Sl. No.	Item Description	Vendor Name	
			CO.
35	DOUBLE GIRDER EOT CRANES UPTO 50T	1	WMI CRANES LTD.
		2	THE TATA IRON & STEEL CO.LTD
		3	UNIQUE INDUSTRIAL HANDLERS PVT.LTD
		4	MUKAND LIMITED,
		5	AVON CRANES PVT.LTD.
		6	REVA INDUSTRIES LTD.
		7	HEAVY ENGG. CORPORATION LTD.
		8	FURNACE & FOUNDRY EQUIPMENT CO.
36	SINGLE GIRDER EOT MISC.CRANES	1	REVA INDUSTRIES LTD.
		2	CONSOLIDATED HOIST PVT LTD
		3	LIFTING EQUIPMENTS & ACCESSORIES
		4	TUOBRO FURGUSON(INDIA)PVT.LTD
37	FURNACE MAINTENANCE PLATFORM	1	N.V.SKY CLIMBER EUROPE S.A
		2	N.V.SKY MAN INTERNATIONAL S.A.
		3	HING WING GONDOLA (HK) CO LTD, HONGKONG
38	ELEVATOR-PASSENGER CUM GOODS	1	KONE ELEVATOR INDIA LTD.
		2	OTIS ELEVATOR
		3	CITY LIFT (I) LTD.
		4	ECE Industries Ltd
39.	CASTABLE REFRACTORY	1	BASKAR REFRACTORIES AND S.W PIPES(P)LTD
		2	THE ACE REFRACTORIES LTD.
		3	DALMIA REFRACTORIES
		4	SOUVENIOR CERAMICS
40.	POURABLE INSULATION	1	BASKAR REFRACTORIES & STONEWARE PIPES(P)LTD
		2	THE ACE REFRACTORIES LTD.
		3	DALMIA REFRACTORIES
41.	FIRE BRICKS	1	BASKAR REFRACTORIES AND STONEWARE PIPES (P) LTD
		2	THE ACE REFRACTORIES LTD.
		3	DALMIA REFRACTORIES
		4	R V REFRACTORIES
42.	WOOL MATTRESS	1	ROCKWOOL INDUSTRIES LTD
		2	MINWOOL ROCK FIBRES LTD
		3	LAPINUS ROCKWOOL PVT. LTD





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Sl. No.	Item Description	Vendor Name	
		4	ROCKWOOL INDIA LTD.
		5	LLOYD INSULATION (I) LTD.
		6	LLOYD ROCKFIBRES LTD.
43.	THERMAL INSULATION OF STEAM TURBINE/THERMAL INSULATION OF TURBINE INTEGRAL PIPING/THERMAL INSULATION- ROCKWOOL MATTRESSES/ PIPE SECTIONS	1	LLOYD INSULATIONS
		2	MINWOOL ROCK FIBERS
		3	ROCKWOOL
		4	LAPNNUS ROCKWOOL
44.	THERMAL INSULATION - ANCILLARY MATERIAL	1	LLOYD INSULATIONS (INDIA) LIMITED
		2	SURESH INDUSTRIAL CORPORATION
		3	ALLIED INSULATIONS (INDIA), GHAZIABAD
		4	ENERGY SAVING & ALLIED PRODUCTS
45	STEAM TRAPS	1	PREMIUM ENERGY TRANSMISSION LTD (GREAVES)
		2	SPIRAX MARSHALL PVT.LTD.
		3	PENNANT ENGINEERING PVT.LTD.
		4	LEADER VALVES LTD.
		5	OTOKLIN PLANTS AND EQUIPMENTS
46	AIR TRAPS	1	PENNANT ENGINEERING PVT.LTD.
		2	SPIRAX MARSHALL PVT.LTD.
47	CW TREATMENT PLANT (Items to be procured from the approved Vendor List)	1	CLEAR WATER LTD.
		2	THERMAX LTD.
		3	DRIPLEX WATER ENGG. LTD.
		4	CHEMBOND ASHLAND WATER TECHNOLOGIES LTD.,MUMBAI
		5	VA TEC WABAG LTD
48	GRAVIMETRIC FEEDER	1	STOCK INDIA
		2	MERRICK
49.	PORTABLE FIRE EXTINGUISHERS	1	ALERT FIRE SERVICES
		2	KOOVERJI DEVSHI & CO.PVT.LTD
		3	SAFEX FIRE SERVICES LTD.
		4	VIJAY INDUSTRIES & PROJECTS LTD
		5	ZENITH FIRE SERVICES (INDIA) PVT LTD
		6	NEW ENGINEERING CORPORATION
		7	NITIN FIRE PROTECTION INDUSTRIES LTD





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Sl. No.	Item Description	Vendor Name	
		8	KANADIA FYR FYTER PVT.LTD.,
		9	GUNNEBO INDIA LIMITED
50	COMPRESSED AIR SYSTEM	1	ATLAS COPCO (INDIA) LTD.
		2	KOBELCO-KIRLOSKAR PNEUMATIC CO.LTD.
		3	INGERSOLL RAND (INDIA) LTD.
			KBL (only for Reciprocating type)
		4	TOSIBA,JAPAN
51	MILL REJECT SYSTEM (PNEUMATIC) (Items to be procured from the approved Vendor List)	1	MACAWBER BEEKAY PVT.LTD.
		2	DC INDTL.PLANT SERVICES PVT.LTD
		3	UNITED CONVEYOR CORPORATION (INDIA) PVT.LTD.,KOLKATA
52	CHLORINATION PLANT (Items to be procured from the approved Vendor List)	1	IEC FABCHEM LIMITED
		2	PERFECT CHLORO SYSTEMS
		3	CAPITAL CONTROLS INDIA PVT. LTD.
		4	PENWATT INDIA LTD
		5	METITO POLLUTION CONTROL INDIA LTD
53	CHEM. DOSING PLANT	1	MILTON ROY INDIA (P) LTD.
		2	SWELORE ENGG.PVT.LTD
		3	V.K.PUMP INDUSTRIES PVT.LTD.
		4	TECHNO CONSULTANTS
		5	PSI ENGINEERING SYSTEMS (P) LTD.,CHENNAI
		6	ENPRO INDUSTRIES PVT.LTD.,PUNE
54	CONDENSATE POLISHING UNIT (Items to be procured from the approved Vendor List)	1	DRIPLEX WATER ENGG. LTD.
		2	THERMAX
		3	ION EXCHANGE (INDIA) LTD
		4	VA TEC WABAG LTD, INDIA.
		5	BGR ENERGY SYSTEMS
55	COLTCS / SCS/DEBRIS FILTER (Items to be procured from the approved Vendor List)	1	TECHNOS, FRANCE
		2	GEA BGR ENERGY SYSTEM INDIA LTD.
		3	MULTITEX FILTRATION ENGINEERS LTD.
		4	FILTRATION ENGINEERS LTD.
		5	EIMCO WATER TECHNOLOGIES ,LLC, USA
		6	TAPROGGE GmbH
		7	KLUMP & KOLLER GmbH





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Sl. No.	Item Description	Vendor Name	
56	ALUMINIUM SHEETS/ COILS	1	BHARAT ALUMINIUM CO.LTD.
		2	INDIAN ALUMINIUM CO.LTD.
		3	HINDALCO INDUSTRIES LTD.
		4	NATIONAL ALUMINIUM COMPANY LTD.
57	HOC TYPE GAS DRIER	1	DELAIR INDIA PVT. LTD.
		2	ATLAS COPCO (INDIA) LTD.
58	REFRIGERATION TYPE GAS DRIER	1	DELAIR INDIA PVT. LTD.
		2	SUMMIT
		3	SAVRO
59	HP BYPASS SYSTEM.	1	SULZER-CCI AG, SWITZERLAND
60	LP BYPASS SYSTEM.	1	SULZER-CCI AG, SWITZERLAND
		2	BOMABA, GERMANY
		3	WELLAND & TUXHORN, GERMANY
61	MISC. TANKS (SHOP)	1	GENERAL MECHANICAL WORKS
		2	UNITECH MACHINES LTD.
		3	TECHNO ELECTRIC & ENGG. CO. LTD.
		4	THERMOPADS PVT LIMITED
		5	VIJAY TANKS & VESSELS LTD
62.	FLAME ARRESTOR (MISCELLANEOUS TANKS)	1	PROCESS INSTRUMENTS
		2	ASIAN INDUSTRIAL VALVES
		3	ACCOUSTICS INDIA PVT. LTD.
		4	MULTITEX FILTERS PVT. LTD.
63	M.E. BELLOWS	1	FLUIDINE ENGRS.INDIA PVT.LTD
		2	EXPANSION JOINT SYSTEMS INC. USA
		3	MUNRO & MILLER FITTINGS LTD., U.K
		4	SENIOR FLEXONICS, U.K.
		5	SUR INDUSTRIES PVT.LTD.,KOLKATA
		6	CORBIS
64	HEAT EXCHANGERS (PLATE TYPE)	1	ALFA LAVAL (INDIA) LTD.
		2	GEA ECOFLEX INDIA PVT LTD
		3	TRANSTER INDIA PRIVATE LIMITED
		4	L&T
65	JOURNAL BEARING BFP & BP/THRUST CUM JOURNAL BEARING FOR CEP/THRUST BEARING (BFP & BP)	1	COLHERENE, UK
		2	WAUKESHA BEARINGS (GLACIER), UK
		3	KINGSBURY, USA
		4	MITCHELL, UK
66.	HYDRAULIC COUPLING	1	VOITH TURBO PVT LTD



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Sl. No.	Item Description	Vendor Name	
67.	DISCONNECTING COUPLING FOR TDBFP	1	ZURN INC, USA
68.	SUCTION STRAINERS (BFP, BP & CEP)	1	OTOKLIN
		2	MULTITEX
		3	GUJARATH OTOFILT
69.	MECHANICAL SEAL (BFP/BP & CEP)	1	BURGMANN, GERMANY.
		2	EAGLE POONAWALA LTD.PUNE
		3	FLOWERVE SANMAR, CHENNAI
70	CONNECTING COUPLING FOR MD BFP SET & CEP	1	FLEXIBOX LTD., UK
		2	TURBOFLEX, UK
		3	BIBBY TURBOFLEX (FORMERLY EUROFLEX), UK
		4	EUROFLEX TRANSMISSION LTD., HYDERABAD.
71	CONNECTING COUPLING (MEMBRANE TYPE/GEAR TYPE) FOR TDBFP	1	EUROFLEX TRANSMISSION, HYDERABAD.
		2	RENK AG,GERMANY
		3	JOHN CRANE, UK
		4	KOPFLEX, USA
		5	BIBBY TURBOFLEX (FORMERLY EUROFLEX), UK
		6	AMERIDRIVES (ZURN), USA
		7	LUFKIN, USA/FRANCE
		8	BHS, GERMANY
		9	FLENDER GRAFFENSTADEN, FRANCE
74	GEAR BOX FOR TDBFP	1	WALCHAND NAGAR, PUNE
		2	RENK AG,GERMANY
		3	LUFKIN, USA/FRANCE
		4	FLENDER GRAFFENSTADEN, FRANCE
		5	BHS, GERMANY
75.	BARE RUBBER BELLOWS	1	CORI ENGINEERS PVT. LTD CHENNAI.
		2	SRM ESOFLEX PVT. LTD. KOLKATTA
		3	CORBIS
76.	SPRING SUPPORTS / HANGERS	1	SARATHI ENGG. ENTERPRISES PVT. LTD.
		2	HYDERABAD PIPING & ENERGY PRODUCTS (P) LTD. NEW DELHI
		3	SHAPE BAHADARABAD
		4	DARSHANI-INDIA
		5	PAL ENGINEERING YAMUNANAGAR
77.	SELF LUBRICATING BEARING	1	TEN MAT LTD UK





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Sl. No.	Item Description	Vendor Name	
	TUBES FOR BF VALVES	2	(FEROFORM T 814 TUBES)
		3	THORDON
		4	THORPLAS TUBES, CANADA
78	FLUIDIZING AIR HEATER	1	ESCORTS
		2	SPHEREHOT
		3	RAYCOLD
		4	INDURE PVT. LTD.
79	ALLOY C.I. FITTINGS & LINERS	1	MENON METALLIKS
		2	CRAWLEY & RAY
		3	SAM CASTINGS
		4	CRESENT
80	ASH SLURRY PUMP/ BA OVERFLOW PUMP	1	SAM TURBO
		2	INDURE PVT. LTD.
81	KNIFE GATE VALVES	1	VAAS
		2	SISTAG, SWITZERLAND
		3	TYCO, USA
		4	VELAN, UK/USA
		5	INDURE PVT. LTD.
		6	ORBINOX INDIA (P) LTD.
82	MS AND GI PIPES	1	SAIL
		2	JINDAL
		3	INDUS TUBES
		4	SURYA ROSHNI
		5	TATA
83	STAINLESS STEEL PIPES	1	RATNAMANI METAL & TUBES
84	BASALT LINED PIPES AND FITTINGS	1	INDURE PVT. LTD.
		2	DEMECH
		3	ENVIRO ABRASION
85	MS ERW PIPES (SLURRY DUTY)	1	SAIL
		2	JINDAL
		3	JCO GAS PIPES
		4	TATA
86	TWIN LOBE TYPE ROTARY FLUIDIZING AIR BLOWER	1	SWAM PNEUMATICS
		2	KAY INTERNATIONAL
		3	EVEREST
87	VACUUM PUMP / MECHANICAL EXHAUSTER (LIQUID RING TYPE)	1	KAKATI KARSHAK
		2	VACUNAIR
		3	GARDNER DENVER, KOREA
88	CRUSHER	1	THYSSENKRUPP.





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Sl. No.	Item Description	Vendor Name	
		2	MCNALLY BHARAT ENGG. CO. LTD.
		3	LARSEN & TOUBRO
		4	ELECON ENGINEERING CO. LTD
		5	TRF LIMITED
89	APRON FEEDER	1	THYSSENKRUPP
		2	LARSEN & TOUBRO
		3	ELECON ENGINEERING CO. LTD.
		4	TRF LIMITED
		5	FL SMITH
		6	METSO
		7	MCNALLY BHARAT ENGG. CO. LTD
90	BELT VULCANIZER	1	SHAW ALMEX
		2	NILOS
		3	S. V. DATTAR
91	CONVEYOR BELT	1	SEMPERTRANS NIRLON, MUMBAI
		2	JONSON RUBBER
		3	PHONIX YULE, KOLKATA
		4	HILTON-FORECH
		5	MRF
		6	YOKOHAMA
92	ROLLER SCREEN	1	MSEL
		2	THYSSENKRUPP.
		3	ELECON ENGINEERING CO. LTD
92	REDUCTION GEAR BOX (Coal Handling Plant Only)	1	PREMIUM ENERGY TRANSMISSION
		2	FLENDER LIMITED
		3	ELECON ENGINEERING CO. LTD.
93	FLUID COUPLING (Coal Handling Plant Only)	1	VOITH
		2	PREMIUM ENERGY TRANSMISSION
		3	FLUIDOMAT
94	FLEXIBLE GEAR COUPLING	1	ELECON ENGINEERING CO. LTD.
		2	FENNER
		3	WELLMAN
		4	CONCORD
		5	GMB MFG. (P) LTD., KOLKATA
		6	HI-CLIFF
		7	LOVEJOY
95	BELT CLEANERS (SPRUNG TYPE) / MODULAR TYPE SKIRT	1	HOSCH EQUIPMENT, KOLKATA
		2	TRF
		3	CORBID ENGINEERING, MUMBAI





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Sl. No.	Item Description	Vendor Name	
	SEALING	4	MASYC PROJECT PVT LTD.
		5	HYQUIP LTD, HYDERABAD.
96	THRUSTER BRAKE	1	BENGAL TECHNOCRAT
		2	WITTON KRAMER
		3	STROM CRAFT
97	BELT WEIGHER	1	INDUSTRIES SYNDICATE
		2	PBL
		3	TRANSWEIGH
		4	IPA
		5	SHENEICK PROCESS
98	TRAVELLING TRIPPER	1	MSEL
		2	BENGAL TOOLS
		3	HMTC
99	IN-LINE MAGNETIC SEPARATOR / SUSPENDED MAGNET	1	ELECTRO-ZAVOD
		2	PBL
		3	ELECTROMAGNETIC INDUSTRIES
100	ELECTRONIC METAL DETECTOR	1	ELECTROMAG DEVICES LTD., MUMBAI
		2	M. R. EQUIPMENT
		3	POWER BUILD, VALLABH VIDYANAGAR
101	CONVEYOR PULLEYS	1	BENGAL TOOLS
		2	MCNALLY BHARAT ENGG. CO. LTD.
		3	ELECON
		4	ARUDRA
102	CONVEYOR IDLERS	1	ELECON ENGINEERING CO. LTD.
		2	ARUDRA
		3	TRF LIMITED
		4	MCNALLY BHARAT, ENGG. CO. LTD.
		5	TEGA
		6	BENGAL TOOLS.
103	CENTRIFUGAL FANS (DE System)	1	ABB
		2	FLAKT INDIA
		3	TOURBOVANT
		4	APC
		5	DUSTVEN
104	VIBRATION ISOLATION	1	GERB
105	IDLER BEARING	1	FAG
		2	SKF
		3	HKT





Sl. No.	Item Description	Vendor Name	
		4	TATA TIMKEN
		5	ZKL
		6	KOYO
		7	NBC
106	RAIL CLAMP	1	SILVERLINE INTERNATIONAL.
		2	TECONNEX
107	PULLEY BEARING (SPLIT TYPE)	1	FAG
		2	SKF
		3	HKT
		4	COOPER
108	SELF ALIGNMENT (CARRIER & RETURN) ROLLER	1	TEGA.
		2	TRF LIMITED
109	RAIL	1	SAIL
		2	TATA
110	DUST EXTRACTION SYSTEM	1	THERMEX
		2	F. HARLEY
		3	TPS,DELHI
		4	SPRAYING SYSTEM , BANGALORE
111	DUST SUPPRESSION SYSTEM	1	KAVERI ULTRA POLYMER LTD.
		2	F. HARLEY
		3	TPS,DELHI
112	COAL SAMPLING UNIT	1	SUNRISE
		2	EASTMAN CRUSHER
113	ADOPTOR SLEEVE	1	SKF.
		2	BENGAL TOOLS
114	ENERGY CHAIN	1	IGUS
115	HYDRAULIC DRIVE FOR BELT CONVEYORS	2	HAGGLUNDS
116	BUNKER SEALING BELT	1	SYNERGY KOLKATA
		2	DHANVANTHRI ENGINEERS PVT. LTD.
		3	ALEX CONVEYOR
		4	MESTO
117	STRAINER	1	STRAINWELL INDIA
		2	ACME FLUID SYSTEMS
		3	SRK STRAINERS & VALVES INDIA
118	ROCK BREAKER AND GRABBER	1	JEHEL
		2	NAKODA MACHINERY
		3	MCQUAID ENGINEERING
		4	JCB INDIA LTD.



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119	RACK AND PINION GATE	1	BENGAL TOOL
		2	MSEL
		3	HMTC
		4	DA ENGG.
120	FLAP GATE	1	DA ENGG.
		2	MERIT CHENNI
		3	MMHE
		4	MSE
121	LINER PLATE	1	SAIL
		2	TATA STEEL
122	TECHNOLOGICAL STRUCTURE MATERIAL	1	SAIL
		2	TATA STEEL
		3	ZINDAL
123	HOPPER CHUTE, SKIRT BOARD WITH SUPPORTING STRUCTURE	1	MSEL
		2	HMTC
		3	MMHE
124	REVERSIBLE BELT CONVEYOR	1	DHANVANTHRI ENGINEERS PVT. LTD.
		2	ALEX CONVEYOR
		3	MESTO
		4	LA MINING
	ELECTRICAL SYSTEM VENDORS		
1	HT SWITCHGEAR (11KV, 3.3 KV)	1	
		2	AREVA LTD.
		3	BHEL.
		4	SIEMENS LTD
2	PMCC, PCC & MCC	1	AREVA LTD.
		2	LARSEN & TOUBRO LTD.
		3	SIEMENS LTD
		4	SCHNEIDER
		5	ABB
3	AIR CIRCUIT BREAKER	1	AREVA LTD.
		2	LARSEN & TOUBRO LTD.
		3	SIEMENS LTD (3WL model only)
		4	SCHNEIDER
		5	ABB
4	AC CONTACTOR / AUX. CONTACTOR	1	L&T
		2	SIEMENS LTD





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Sl. No.	Item Description	Vendor Name	
		3	SCHNEIDER
		4	ABB
		5	GE Power
5	AMMETER (INDICATING)	1	AUTOMATIC ELECTRIC
		2	IMP
		3	RISHABH INDUSTRIAL (L&T)
6	BREAKER CONTROL SWITCH/ SELECTOR SWITCH	1	KAYCEE
		2	ALSTOM LTD.
		3	GE – POWER
		4	SALZER, L&T
7	CURRENT TRANSFORMER	1	KAPPA ELECTRICALS
		2	PRAGATI ELECTRICALS
		3	PRAYOG
		4	SILKAANS
		5	PRECISE ELECTRICS
		6	SOUTHERN ELECTRICS
		7	SIEMENS
		8	AUTOMATIC ELECTRIC
		9	INDCOIL
8	CONTROL TRANSFORMERS	1	KAPPA ELECTRICALS
		2	SILKAANS
		3	SOUTHERN ELECTRICS
		4	PRECISE ELECTRICS
		5	AUTOMATIC ELECTRIC
		6	INDCOIL
9	VOLTAGE TRANSFORMERS (VT)	1	INDCOIL
		2	KAPPA ELECTRICALS
		3	PRAGATI ELECTRICALS
		4	PRAYOG
		5	PRECISE ELECTRICS
		6	SILKAANS
		7	SOUTHERN ELECTRICS
		8	AUTOMATIC ELECTRIC
		9	SIEMENS
10	ACDB, DCDB, AC/DC FUSE BD, MLDB, ELDB, PDB, WELDING DB, VENTILATION DB	1	SCHNEIDER
		2	L&T
		3	SIEMENS
		4	GE – POWER
		5	ABB





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Annexure-I

Sl. No.	Item Description	Vendor Name	
11	OIL FILLED TRANSFORMER (More than 10 MVA)	1	BHEL
		2	GE
		3	AREVA T & D INDIA LIMITED
		4	FUJI
		5	ABB
		6	ALSTOM
12	OLTC	1	BHEL
		2	CTR
		3	MASCHINENFABRIK REINHAUSEN(MR)
13	OIL FILLED TRANSFORMER (Less than 10MVA)	1	CROMPTON GREAVES LTD.
		2	GE
		3	AREVA T & D INDIA LIMITED NAINI
		4	FUJI
		5	ABB
		6	ALSTOM
		7	KIRLOSKAR ELECTRIC CO. LTD.
		8	VOLTAMP TRANSFORMER LTD.
		9	ANDREW YULE & COMPANY LTD.
		10	BHEL
14	ELECTRONIC MOTOR PROTECTION RELAY (EMPR) INCLUDING EOCR	11	SUDHIR TRANSFORMER
		1	AREVA
		2	SIEMENS
		3	L&T
		4	GE – POWER
15	ENERGY METER	5	SCHNEIDER
		1	SECURE METERS (SEMS)
		2	SCHNEIDER CONZERVE
16	FUSES ALONG WITH FUSE BASE	3	L&T
		1	L&T
		2	ALSTOM LTD.
		3	SIEMENS
		4	SCHNEIDER
17	ISOLATING SWITCH	5	ABB
		1	SALZER, L&T
		2	SIEMENS
		3	ALSTOM LTD.
		4	GE – POWER
		5	SCHNEIDER





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Annexure-I

Sl. No.	Item Description	Vendor Name	
		6	ABB
		7	KAYCEE
18	INTERPOSING RELAYS	1	JYOTI
		2	OEN
		3	ABB
		4	ELESTA
19	INDICATING LAMP (LED)	1	SIEMENS
		2	VAISHNO
		3	L&T
		4	ALSTOM LTD.
		5	BCH
		6	GE – POWER
		7	SCHNEIDER
		8	CONCORD
		9	TECKNIC CONTROLS
		10	ABB
		11	ESSEN DEINKI
20	NON SEGREGATED PHASE BUS DUCTS	1	M/S KGS Engineering Limited
		2	L&T
		3	SIEMENS
		4	ALSTOM LTD.
		5	BEST & CROMPTON
21	LPBS (NON-FLAME PROOF)	1	L&T
		2	SCHNEIDER
		3	SIEMENS
22	LPBS(FLAME PROOF)	1	BALLIGA
		2	EX-PROTECTA
23	LOCAL MOTOR STARTER	1	L&T
		2	TELEMACHANIQUE (SCHNEIDER)
		3	SIEMENS
		4	ABB
		5	GE – POWER
24	MCCB(AC)	1	L&T
		2	GE – POWER
		3	SIEMENS
		4	SCHNEIDER
		5	ABB.
25	MCCB(DC)	1	L&T
		2	GE – POWER





Sl. No.	Item Description	Vendor Name	
		3	SIEMENS
		4	SCHNEIDER
		5	ABB.
26	MULTIFUNCTION METER	1	SECURE METERS (SEMS)
		2	SCHNEIDER CONZERVE
27	MINIATURE CIRCUIT BREAKER (MCB)	1	SCHNEIDER
		2	L&T
		3	SIEMENS
		4	ABB
28	MOTOR PROTECTION CIRCUIT BREAKER (MPCB)	1	AREVA
		2	SIEMENS
		3	L&T
		4	SCHNEIDER
		5	ABB.
29	NGR	1	RESITECH
		2	S. R. NARKHEDE
		3	RSI SWITCHGEAR
30	NUMERICAL RELAY	1	ABB
		2	AREVA MICOM
		3	SIEMENS (SIPROTEC)
		4	GE – POWER
		5	SCHNEIDER MICOM
		6	ALSTOM MICOM
31	SYNCHROSCOPE	1	AUTOMATIC ELECTRIC
		2	GEC - ALSTHOM
32	SWITCH & SOCKET (INDUSTRIAL TYPE)	1	CROMPTON GREAVES
		2	BCH
		3	ANCHOR
		4	BEST & CROMPTON
		5	ABB
33	SPACE HEATER	1	C&S ELECTRIC
		2	SPACEAGE
34	TRANSDUCER	1	AUTOMATIC ELECTRIC LTD.
		2	ELSTER
		3	SOUTHERN TRANSDUCERS
		4	CAMILLE BAUER, GERMANY
35	THERMAL OVERLOAD RELAY	1	L&T
		2	SIEMENS
		3	SCHNEIDER



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Sl. No.	Item Description	Vendor Name	
		4	GE – POWER
		5	ABB
36	TIMER	1	BCH
		2	ALSTOM
		3	L&T
		4	SCHNEIDER
		5	ABB
37	TERMINALS BLOCK (FIXED / DRAW OUT)	1	PHOENIX
		2	CONNECT WELL
		3	ELEMEX
		4	WAGO
		5	ESSEN DEINKI
38	VOLTMETER (INDICATING)	1	AUTOMATIC ELECTRIC
		2	IMP
		3	RISHABH INDUSTRIAL (L&T)
39	LT PVC CONTROL CABLES	1	CABLE CORPORATION OF INDIA
		2	CORDS CABLE INDUSTRIES LTD
		3	DELTON CABLES LTD.
		4	KEC
		5	CRYSTAL CABLE INDUSTRIES LTD.
		6	KEI INDUSTRIES LTD.
		7	NICCO CORPORATION LTD.
		8	POLYCAB WIRES PVT.LTD
		9	TORRENT CABLES LTD.
		10	UNIVERSAL CABLES D.
		11	RPG
40	LT XLPE POWER CABLES	1	CABLE CORPORATION OF INDIA
		2	HINDUSTHAN VIDYUT PRODUCTS
		3	KEC INTERNATIONAL
		4	TORRENT CABLES LTD.
		5	UNIVERSAL CABLES LTD.
		6	POLYCAB WIRES PVT.LTD
		7	KEI INDUSTRIES LTD.
		8	NICCO
		9	CRYSTAL CABLE INDUSTRIES LTD.
41	LT PVC POWER CABLES	1	CORDS CABLE INDUSTRIES LTD
		2	CRYSTAL CABLE INDUSTRIES LTD.
		3	HINDUSTHAN VIDYUT PRODUCTS
		4	KEI INDUSTRIES LTD.





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Sl. No.	Item Description	Vendor Name	
		5	NICCO CORPORATION LTD.
		6	POLYCAB WIRES PVT.LTD
		7	TORRENT CABLES LTD.
		8	UNIVERSAL CABLES LTD.
		9	CABLE CORPORATION OF INDIA
42	HT XLPE POWER CABLES	1	CABLE CORPORATION OF INDIA
		2	KEI INDUSTRIES LTD.
		3	HINDUSTHAN VIDYUT PRODUCTS
		4	NICCO CORPORATION LTD.
		5	UNIVERSAL CABLES LTD.
43	SCREENED CONTROL CABLES	1	DELTON CABLES LTD.
		2	KEI INDUSTRIES LTD.
		3	NICCO CORPORATION LTD.
		4	POLYCAB WIRES PVT.LTD
		5	CORDS CABLE INDUSTRIES LTD
		6	THERMO CABLES
44	220V DC LEAD ACID BATTERIES (TUBULAR AND PLANTE)	1	EXIDE INDUSTRIES LTD
		2	HOPPECKE, GERMANY / MALAYSIA
45	NICKEL – CADMIUM BATTERY	1	HBL POWER SYSTEMS, HYDERABAD
46	220V DC BATTERY CHARGER (More than 100 AH)	1	CHLORIDE POWER SYSTEMS & SOLUTIONS LTD
		2	STATCON POWER LTD.
		3	HBL POWER SYSTEMS LTD
47	220V DC BATTERY CHARGER (Upto 100 AH)	1	CHHABI ELECTRICALS PVT. LTD.
		2	AMARA RAJA POWER SYSTEMS PVT. LTD
		3	CHLORIDE POWER SYSTEMS & SOLUTIONS LTD
		4	STATCON POWER LTD.
		5	HBL POWER SYSTEMS LTD
48	TRANSFORMER (DRY TYPE)	1	VOLTAMP
		2	BHARAT BIJLEE
		3	AREVA
		4	CGL
		5	SUDHIR TRANSFORMER
		6	BHEL
49a	HT MOTORS (above 500 kW)	1	ABB
		2	BHEL
		3	SIEMENS





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Sl. No.	Item Description	Vendor Name	
49b	HT MOTORS (upto 500 kW)	1	ABB
		2	BHEL
		3	SIEMENS
		4	CROMPTON GREAVES
		5	MARATHON
50	LT MOTORS	1	ABB
		2	SIEMENS
		3	CROMPTON GREAVES
		4	KIRLOSKAR
		5	BHARAT BIJLEE
		6	MARATHON
51	LIGHTING SYSTEM	1	BAJAJ ELECTRICALS LTD.
		2	CROMPTON GREAVES LTD.
		3	PHILIPS INDIA LTD.
52	LIGHTING MAST, LIGHTING TOWER	1	CGL
		2	BAJAJ
		3	PHILLIPS
53	LIGHT FITTINGS	1	BAJAJ
		2	PHILLIPS
		3	CGL
54	CABLE TERMINATION & JOINTING KITS	1	RAYCHEM RPG LIMITED,MUMBAI
		2	3M ELECTRO & COMMUNICATION
55	CABLE TRAYS & ACCESSORIES	1	JAMNA METAL COMPANY
		2	UNITECH FABRICATORS & ENGINEERS
		3	PATNY SYSTEMS (P) LTD.
		4	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.
		5	INDUSTRIAL PERFORATION (INDIA) PRIVATE LIMITED.
		6	RABI ENGINEERING WORKS ,
		7	PREMIER POWER PRODUCTS PVT.LTD.
		8	PARMAR METAL PVT. LTD.
56	CABLE TRAYS SUPPORT SYSTEM WELDED TYPE (HOT DIP GALVANIZED)	1	JAMNA METAL COMPANY
		2	INDUSTRIAL PERFORATION (INDIA) PRIVATE LIMITED.
		3	PATNY SYSTEMS (P) LTD.
		4	RATAN PROJECTS & ENGINEERING CO. PVT.LTD.
		5	RABI ENGINEERING WORKS





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Sl. No.	Item Description	Vendor Name	
		6	UNITECH FABRICATORS & ENGINEERS PVT.LTD.
57	TREFOIL CLAMPS	1	MOULDED FIBRE GLASS PRODUCTS
		2	ELECTROMAC INDUSTRIES
		3	SUMIP COMPOSITES PVT.LTD.
		4	AJMERA INDUSTRIAL & ENGINEERING WORKS
58	ABOVE GROUND EARTHING MATERIALS, GS FLAT, MATERIAL FOR LIGHTNING PROTECTION	1	RATAN PROJECTS &ENGINEERING CO. PVT.LTD.
		2	RABI ENGINEERING WORKS
		3	UNITECH FABRICATORS & ENGINEERS PVT.LTD.
		4	INDUSTRIAL PERFORATION (INDIA) PRIVATE LIMITED.
		5	JAMNA METAL COMPANY
		6	PATNY SYSTEMS (P) LTD.
59	MS ROD FOR BELOW GROUND EARTHING	1	STEEL AUTHORITY OF INDIA LIMITED
		2	RASHTRIYA ISPAT NIGAM LIMITED
60	400 kV DISC INSULATOR/ LONG ROD INSULATOR (120KN)/ BUS POST INSULATOR (For Switchyard)	1	BHEL
		2	NGK BIRLA, JAYASHREE
		3	W.S
		4	INDIAN POTTERIES
		5	SARBHANA
61	INSULATOR HARDWARE	1	EMC
		2	ITPPL
		3	TYCO
		4	Tag Corporation, Chennai
		5	IAC
		6	ELECTROMECH & TRANSTECH
62	CLAMPS & CONNECTOR	1	KLEMMEN
		2	UTSAV
		3	TYCO
		4	IAC
		5	MEGHNA
		6	ELECTROMECH & TRANSTECH
63	400 kV SF6 BREAKERS	1	ABB
		2	CGL
		3	SIEMENS
		4	AREVA T&D
64	400 kV SWITCHYARD CT	1	ABB
		2	CGL





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Sl. No.	Item Description	Vendor Name	
		3	ALSTOM
		4	SIEMENS
65	400 kV SWITCHYARD PT	1	ABB
		2	CGL
		3	SIEMENS
		4	ALSTOM
		5	BHEL
66	400 kV ISOLATOR	1	SIEMENS
		2	ABB
67	400 kV EARTH SWITCH	1	SIEMENS
		2	ABB
68	400 KV STRUCTURE	1	GOOD LUCK STEEL TUBES LTD., BULANDSHAHAH (UP)
		2	UTKARSH TUBES AND PIPES LIMITED, KOLKATA, WEST BENGAL
69	400 kV LIGHTNING ARRESTER	1	CGL
		2	ELPRO INTERNATIONAL LIMITED, PUNE
		3	ALSTOM
		4	OBLUM ELECTRICAL INDUSTRIES PVT.LTD., HYDERABAD
70	LIGHTING POLE	1	BOMBAY TUBE & POLES CO..
		2	BAJAJ ELECTRICALS LTD.
71	SEGREGATED PHASE BUSDUCTS	1	M/S KGS Engineering Limited
		2	L&T
		3	SIEMENS
		4	ALSTOM LTD.
		5	BEST & CROMPTON
		6	BHEL
72	ISOLATED PHASE BUS-DUCT	1	BHEL
		2	SIMELECTRO, FRANCE
73	SURGE ARRESTOR (Less than 15 kV)	1	ELPRO
		2	CGL
		3	OBLUM
74	POST INSULATORS	1	BHEL
		2	ADITYA BIRLA INSULATORS
		3	MOULDED FIBRE GLASS PRODUCTS
		4	W.S. INDUSTRIES LTD,CHENNAI
75	DISK/PIN INSULATOR	1	BHEL
		2	ADITYA BIRLA INSULATORS





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Sl. No.	Item Description	Vendor Name	
		3	IEC
76	MOOSE CONDUCTOR	1	HINDUSTAN VIDYUT PRODUCTS LTD., HARYANA
		2	GUPTA POWER INFRASTRUCTURE LTD., BHUBANESWAR
		3	HIREN ALUMINIUM Ltd., SILVASSA DADRA & NAGAR HAVELI
77	ALUMINIUM TUBE	1	HINDALCO INDUSTRIES LIMITED
		2	JINDAL ALUMINIUM LIMITED
		3	BALCO
78	STRUCTURE HARDWARE	1	DEEPAK FASTNERS LTD
		2	NAVEEN METAL INDUSTRIES, KOLKATA
		3	NEW INDIA ENGINEERING CORPORATION
79	LUGS	1	UNIVERSAL MACHINES
		2	COMET
		3	MAHAVEER ENGINEERING
		4	DOWELLS
		5	SUNIL & CO. PVT. LTD.
80	FAST BUST TRANSFER	1	AARTECH SOLONICS LTD, MP
		2	ABB
81	RAIL POLE	1	SAIL
		2	RINL
		3	TATA
82	FRP JUNCTION BOXES/ JUNCTION BOXES (POWER/CONTROL), LIGHTING JB	1	SCHNEIDER
		2	CONTROL DEVICE
		3	SWITCHING CIRCUIT
		4	JASPER ENGINEERS
		5	BAJAJ ELECTRICALS
		6	AJMER
		7	S B EIEC. EENGINEERING CORP. Ltd
		8	PYROTECH
		9	ENGG. CONSTRUCTION CORP.
		10	L&T
83	LOCAL STARTER PANEL, LOCAL CONTROL PANEL, LIGHTING PANEL, ACELP, DCELP	1	PYROTECH
		2	L&T
		3	CONTROL DEVICE
		4	SCHNEIDER
84	LIGHTING WIRE	1	ISI MARK





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Annexure-I

Sl. No.	Item Description	Vendor Name	
85	ACTUATOR	1	AUMA
		2	LIMITORQUE
86	CABLE for ROLLED -E-CHAIN	1	IGUS
87	CABLE GLAND	1	SUNIL & COMPANY
		2	ARUP ENGG. & FOUNDRY WORKS
		3	COMMET BRASS PRODUCTS
		4	ELECTROMAC INDUSTRIES
		5	BALIGA LIGHTING EQPT.
88	BAY CONTROL UNIT	1	ALSTOM
		2	SIEMENS
		3	ABB
89	TRANSFORMER BUSHING	1	ABB
		2	AREVA
		3	ALSTOM
		4	BHEL
90	EARTH LEAKAGE CB	1	SCHNEIDER
		2	L&T
		3	SIEMENS
		4	ABB
91	EARTH LEAKAGE RELAY [ELR] ALONG WITH CBCT	1	AREVA
		2	PRO'KDEVICES
92	PUSH BUTTON	1	BCH
		2	L&T
		3	SCHNEIDER
		4	SIEMENS
		5	TECKNIC CONTROL
		6	GE – POWER
		7	ABB
93	RELAYS (OTHER THAN INTERPOSING & NUMERICAL RELAYS)	1	ABB
		2	AREVA
		3	SIEMENS
		4	GE – POWER
		5	ALSTOM
94	ENERGY MANAGEMENT SYSTEM	1	SCHNEIDER
		2	SECURE





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Sl. No.	Item Description	Vendor Name	
	CONTROL & INSTRUMENTATION SYSTEM VENDORS		
1	DISTRIBUTED CONTROL SYSTEM	1	ABB
		2	HONEYWELL
		3	EMERSON
		4	VALMET (FORMERLY METSO)
2	PLC (Programmable Logic Controller)	1	ROCKWELL AUTOMATION INDIA LTD.
		2	GE
		3	SCHNEIDER ELECTRIC INDIA PVT.LTD.
3	DIGITAL INDICATOR	1	ABB
		2	GOSSEN / CAMILLE BAUER / METRAWATT
		3	YOKOGAWA
4	VERTICAL MOVING COIL INDICATOR	1	ABB
		2	GOSSEN
		3	CAMILLE BAUER
		4	METRAWATT
		5	YOKOGAWA
5	TRANSDUCERS	1	SIEMENS
		2	ABB
		3	CAMILLEBAUER
		4	ELSTER
		5	PYROTECH
		6	SOUTHERN TRANSDUCERS
		7	ADEPT
6	LARGE VIDEO SCREEN	1	BARCO
		2	PLANAR
7	PC	1	DELL
8	TFT MONITOR	1	DELL
		2	HP
		3	IBM-LENOVO
9	DOT MATRIX PRINTERS	1	EPSON
		2	TVS
10	PRINTERS (LASER)	1	HP
		2	IBM
11	COMPUTER FURNITURE	1	ADARSH CONTROLS
		2	COSMOS MEDIA
		3	FEATHER LITE
		4	GODREJ
		5	OTS





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Sl. No.	Item Description	Vendor Name	
		6	PYROTECH
12	CONTROL PANEL/RACK	1	PYROTECH
		2	RITTAL
13	PRESSURE GAUGES	1	A. N. INSTRUMENTS PVT. LTD.
		2	ASHCROFT INDIA
		3	GENERAL INSTRUMENTS CONSORTIUM
		4	MANOMETER (INDIA) PVT.LTD
		5	WIKA
		6	FORBES MARSHALL LTD.
		7	GLUCK (INDIA) MFG.CO.
		8	WAAREE INDUSTRIES
		9	BUDENBERG GAUGE CO. LTD.
14	PRESSURE SWITCHES	1	ASHCROFT INDIA
		2	INDFOS INDUSTRIES LTD.
		3	SOR INC.
		4	SWITZER INSTRUMENT CO.
		5	TRAFAG-INDIA
		6	DELTA CONTROLS LTD.
15	ELECTRONIC TRANSMITTER	1	EMERSON PROCESS
		2	HONEYWELL
		3	YOKOGAWA
		4	FUJI
16	TEMPERATURE GAUGE	1	A. N INSTRUMENTS PVT. LTD.
		2	ASHCROFT INDIA
		3	GENERAL INSTRUMENTS CONSORTIUM
		4	GOA THERMOSTATIC INSTUMENTS
		5	WIKA
		6	FORBES MARSHALL
		7	WAREE
17	TEMPERATURE SWITCH	1	GENERAL INSTRUMENTS CONSORTIUM
		2	INDFOS INDUSTRIES LTD.
		3	SWITZER INSTRUMENT CO.
		4	AN INSTRUMENTS
18	TEMPERATURE ELEMENT	1	DETRIVE
		2	GENERAL INSTRUMENS CONSORTIUM





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Sl. No.	Item Description	Vendor Name	
		3	INDUSTRIAL INSTRUMENTS
		4	PYRO ELEC INSTRUMENTS GOA P. LTD.
		5	TEMPSENS INSTRUMENTS (I) PVT. LTD.
19	ROTA METER	1	EUREKA
		2	FLUIDYNE INSTRUMENTS
		3	IEPL
		4	PLACKA INSTRUMENTS INDIA PVT. LTD.
		5	TRAC
20	SIGHT FLOW INDICATOR	1	CHEMTROLS SAMIL
		2	LEVCON INSTRUMENTS PVT. LTD.
		3	V.AUTOMAT & INSTRUMENTS PVT LTD.
		4	FORBES MARSHALL LTD.
21	FLOW SWITCH	1	GENERAL INSTRUMENTS CONSORTIUM
		2	KROHNE MARSHALL
		3	SWITZER INSTRUMENT CO.
22	IMPACT HEAD TYPE ELEMENT	1	DETREICH / EMERSON PROCESS
		2	MIDWEST
		3	STARMECH
		4	SWITZER INSTRUMENT CO.
		5	VERIS INC.
23	LEVEL GAUGE	1	CHEMTROLS ENGG. (P) LTD.
		2	LEVCON INSTRUMENTS (P) LTD.
		3	S. B. ELECTRO-MECHANICALS PVT. LTD.
		4	V. AUTOMAT & INSTRUMENTS PVT. LTD.
		5	DK INSTRUMENTS
		6	SIGMA INSTRUMENTS COMPANY
24	LEVEL SWITCH (FLOAT TYPE)	1	CHEMTROLS
		2	MAGNETROL INTERNATIONAL NV
		3	DK INSTRUMENTS
		4	LEVCON INSTRUMENTS P LTD.
25	LEVEL SWITCH (CONDUCTIVITY TYPE)	1	LEVEL STATE, UK
		2	SOLARTON/MOBREY, UK
		3	YARWAY
26	LEVEL SWITCH	1	ENDRESS + HAUSER





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Sl. No.	Item Description	Vendor Name	
	(CAPACITANCE TYPE)	2	DK INSRTUMENTS
27	LEVEL SWITCH (DISPLACEMENT TYPE)	1	DRESSER VALVES INDIA LTD.
		2	CHEMTROLS
		3	DK INSRTUMENTS
		4	ECKARDT
28	LEVEL TRANSMITTER (ULTRASONIC TYPE)	1	EMERSON PROCESS
		2	ENDRESS + HAUSER
		3	SIEMENS MIL TRONICS
		4	VEGA
29	LEVEL TRANSMITTER (RADAR Type)	1	ENDRESS + HAUSER
		2	VEGA
30	BUNKER/SILO LEVEL 3D MONITORING (ULTRASONIC TYPE)	1	E & H
		2	SIEMENS
		3	VEGA-GERMANY
31	VIBRATION MONITORING SYSTEM /TURBINE SUPERVISORY MONITORING SYSTEM	1	GE (for BENTLY NEVADA SYSTEM)
		2	MEGGIT
		3	SHINKAWA, JAPAN
32	MERCURY MONITORING	1	DURAG GMBH AND CO KG
		2	SICK
		3	SHINKAWA
33	Dust Density Monitor	1	CODEL INTERNATIONAL LTD.
		2	DURAG GMBH AND CO KG
		3	LAND INSTRUMENTS INTERNATIONAL
		4	SICK GMBH
34	CO Analyzer (in situ type)	1	CODEL INTERNATIONAL LTD.
		2	LAND INSTRUMENTS INTERNATIONAL
		3	SICK GMBH
35	Oxygen Analyzer (Zirconia Probe type)	1	EMERSON PROCESS MANAGEMENT
36	SO ₂ -NO _x /CO/CO ₂ Analyzer(Insitu Type)	2	CODEL INTERNATIONAL LTD
		3	PROCAL
		4	SICK GMBH
37	SWAS system (with selected analysers from Rosemount Analytical / Hack Ultra-France, Orion – USA, Hach-USA. ABB – UK, Polymetron- France/Zeltwegger -Analyticals)	1	ABB LTD.
		2	EMERSON PROCESS MANAGEMENT INDIA PVT.
		3	FORBES MARSHALL
38	DUST MONITOR	1	SIEMENS MILLTRONICS





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Sl. No.	Item Description	Vendor Name	
		2	FILTER SENSE
		3	BIN MASTER
39	PULSE JET CONTROLLER	1	SWITCHING CIRCUIT
		2	ADVANCE CONCEPT
		3	VOLTCRAFT
		4	SQUARE M
		5	MICRO SYSTEM
40	AIR FILTER REGULATOR	1	JRU INSTRUMENTS (Formerly PLACKA)
		2	SHAVO NORGREN (INDIA) PVT. LTD.
41	ELECTRO PNEUMATIC CONTROLLER	1	MTL INDIA PVT. LTD.
		2	WATSON SMITH LTD.
		3	FAIRCHILD
42	SMART POSITIONER	1	EMERSON PROCESS MANAGEMENT
		2	SIEMENS
		3	ABB
43	SOLENOID VALVE	1	ASCO (I) LTD.
		2	ROTEX AUTOMATION LTD.
		3	NUCON INDUSTRIES PVT LTD
44	FEP INSULATED CABLE (For TG control)	1	DELTON CABLES
		2	HABIA CABLES
		3	LAPP CABLES
		4	LEONI KERPEN
		5	TEMPENS INSTRUMENTS (I) PVT. LTD.
		6	THERMOELECTRIC
45	PTFE INSULATED CABLES (For TG control)	1	ADVANCE CABLES TECHNOLOGIES
		2	DELTON CABLES
		3	FLUTEF INDUSTRIES
		4	RELIANCE INDUSTRIES
		5	RJ INDUSTRIAL CORPORATION
		6	TEMPSENS INSTRUMENTS (I) PVT. LTD.
		7	TOSHNIWAL CABLES PRIVATE LTD
		8	UNIVERSAL CABLES LIMITED
46	INSTRUMENTATION CONTROL CABLE/ COMPENSATING CABLE / THERMOCOUPLE EXTENSION CABLES	1	ADVANCE CABLES TECHNOLOGIES
		2	CORDS CABLE INDUSTRIES PVT. LTD.
		3	DELTON CABLES LTD.
		4	HABIA CABLES
		5	KEI INDUSTRIES LTD.
		6	KERPEN CABELS





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Sl. No.	Item Description	Vendor Name	
		7	LAPP CABLES
		8	NICCO CABLE
		9	POLYCAB WIRES PVT.LTD
		10	THERMO CABLES LTD.
		11	THERMO ELECTRIC
		12	UNIVERSAL CABLES LTD.
47	POWER CABLE (LT)	1	CCIL
		2	KEI INDUSTRIES LTD.
		3	POLYCAB
		4	RELIANCE ENGRS.
		5	THERMO ELECTRIC
		6	ADVANCE CABLES TECHNOLOGIES
		7	RELIANCE ENGRS.
		8	CORDS CABLES
		9	DELTON CABLES
		10	INCAB
		11	PARAMOUNT CABLES
		12	RADIANT CABLES
		13	TORRENT
		14	UNIVERAL CABLES
48	FO CABLES	1	SYSTIMAX
		2	TYCO/AMP
		3	MOLEX
49	UPS & ACDB	1	EMERSON NETWORK
		2	MERLINEGERINE
		3	HITACHI HIREL ELECTRONICS
50	24 V DC BATTERY CHARGER & DCDB	1	CALDYNE
		2	CHHABI ELECTRICALS
		3	HBL POWER SYSTEMS
		4	DB POWER
51	HART COMMUNICATOR (HAND HELD)	1	EMERSON PROCESS
		2	YOKOGAWA
		3	ABB
		4	HONEYWELL
52	MASTER & SLAVE CLOCK SYSTEM	1	HATHWAY
		2	HOPF
		3	SERTEL ELECTRONICS
		4	MASIBUS





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Sl. No.	Item Description	Vendor Name	
53	PUBLIC ADDRESSING SYSTEM (ANALOG SYSTEM)	1	BOSCH SECURITY SYSTEMS
		2	STENTOFONE (from ZENITAL GROUP)
	PUBLIC ADDRESSING SYSTEM (IP ADDRESSABLE)	3	INDUSTRONIC
		4	COMMEND
54	EPABX	1	ABB INDIA PVT. LTD.
		2	BPL TELECOM PVT. LTD.
		3	CROMPTON GREAVES LTD.
		4	HCL INFINET LTD.
		5	SIEMENS LTD.
		6	ABC INDIA PVT LTD.
55	CCTV System	1	BOSCH
		2	HONEYWELL
		3	PELCO
56	LIE/LIR	1	CHEMIN CONTROLS
		2	ELECTRONICS CORP. OF INDIA LTD.
		3	PYROTECH
		4	FORBES MARSHAL
		5	INSTRUMENTATION LIMITED
		6	PRAMMEN INDUSTRIES
57	CONDENSATE POTS	1	FLOWTECH
		2	INSTRUMENTATION LIMITED
		3	PRECISION ENGG INDUSTRIES
		4	BALDOTA VALVE AND FITTING CO. PVT LTD.
		5	METPRESS ENGINEERING WORKS
		6	MICROPRECISION
58	IMPULSE PIPES	1	BHARAT HEAVY ELECTRICALS LTD.
		2	INDIA SEAMLESS METAL TUBES LTD. (only for CS Pipes)
		3	JINDAL SAW PIPES LTD.
		4	MAHARASHTRA SEAMLESS (only for CS Pipes)
		5	MANNESMANN AG
		6	SUMITOMO CORPORATION
		7	TPS TECHNITUBE ROHREN WERKE GMBH
		8	TROUVAY CAUVIN GULF E.C. DUBAI
		9	BALDOTA VALVE AND FITTING CO. PVT. LTD.





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Sl. No.	Item Description	Vendor Name	
		10	BHARAT HEAVY ELECTRICALS LTD.
		11	EXCEL HYDRO – PHEUMATICS PVT. LTD.
		12	INSTRUMENTATION LTD.
		13	METPRESS ENGINEERING WORKS
		14	MAHALAKSHMI SEAMLESS
		15	RATNAMANI METALS & TUBES LTD.
59	INSTRUMENT VALVES / MANIFOLDS	1	BHARAT HEAVY ELECTRICALS LTD.
		2	BALDOTA VALVE AND FITTING CO PVT LTD.
		3	INSTRUMENTATION LIMITED
		4	METPRESS ENGINEERING WORKS
		5	EXCEL HYDRO-PNEUMATICS PVT. LTD.
		6	METPRESS ENGINEERING WORKS
		7	FLOWTECH
60	COMPRESSION FITTINGS	1	PARKER HANNIFIN
		2	PRECISION ENGG INDUSTRIES
		3	TROUVAY & CAUVIN
		4	HOKE (TECHNICAL PARTS CO. MUMBAI)
		5	SWAGELOCK
		6	METPRESS ENGINEERING WORKS
61	SOCKET WELD FITTINGS	1	EXCEL HYDRO-PNEUMATICS PVT. LTD.
		2	METPRESS ENGINEERING WORKS
		3	V.K. INDUSTRIES
		4	VIKAS INDUSTRIAL PRODUCTS
		5	BALDOTA VALVE AND FITTING CO PVT LTD.
		6	FLOWTECH
FIRE DETECTION AND HYDRANT SYSTEM VENDORS			
1	HYDRANT VALVES	1	SHAH BHOGILAL
		2	SUKAN
		3	NEWAGE
		4	VENUS
		5	WINCO
2	FIRE HOSES	1	NEWAGE
		2	CHATTARIA RUBBER
3	WATER MONITOR & WATER-	1	SHAH BHOGILAL





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Sl. No.	Item Description	Vendor Name	
	CUM FOAM MONITORS	2	HD FIRE
		3	NEW AGE
		1	SUKAN
		2	VENUS
4	BRANCH PIPE, NOZZLES, COUPLINGS & FIRE BRIGDAE CONNECTIONS	3	NEW AGE
		4	WINCO
		1	HD FIRE
		2	TYCO (GRINELL)
5	DELUGE VALVES	3	KIDDE (I) LTD.
		1	KIDDE (I) LTD.
		2	TYCO
6	HVW/ MVW SPRAY NOZZLE	3	HD FIRE
		1	TYCO(GRINELL)
		2	HD FIRE
7	QUARTZOID BULB SPRINKLERS/DETECTORS	3	NEWAGE INDUSTRIES
		1	ARC WELD ENGINEERS
		1	SIMPLEX
8	HYDRO PNEUMATIC TANK	2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON
		6	GENT
		1	AP SENSING, Germany
9	MICROPROCESSOR BASED FIRE ALARM PANEL	2	SENSA, UK
		1	Listec (Schrack)
10	LHS CABLE (FO Type)	1	DEL PD PUMPS & GEARS
11	LHS CABLE (Intelligent Addressable Thermal Sensor Based)	1	ARC WELD ENGINEERS
12	FOAM PUMP	1	SIMPLEX
		2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON
		6	GENT
13	ADDRESSABLE MULTISENSOR TYPE DETECTORS	1	SIMPLEX
		2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON
14	ADDRESSABLE PHOTO ELECTRIC TYPE DETECTORS	4	GENT
		1	SIMPLEX
		2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON





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Sl. No.	Item Description	Vendor Name	
		6	GENT
15	ADDRESSABLE HEAT DETECTORS	1	SIMPLEX
		2	SCHRACK
		3	ESSER HONEYWELL
		4	DETECTOMAT
		5	SECUTRON
		6	GENT
16	INFRA RED DETECTORS	1	PATOL
		2	SYSTEM SENSOR
17	COATING & WRAPPING MATERIAL/ TAPE (COAL TAR BASED)	1	IWL LTD.
		2	RUSTECH
18	INERT GAS SYSTEM	1	GINGEKERR
		2	ANSUL
		3	SRI
		4	SIEMENS
19	BATTERY	1	EXIDE
		2	AMCO
20	FIRE SURVIVAL CABLES	1	POLYCAB
		2	RRKABEL
		3	KEI
		4	DELTON
21	HOSE REEL	1	SIEMENS
		2	WINCO
23	FIRE EXTINGUISHER	1	BIS APPROVED SOURCES WITH VALID LICENSE
24	PROBE TYPE HEAT DETECTOR	1	KIDDE
		2	TYCO
	HVAC SYSTEM VENDORS		
1	AIR WASHER & UAF	1	HYDERABAD POLLUTION CONTROL
		2	ADVANCE VENTILATION
		3	DRAFT AIR
		4	BLUE STAR
		5	VOLTAS
		6	STERLING WILSON
		7	ROOTS COOLING SYSTEM
		8	C DOCTOR
2	CENTRIFUGAL FAN	1	FLAKT
		2	KRUGER





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Annexure-I

Sl. No.	Item Description	Vendor Name	
		3	DRAFT AIR
		4	HYDERABAD POLUTION CONTROL
		5	ADVANCE VENTILATION
		6	PATEL AIR
		7	MARATHON
		8	CB DOCTOR
		9	SARLA
3	FRESH AIR/ SUPPLY/ EXHAUST/ RE UNIT FANS / PROPELLAR	1	HYDERABAD POLUTION CONTROL
		2	ADVANCE VENTILATION
		3	KRUGER
		4	NICOTRA
		5	MARATHON
		6	FLAKT
		7	CB DOCTOR
		8	KHAITAN
4	PUMPS	1	BEST & CROMPTON
		2	JYOTI
		3	SAM TURBO
		4	KBL
		5	KSB
		6	M&P
		7	VOLTAS
		8	WORTHINGTON
		9	FLOWMORE
		10	SULZER PUMPS INDIA LTD.
		11	FLOWSERVE INDIA CONTROL PVT LTD
5	LV MOTORS (NON FLAME PROOF)	1	SIEMENS
		2	ABB
		3	CGL
		4	MARATHON
		5	KEC
		6	BHARAT BIJLEE
		7	NGEF
6	AIR FILTER	1	PUROLATOR
		2	FMI
		3	ANFILCO
		4	JOHN FOWLER
		5	SPECTRUM





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Sl. No.	Item Description	Vendor Name	
		6	AIR TECH
		7	PUROMATIC
7	INSULATION MATERIAL	1	BEARDSHEL
		2	ARMAFLEX
		3	LLOYDS
		4	UP TWIGA
		5	AEROCELL
8	FIRE DAMPER	1	TSC
		2	CARRYAIRE
		3	RAVISTAR (SYSTEM AIR)
9	GRILL/ DIFFUSER/ VOLUME CONTROL DAMPER	1	CARRYAIRE
		2	RAVISTAR (SYSTEM AIR)
10	HUMIDISTAT	1	JHONSON CONTROL
		2	HONEYWELL AUTOMATION
		3	PENN
11	SCREW CHILLER	1	CARRIER
		2	KIRLOSKAR
		3	DUNHAM BUSH
		4	BLUE STAR
		5	VOLTAS
		6	MCQUAY (DAIKIN)
		7	CLIMAVENETA
12	PRECISION AC	1	STULZ
		2	UNIFLAIR
		3	BLUEBOX
		4	EMERSON PROCESS MANAGEMENT
		5	CLIMAVENETA
13	SPLIT AC	1	VOLTAS
		2	BLUE STAR
		3	CARRIER
		4	HITACHI
		5	DAIKIN
		6	LG
14	AIR HANDLING UNITS	1	VOLTAS
		2	BLUE STAR
		3	ZECO
		4	CARRYAIRE (flakt)
		5	EDGETECH





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Sl. No.	Item Description	Vendor Name	
		6	ETHOS
		7	SYSTEM AIR
		8	WAVES AIRCON
15	AHU FAN (CENTRIFUGAL FAN)	1	CB DOCTOR
		2	FLAKT
		3	KRUGER
		4	NICOTRA
		5	COMEFRI
		6	MARATHON
		7	ADVANCE
		8	DRAFT AIR
		9	HYDERABAD POLLUTION
16	PUMPS	1	BEST & CROMPTON
		2	JYOTI
		3	SAM TURBO
		4	KBL
		5	KSB
		6	M&P
		7	VOLTAS
		8	BEACON-WEIR
		9	WORTHINGTON
		10	FLOWMORE
		11	SULZER PUMPS INDIA LTD.
		12	FLOWSERVE INDIA CONTROL PVT LTD
		13	V-FLOW PUMPS & SYSTEMS CO
17	COOLING TOWER	1	PAHARPUR COOLING TOWER
		2	FLOWTECH
		3	BELL
18	LV MOTORS (NON FLAME PROOF)	1	SIEMENS
		2	ABB
		3	CGL
		4	MARATHON
		5	KEC
		6	BHARAT BIJLEE
		7	NGEF
		8	JYOTI
19	AIR FILTER	1	PUROLATOR





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Sl. No.	Item Description	Vendor Name	
		2	FMI
		3	ANFILCO
		4	TENACITY
		5	JOHN FOWLER
		6	SPECTRUM
		7	AIR TECH
		8	PUROMATIC
20	BALANCING VALVE	1	ADVANCE
21	4 WAY MIXING VALVE WITH ACTUATING MOTOR	1	SIEMENS BUILDING TECHNOLOGY
		2	JOHNSON
		3	BELIMO
		4	HONEYWELL AUTOMATION
		5	RAPID CONTROL
		6	ALC
22	Y / POT STRAINER	1	MULTITEX
		2	GREAVES COTTON
		3	JAYPEE
		4	SANT VALVES
		5	OTOKLIN
		6	GUJARAT OTOFILT
		7	DS ENGG
		8	SAROJINI ENTERPRISE
		9	BHATIA ENGINEERING
		10	FILTRATION ENGINEERS INDIA PVT LTD
23	STRIP HEATER	1	ESCORTS
		2	RACOLDS
		3	ALCO
		4	HEATCO
24	PAN HUMIDIFIER	1	RAPID COOL
		2	HOTSET
		3	ALCO
25	RELIEF / PURGE VALVE	1	BRASSOMATIC
26	THERMOSTATS	1	HONEYWELL AUTOMATION
		2	RANCO
		3	PENN
		4	DANFOSS
		5	RANUTROL
		6	INDFOSS JHONSON CONTROL





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Sl. No.	Item Description	Vendor Name	
27	ANTI FREEZE THERMOSTAT	1	RANCO
		2	HONEYWELL AUTOMATION
		3	PENN
		4	DANFOSS
		5	INDFOSS
28	RH SENSOR/TEMP SENSOR	1	HONEYWELL AUTOMATION
		2	JOHNSON
		3	SIEMENS
		4	GENERAL INSTRUMENT CONSORTIUM
29	WATER SOFTENING PLANT	1	THERMAX
		2	ION EXCHANGE



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SECTION-VII

ENGINEERING SERVICES



Development Consultants Pvt. Ltd.

Volume : II-A
Section : VII
Engineering Services



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SECTION-VII

OWNER'S ENGINEERING SERVICES

1.00.00 GENERAL

1.01.00 As part of the overall project management activity, the Successful Bidder shall be responsible for proper Owner's Engineering and co-ordination of activities during various phases of execution of the contract. The Successful Bidder shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Owner's Engineer or the Review Consultant shall interact on matters related to Owner's Engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Successful Bidder and shall be responsible for all Owner's Engineering co-ordination. The Owner /Consultant /Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Successful Bidder or on matters involving the Successful Bidder, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the Successful Bidders. However such interaction will not, under any circumstance, dilute the responsibility of the Successful Bidder to provide a fully Owner's Engineered and coordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of Owner's Engineering information will be mutually agreed and finalized between the Owner and the Successful Bidder.

2.00.00 DESIGN COORDINATION MEETING

The Successful Bidder and his sub-vendors will be called upon to attend design co-ordination meetings with the Owner's Engineer, other Successful Bidders and the Consultants of the Owner during the period of execution of contract. The Successful Bidder including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata/ or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING OWNER'S ENGINEERS

The Successful Bidder shall agree to cooperate with the Owner's other Contractors and Consulting Owner's Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Owner's Engineer shall be provided with copies of all correspondences addressed by the Successful Bidder to other Sub- Vendors and Consulting Owner's Engineers in respect of such exchange of technical information.





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4.00.00 GUIDELINES FOR OWNER'S ENGINEERING SERVICES

- 4.01.00 Prior to commencement of the Owner's Engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed Owner's Engineering work.
- 4.02.00 Owner's Engineering work shall be performed on modern and proven concepts and internationally accepted good Owner's Engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the Owner's Engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Successful Bidder.
- 4.03.00 At any stage during the performance of assignment, the Successful Bidder may be required to make certain changes/modification/improvements in design/drawing/other documents, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution/operation of similar units. Such changes/modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and Scope of the Successful Bidder.
- 4.04.00 During the course of review of detailed Owner's Engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.
- 4.05.00 During the course of review of detailed Owner's Engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants Owner's Engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.
- 4.06.00 It is not the intent to give details of every single task covered in the total Owner's Engineering work to be carried out by Successful Bidder, however, all Owner's Engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Successful Bidder. Broadly, the following are the minimum requirements in respect of scope of major items of work:
- 4.06.01 Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations/ floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Successful Bidder from time to time, as detailed





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designs are developed, shall be submitted for Owner's/ Consultant's approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.

- 4.06.02 Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-Vendors.
- 4.06.03 Review of sub-Vendor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.
- 4.06.04 Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments, etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.
- 4.06.05 Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.
- 4.06.06 Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.
- 4.06.07 Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support Owner's Engineering.
- 4.06.08 Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.
- 4.06.09 Certification and submission of final as-built drawings for all areas.
- 4.06.10 Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.
- 4.06.11 All erection and assembly drawings which may be required at site.

5.00.00 **INSTRUCTION MANUALS**

- 5.01.00 The Bidder shall provide all necessary instruction manuals for the Owner's review, comment, and final acceptance as required in the contract. The instruction manual shall contain full details required for erection, commissioning, operation and maintenance of each equipment. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies.





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Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase – III

5.02.00 Erection Manuals

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

- a) Erection strategy.
- b) Sequence of erection.
- c) List of tools, tackles, heavy equipments like cranes, dozers etc required for erection.
- d) Bill of Materials.
- e) Safety precautions to be followed during erection.
- f) Erection instructions.
- g) Critical checks and permissible deviation/tolerances.
- h) Check-list for pre-commissioning activities
- i) Check-list for commissioning of the system.
- j) Procedure for initial checking, testing and acceptance norms.

5.03.00 Operation & Maintenance Manuals

5.03.01 The operating and maintenance instructions together with drawings of the equipment, as completed, shall be in sufficient detail to enable the Owner to operate, maintain, dismantle, reassemble, and adjust all parts of the equipment. They shall outline a step-by-step procedure for all operations likely to be carried out during the life of the plant/ equipment. Each manual shall include a complete set of drawings together with performance/ rating curves of the equipment and test certificates wherever applicable.

5.03.02 If after commissioning and initial operation of the plant, the manuals require any modification/ additions in the view of the Owner or Bidder, the same shall be incorporated and the updated final manuals shall be submitted to the Owner.

5.03.03 The manuals shall include the following:

- a) List of spare parts along with their drawing and catalogue and Pro-forma for ordering spares.
- b) Location and identification guide for bearings of various equipments and lubrication schedule including charts showing lubrication checking, testing and replacement procedure.



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Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase – III

- c) Wherever applicable, fault location charts shall be included to facilitate fault detection.
- d) Detailed specification for all consumables (including lubricating oils, greases, chemicals etc.) required for each equipment.

6.00.00

PLANT HANDBOOK

The Bidder shall provide the plant handbook to the Owner as per provision of the contract.

The Plant Handbook shall contain the following as a minimum:

- a) Design and performance data
- b) Process & instrumentation diagrams
- c) Single line diagrams
- d) Sequence & Protection interlock schemes
- e) Alarm and trip values
- f) Performance curves
- g) General layout plan and layout of Balance of Plant building and auxiliary buildings
- h) Important Do's and Don'ts.

7.00.00

TENDER STAGE DOCUMENT SUBMISSION

7.01.00

The Bidder shall submit along with his bid all documents/drawings as specified in RFP and respective sections of the Technical Specifications in Vol-II and Vol-III. The documents shall include but not be limited to the following:

- a) All Bid proposal sheets duly filled up.
- b) Detailed experience list and financial resources of the Prime Bidder his collaborators/associates in this bid as well as the sub-vendors proposed.
- c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.
- d) List of terminal points of the package offered together with quality and quantity of various input (i.e. water, air, electricity etc.) as required from the Owner at such interfaces.
- e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.





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Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase – III

- f) High level project schedule network indicating target dates for intermediate milestones and final commissioning of plant systems; This network shall be supplemented by a detailed write-up on proposed sequence and method of execution for project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.

8.00.00 **CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE**

- 8.01.00 Owner's Engineering schedule shall be submitted by the Bidder as indicated in the RFP. Owner's Engineering schedule shall be developed in format as desired by the Owner/consultant.

The documents shall be divided into two categories: a) for approval and b) for information/further Owner's Engineering and co-ordination by the Consultant.

In preparing this schedule, the Bidder shall allow one (1) week from date of receipt for review and comments by the Consultant for each submission of a document.

This document submission schedule shall require acceptance by the Owner/Consultant.

Bidder shall also develop and submit a Master drawing list to the Owner/consultant.

- 8.02.00 All contract documents shall be marked with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

- 8.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval/information of the Owner/Consultant.

- 8.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Consultant:

- a) System scheme and Process & instrumentation Diagrams (P & IDs).
- b) Design basis documents / memoranda / calculations justifying sizing and selection of equipment, vessels, tanks, piping, valves & specialities as well as the process parameters.
- c) Equipment data sheets and general arrangement drawings.
- d) Materials of construction.





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EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase – III

- e) General Arrangement and Layout drawings.
- f) Typical control schemes, circuit diagrams, drive/ feeder-wise control scheme showing all external interfaces.
- g) Control System Configuration
- g) Shop Inspection and Testing Procedures, Test Set-up & Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- h) Performance Test Procedures, Instrumentation, Acceptance Criteria and Codes / Standards followed, correction curves / charts, etc.
- i) Schedules covering equipment delivery schedules, erection, testing and commissioning schedules at L1 and L2 levels.

8.05.00 Unless specified otherwise, the following categories of documents / drawings would be treated for information/further Owner's Engineering by the Owner/Consultant. The Bidder shall, however, incorporate all additional information and clarifications in these documents/ drawings as and when desired by the Owner/ Consultant.

- a) Equipment foundation drawings.
- b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
- c) Predicted performance curves of equipment.
- d) Various bills of quantity, schedules etc.
- e) Piping fabrication drawings, isometrics etc.
- f) Panel wiring diagrams.
- g) Instruction/Operation manuals.
- h) Service manuals and trouble shooting guide for C & I system including field instruments.
- i) Operation logic diagrams.
- j) Cable schedule and interconnection chart.

In essence, the Bidder is solely responsible for corrections and adequacy of design & Owner's Engineering for documents under this category.

8.06.00 Upon review, the Consultant shall put his remarks and one of the following action stamps on the drawing / document:

- a) Approved.





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EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase – III

- b) Approved except as noted, forward final drawing
- c) Approved except as noted, resubmission required.
- d) Disapproved.
- e) For information/reference only.

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Consultant. For action stamp in category (b), further review by Owner/Consultant would not be necessary provided the Bidder agrees & incorporates the minor comments made on the document.

Except for action stamp under category (c) & (d), the Bidder can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/Consultant.

The Consultant may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Bidder shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds.

The Bidder's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Consultant.

- 8.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.
- 8.08.00 For review by the Consultant, the Bidder shall furnish three (3) prints of each drawing (only for first submission). There upon all transaction of drawings including reviewed comments and stamping shall be done in soft. All transaction of drawings shall be accompanied by a reference letter mentioning the date, revision no. and document status. Only on receiving the Approval Stamping, bidder shall distribute 6 sets of drawings (2 at WBPDC corporate office and 4 sets at WBPDC site office).. The Bidder shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.
- 8.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.





4 X 250 MW NABINAGAR FGD
COMPRESSED AIR SYSTEM

SPECIFICATION No: PE-TS-463-555-A001

VOLUME: II B

SECTION : C2-C

REV. 00

DATE: Dec., 19

SHEET: 1 OF 1

SECTION: C2-C PERFROMANCE GUARANTEE TESTS



**COMPRESSED AIR SYSTEM
FUNCTIONAL GUARANTEES
& LIQUIDATED DAMAGES**

DOCUMENT NO.: PE-TS-445-555-A001

VOLUME- IIB

SECTION-C

REV. 00

SHEET 1 OF 1

1.0 For Category-A Guarantees.

Reject the equipment/system/plant and recover the payments already made.

OR

Accept the equipment/system/plant after levying Liquidated damages as specified.

- A) Power consumption of one Instrument Air Compressor, two Air Dryer Plant and one Service Air compressor.

2.0 For Category-B Guarantees.

Reject the equipment/system/plant and recover from the contractor the payments already made.

OR

Accept the equipment/system after assessing the deficiency in respect of the various ratings, performance parameters and capabilities and recover from the contract price an amount equivalent to the damages as determined by the employer.

- A) Capacity and discharge pressure of each compressor (to be demonstrated at shop).
 B) Parallel operation of air compressors (to be demonstrated at site).
 C) Pressure drop across Air Drying Plant and dew point of air at the outlet of air drying plants (to be demonstrated at site).
 D) Vibration level and noise level of each air compressor, blowers and any other rotating equipments of each air drying plant shall be demonstrated at site.
 E) Integration of Existing and Present compressed air system equipments with the respective DCS inline with the control philosophy mentioned in the specification.

	1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5 COMPRESSED AIR SYSTEM	SPECIFICATION No: PE-TS-445-555-A001	
		VOLUME: II B	
		SECTION : C2-D	
		REV. 00	DATE: Mar. 21
		SHEET: 1 OF 1	

SECTION: C2-D
QUALITY ASSURANCE



SECTION-VIII

QUALITY ASSURANCE REQUIREMENTS





CONTENT

CLAUSE NO.	DESCRIPTION	PAGE NO.
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2.00.00	GENERAL REQUIREMENTS QUALITY ASSURANCE	2
3.00.00	QUALITY ASSURANCE DOCUMENTS	4
4.00.00	INSPECTION, TESTING & INSPECTION CERTIFICATES	5





SECTION-VIII

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Successful Bidder's works or at his Sub-Vendor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Successful Bidder shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Successful Bidder and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Successful Bidder shall generally cover the following :

- a) His organisation structure for the management and implementation of the proposed quality assurance programme.
- b) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) The procedure for purchase of materials, parts, components and selection of Sub-Vendor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.



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- n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-A to this section.

2.00.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

- 2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured and tested at all the stages, as well as Services provided for erection, commissioning and testing shall be as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Bidder for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Bidder's responsibility to draw up and implement such programme and reviewed by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Owner's representative for review. Schedule of finalisation of such quality plans will be finalised before award.
- 2.02.00 Manufacturing Quality Plan will detail out for all the components and equipment, various tests/inspection, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Bidder's Quality Control organisation, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing.
- 2.03.00 Field Quality Plans will detail out for all the equipment, the quality practices and procedures etc. to be followed by the Bidder's site Quality Control organisation, during various stages of site activities from receipt of materials/equipment at site.
- 2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Consultant's approval without which manufacture shall not proceed. In these approved quality plans, Owner/Authorised representative/Consultant shall identify Customer Hold Points (CHP), test/checks which shall be carried out in presence of the Owner/Consultant/Owners Owner's Engineer or his Authorised Representative and beyond which the work will not proceed without consent of Owner/Authorised representative/Consultant in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to Owner/Authorised Representative/Consultant for acceptance and dispositioning.
- 2.05.00 The Bidder shall provide adequate notice to the Owner for inspection before the material is dispatched as per the provisions of the Contract. No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of





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all previous tests/inspections by Owner's Owner's Engineer/Authorised representative, and duly authorised for despatch issuance of Material Despatch Clearance Certificate (MDCC).

2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.

2.07.00 All the individual and assembled rotating parts shall be statically and dynamically balanced in the works.

Where accurate alignment is necessary for component parts of machinery normally assembled on site, the Bidder shall allow for trial assembly prior to despatch from place of manufacture.

2.08.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.

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

All brazers, welders etc. employed on any part of the contract at Bidder's/Sub-Vendor's works or at site shall be qualified as per ASME Section-IX or BS-4871 or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner/his authorised representative.

For welding of pressure parts and high pressure piping the requirements of IBR shall also be complied with.

Under no circumstances any repair or welding of castings be carried out without the consent of the Owner. Proof of the effectiveness of each repair by radiographic and/or other non-destructive testing technique, shall be provided to the Owner.

All pressure parts shall be subjected to hydraulic testing as per the requirements of IBR. Other parts shall be tested for one and half times the maximum operating pressure, for a period not less than thirty (30) minutes.

2.10.00 All non-destructive examination (NDT) shall be carried out in accordance with approved international standard. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT shall be properly recorded and submitted for acceptance.

All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid





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penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination and ultrasonic testing shall be employed wherever necessary/ recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed. Statutory payments in respect of IBR approvals including inspection shall be made by Bidder. Bidder's scope and responsibility shall also include preparation and submission of all necessary documents in the specific formats and manner stipulated by the statutory bodies, coordination and follow up for above approvals.

2.11.00 All the Sub-Vendors proposed by the Bidder for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Bidder and finalised with the Owner shall be subject to Owner's review. Quality Plans of the successful Sub-Vendors shall be discussed, finalised and accepted by the Owner/Authorised representative and form part of the Purchase Order between the Bidder and the Sub-Vendor.

2.12.00 All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Bidder and finalised with the Owner shall be furnished to the Owner for comments and subsequent acceptance before orders are placed.

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

Quality audit/acceptance of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Bidder in earning satisfactory performance of equipment as per specification.

2.13.00 Quality requirements for main equipment shall equally apply for spares and replacement items.

2.14.00 Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the acceptance of the Owner.

2.15.00 For quality assurance of all civil works refer to the specifications for civil works.

3.00.00 **QUALITY ASSURANCE DOCUMENTS**

3.01.00 The Bidder shall be required to submit two (2) copies and two (2) sets of microfilms of the following Quality Assurance documents within three (3) weeks after despatch of the equipment:

- a) Material mill test reports on components as specified by the specification.





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- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
- c) Non-destructive examination results /reports including radiography interpretation reports.
- d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
- e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
- f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
- g) Stress relief time temperature charts.
- h) Inspection reports duly signed by QA personnel of the Owner and Bidder for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
 - i) When some important repair work is involved to make the job acceptable.
 - ii) The repair work remains part of the accepted product quality.
- i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 INSPECTION, TESTING AND INSPECTION CERTIFICATES

4.01.00 The Successful Bidder shall give the Owner's Engineer/Inspector fifteen (15) days written notice of any material being ready for testing. Such tests shall be to the Successful Bidder's account except for the expenses of the Inspector. The Owner's Engineer/Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection failing which the Successful Bidder may proceed with test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of test reports in six (6) copies.

4.02.00 The Owner's Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Successful Bidder, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract. The Successful Bidder shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Owner's Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract.





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- 4.03.00 When the factory tests have been completed at the Bidder's or sub-Vendor's works, the Owner/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests but if the tests are not witnessed by the Owner/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Bidder's test certificate by the Owner/Inspector. Failure of the Owner/Inspector to issue such a certificate shall not prevent the Bidder from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract.
- 4.04.00 The Bidder shall furnish quarterly inspection programme indicating schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.



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FORMAT OF QUALITY ASSURANCE PROGRAMME

Name of Company / Successful Bidder	NAME OF CONTRACT PACKAGE			QUALITY PLAN FOR						
	Package No. : _____			QP No. : _____ Date _____						
	Contractor : _____			Rev.No.: _____ Date _____						
Sl. No.	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check	Reference Document	Acceptance Norm	Format of Record	Agency	Remarks





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FIELD WELDING SCHEDULE

PROJECT : FWS NO :

CONTRACTOR : REV NO. :

PACKAGE : FIELD WELDING CODE :

SYSTEM : PAGE NO. :

SI No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method	Quantum	NDT Specification Number	Acceptance Norm Ref.	Remarks
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The Field Welding Schedule should be submitted for :

- o Pressure Parts
- o Tanks/Vessels
- o Piping
- o Heavy/Important Structural Steel
- o Heat Exchangers
- o Bus Ducts



Development Consultants Pvt. Ltd.

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Volume : II-A
Section : VIII
Quality Assurance Requirements

	1 X 660MW SAGARDIGHI TPS EXTN. UNIT#5 COMPRESSED AIR SYSTEM	SPECIFICATION No: PE-TS-445-555-A001	
		VOLUME: II B	
		SECTION : C-3	
		REV. 00	DATE: Mar.21
		SHEET: 1 OF 1	

SECTION: C-3
TECHNICAL SPECIFICATION (ELECTRICAL PORTION)

**THE WEST BENGAL POWER DEVELOPMENT
CORPORATION LIMITED**

**SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III**

**COMPRESSED AIR SYSTEM
TECHNICAL SPECIFICATION
(ELECTRICAL PORTION)**



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT,
NOIDA, U.P., INDIA**

266565/2021/PS-PEM-MAX:



**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

**SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III**

SPECIFICATION NO.

VOLUME NO. : **II-B**SECTION: **C**REV NO. : **00** DATE: 05.04.21

SHEET: 1 OF 1

CONTENTS

SECTION	TITLE	NO OF SHEETS
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I	ELECTRICAL SCOPE BETWEEN BHEL & VENDOR (ANNEXURE-I)	2
I	ELECTRICAL LOAD DATA FORMAT (ANNEXURE-II)	1
I	CABLE SCHEDULE FORMAT (ANNEXURE-III)	1
I	EXPLANATORY NOTES FOR CABLE ROUTING	2
I	TECHNICAL SPECIFICATION FOR MOTORS	10
I	MOTOR DATASHEET-A	1
II	MOTOR DATASHEET-C	2
II	GENERAL TECHNICAL REQUIREMENT FOR LV MOTORS	4
II	SQP_LV MOTORS UPTO 55KW	2
II	SQP_LV MOTORS 55KW & ABOVE	9
II	CABLE TRAY DRAWING	2

The requirements mentioned in Section-I shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the descriptive portion in Section-II.



**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM
(ELECTRICAL PORTION)**

**SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III**

SPECIFICATION NO.

VOLUME NO. : **II-B**

SECTION : **C**

REV NO. : **01** DATE : 05/04/21

SHEET : 1 OF 1

SPECIFIC TECHNICAL REQUIREMENTS: ELECTRICAL

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER:

- a) Services and equipment as per “Electrical Scope between BHEL and Vendor”.
- b) Any item/work either supply of equipment or erection material which have not been specifically mentioned but are necessary to complete the work for trouble free and efficient operation of the plant shall be deemed to be included within the scope of this specification. The same shall be provided by the bidder without any extra charge.
- c) Supply of mandatory spares as specified in the specifications of mechanical equipments.
- d) Electrical load requirement for **COMPRESSED AIR SYSTEM**
- e) All equipment shall be suitable for the power supply fault levels and other climatic conditions mentioned in the enclosed project information.
- f) Bidder to furnish list of makes for each equipment at contract stage, which shall be subject to customer /BHEL approval without any commercial and delivery implications to BHEL
- g) Various drawings, data sheets as per required format, Quality plans, calculations, test reports, test certificates, operation and maintenance manuals etc shall be furnished as specified at contract stage. All documents shall be subject to customer/BHEL approval without any commercial implication to BHEL.
- h) Motor shall meet minimum requirement of motor specification.
- i) Vendor to clearly indicate equipment locations and local routing lengths in their cable listing furnished to BHEL.
- j) Cable BOQ worked out based on routing of cable listing provided by the vendor for “both end equipment in vendor’s scope” shall be binding to the vendor with +10 % margin to take care of slight variation in routing length & wastages.

2.0 EQUIPMENT & SERVICES TO BE PROVIDED BY PURCHASER FOR ELECTRICAL & TERMINAL POINTS:

Refer “Electrical Scope between BHEL and Vendor”.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 The electrical specification without any deviation from the technical/quality assurance requirements stipulated shall be deemed to be complied by the bidder in case bidder furnishes the overall compliance of package technical specification in the form of compliance certificate/No deviation certificate.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

- a) Electrical scope between BHEL & vendor (Annexure –I)
- b) Electrical Load data format (Annexure –II)
- c) BHEL cable listing format (Annexure –III)
- d) Technical specification for motors.
- e) Datasheets & quality plan for motors.

ANNEXURE-1

SECTION-1

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES : COMPRESSED AIR SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 1x660 MW SAGARDIGHI TPS

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	11 kV/ 6.6 KV / 3.3 KV / 415 V Switchgear	BHEL	BHEL	415 V AC (3 ph 4 wire)/240 V AC (supply feeder) shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motors.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCs.
6	Cable trays, accessories & cable trays supporting system. 100/50 mm cable trays/Conduits/Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs as per approved layout drawing during contract stage.
7	Cable glands, lugs & bimetallic strip for equipments supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
8	Conduit and conduit accessories for cabling between equipments supplied by vendor.	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	--
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	--
12	Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGES : COMPRESSED AIR SYSTEM

SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

PROJECT: 1x660 MW SAGARDIGHI TPS

15	Any other equipment/material/service required for completeness of system based on the system offered by vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	--	
16	a. Input cable schedules (C & I) b. Cable interconnection detail for the above c. Cable block diagram	Vendor Vendor Vendor	- - -		Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Cabling layout drawings	BHEL/ Vendor	-		a. In case of Compressor are HT motors, cable tray/trench layout inside compressed air building shall be prepared by BHEL. Vendor to furnish drawing (both in print form as well as in AUTOCAD) of compressor room layout clearly indicating all motors, panels, JB's etc. which require cabling alongwith their terminal box/location/ Foundation etc. b. In case of Compressor are LT motors, for ensuring cabling requirements are met, vendor shall prepare & submit cable tray/trench & equipment layout (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling for BHEL review & approval.
18	Electrical equipment GA drawing	Vendor	-		For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of junction box arises on account of power cable size mismatch due to vendor engineering at later stage, vendor shall supply the junction box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

[illegible]

[illegible]

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

(A) SYSTEM VOLTAGE CODES:

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V

(dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) CABLE VOLTAGE CODES:

A = 11KV (Power cables)

Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

- B = 6.6KV (Power cables)
- C = 3.3KV (Power cables)
- D = 1.1KV (LV & DC system power & control cables)
- E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

- | | |
|---------------------|-------------------------|
| A = Armoured FRLS | B = Armoured Non-FRLS |
| C = unarmoured FRLS | D = Unarmoured Non-FRLS |

PVC Aluminium

- | | |
|---------------------|-------------------------|
| E = Armoured FRLS | F = Armoured Non-FRLS |
| G = unarmoured FRLS | H = Unarmoured Non-FRLS |

XLPE Copper

- | | |
|---------------------|-------------------------|
| J = Armoured FRLS | K = Armoured Non-FRLS |
| L = unarmoured FRLS | M = Unarmoured Non-FRLS |

XLPE Aluminium

- | | |
|---------------------|-------------------------|
| N = Armoured FRLS | P = Armoured Non-FRLS |
| Q = unarmoured FRLS | R = Unarmoured Non-FRLS |

- S = FIRE SURVIVAL CABLES
- T = TOUGH RUBBER SHEATH
- U = OVERALL SCREENED
- V = PAIRED OVERALL SCREENED
- W = PAIRED INDIVIDUAL SCREENED
- Y = COMPENSATING CABLES
- I = PRE-FABRICATED CABLES
- Z = JELLY FILLED CABLES



SECTION-I

SECTION - II**A.C. & D.C. MOTORS****1.00.00 SCOPE**

- 1.01.00 This specification covers the general requirements of the electric motors for plant auxiliary equipment except for special application like crane, lift, submersible pump etc., motors for which are covered in individual equipment specifications.
- 1.02.00 Motors shall be furnished in accordance with both this general specification and the accompanying driven equipment specification.
- 1.03.00 In case of any discrepancy, the driven equipment specification shall govern.

2.00.00 STANDARDS

- 2.01.00 All motors shall conform to the latest applicable IS, IEC and CBIP Standards/Publications except when otherwise stated herein or in the driven equipment specification.
- 2.02.00 Equipment and materials conforming to any other standard, which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

3.00.00 SERVICE CONDITIONS

- 3.01.00 The motors will be installed in hot, humid and tropical atmosphere, highly polluted area.
- 3.02.00 Unless otherwise noted, electrical equipment/system design shall be based on the service conditions and auxiliary power supply given in the annexure of this specification.
- 3.03.00 For motor installed outdoor and exposed to direct sun rays, the effect of solar heat shall be considered in the determination of the design ambient temperature.

4.00.00 TYPE AND RATING**4.01.00 A.C. Motors**

- 4.01.01 Motors shall be general purpose, constant speed, squirrel cage, three/single phase, induction type.
- 4.01.02 All motors shall be either totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) or closed air water cooled (CACW) type. Temperature rise shall be limited to 70 deg C by resistance method.
- 4.01.03 All motors shall be rated for continuous duty. They shall also be suitable for long period of inactivity.





SECTION-I

- 4.01.04 All LT motor shall conform to minimum efficiency performance standards (MEPS) of IE2 mentioned in IS: 12615. All HT motors shall have efficiency and power factor higher than 90% and 0.83 respectively.
- 4.01.05 The motor name-plate rating at 50°C shall have at least 15% margin for LT system and 10% margin for HT system, over the input power requirement of the driven equipment at rated duty point and also covering the maximum load demand of the driven equipment under entire operating range, including voltage and frequency variations, unless stated otherwise in driven equipment specification or in general electrical specification.
- 4.01.06 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service. The direction of rotation of motor and its cooling fan should be properly matched with the driven equipment.
- 4.02.00 AC motor for VFD application (If applicable)
- 4.02.01 Inverter duty motors are designed according to the requirements of IEC/TS-60034 part17 & part 25 or NEMA MG-1, Part-30, Part 31 and have performance characteristics match with the driven equipment and variable speed requirement.
- 4.02.02 Induction motors to be operated in adjustable-speed drive applications should be de-rated as per NEMA/IEC standard due to the reduction in cooling resulting from any reduction in operating speed and the effect of additional losses introduced by harmonics generated by the control.
- 4.02.03 Inverter duty motors shall have VPI/improved insulation systems that do not degrade readily due to transient voltage spikes and have an adequate thermal margin.
- 4.02.04 Inverter duty motors shall be self ventilated without any auxiliary blower. Force ventilation shall be subject to purchaser approval.
- 4.02.05 Inverter motor shall be suitable for scalar (open loop) control, without any speed feedback signal, where fast response is not required. Vector (closed loop) control will be used with encoder if specified.
- 4.02.06 The breakdown torque at any frequency within the defined frequency range shall be not less than 150% of the rated torque at that frequency when rated voltage for that frequency is applied.
- 4.02.07 The motor should be capable of producing a breakaway torque of at least 140% of rated torque requiring not more than 150% rated current when the voltage boost is adjusted to develop rated flux in the motor and when the inverter is able to produce the required minimum fundamental frequencies
- 4.02.08 The motor shall be provided with insulated bearing on one side.
- 4.02.09 Normally the maximum safe speed shall be as per IEC/NEMA, however it should be coordinated with VSD requirement.



4.02.10 In case of a conflict, the requirement mentioned under clause no. 4.02.00 for motors for VFD application shall supersede the corresponding requirement for standard motors.

4.03.00 **D. C. Motors**

4.03.01 D.C. motor provided for emergency service shall be shunt wound type. It can also be of compound-wound type with the series field shorted.

4.03.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.

5.00.00 **PERFORMANCE**

5.01.00 **Running Requirements**

5.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as given in the annexure.

5.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.

5.02.00 **Starting Requirements**

5.02.01 Motor shall be designed for direct on line starting at full voltage. Starting current at rated voltage for LT motors shall be 6 times of full load current plus IS tolerance. For 3.3KV and 11KV motor except BFP, starting current shall be maximum 6 times of full load current inclusive IS tolerance. For Boiler feed pump motor, starting current shall be limited to 4.5times of full load current plus IS tolerance.

For D.C. Motors the starting current shall be limited to 2 times full load current.

5.02.02 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.

5.02.03 Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals without exceeding acceptable winding temperature.

5.02.04 Motor shall be capable of three equally spread starts per hour, two starts in quick succession from cold condition and one restart from hot condition.

5.02.05 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.

5.03.00 **Stress During Bus Transfer**

5.03.01 The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

5.03.02 The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.





SECTION-I

- 5.04.00 Locked Rotor Withstand Time
- 5.04.01 For motors with starting time upto 20 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 2.5 secs.
- For motors with starting time more than 20 secs. and upto 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 5 secs.
- For motors with starting time more than 45 secs, starting time at minimum permissible voltage should be less than the locked rotor withstand time under hot condition at highest voltage limit by at least 10% of the starting time
- 5.04.02 To prevent unwanted tripping of a high inertia load at start-up, there may be need to shunt out the motor's overload trip device. Speed switches mounted on the motor shaft may be provided in such case. Heating experienced during start-up must still be considered when sizing the motor.
- 5.04.03 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.
- 5.05.00 Torque Requirements
- 5.05.01 Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- 5.05.02 Pull out torque at rated voltage shall not be less than 205% of full load torque.
- 6.00.00 SPECIFIC REQUIREMENTS**
- 6.01.00 Enclosure**
- 6.01.01 Enclosures for the motor and the cable box shall conform to the degree of protection IP-55 unless otherwise specified.
- 6.01.02 Motors like circulating water pumps of large output ratings, located inside a building and not directly exposed to coal dust or fly ash, could have screen protected drip proof enclosure conforming to IP-23.
- 6.01.03 Motor located in hazardous area shall have flameproof enclosure conforming to IS: 2148 /Equiv. as detailed below:
- a) Fuel Oil area : Group IIB
 - b) Hydrogen generation plant area : Group IIC (or Group-I, Div-II as per NEC or Class-1, Gr-B, Div-II as per NEMA/IEC60034)
- Separate Canopy shall be provided for LT motors located in outdoor or semi-outdoor area.



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- 6.02.00 **Cooling**
- 6.02.01 The motor shall be self ventilated type, either totally enclosed fan cooled (TEFC) or closed air circuit air cooled (CACA).
- 6.02.02 For large capacity motors, totally enclosed tube ventilated (TETV) may be considered for acceptance. In case of motors rated 3000kW and above, closed air circuit water cooled (CACW) motors may be offered for consideration before proceeding with design and manufacturing.
- 6.03.00 **Winding and Insulation**
- 6.03.01 All insulated winding shall be of copper.
- 6.03.02 HT motors shall have Class F insulation with winding temperature limited to 120°C. Windings shall be impregnated to make them non-hygroscopic and oil resistant. The lightning impulse and coil inter-turn insulation surge withstand level shall be as per IEC-60034 – Part 15.
- 6.03.03 LT motors shall have Class F or higher insulation with temperature limited to 120°C.
- 6.04.00 **Tropical Protection**
- 6.04.01 All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.
- 6.04.02 All fittings and hardware shall be corrosion resistant.
- 6.05.00 **Bearings**
- 6.05.01 Motor rated above 1000kW shall have insulated bearings to prevent flow of shaft currents.
- 6.05.02 Vertical shaft motors shall be provided with thrust and guide bearings.
- 6.06.00 **Noise & Vibration**
- 6.06.01 Noise level shall not exceed 85 db (A) except for BFP motor for which the maximum limit shall be 90 db (A).
- 6.06.02 Peak amplitude of vibration shall be limited within the values prescribed in IS:12075 / IEC 60034-14.
- 6.07.00 **Motor Terminal Box**
- 6.07.01 Motor terminal box shall be detachable type, made of cast iron or pressed steel and located in accordance with Indian Standards clearing the motor base- plate/ foundation.
- 6.07.02 Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved.
- 6.07.03 Terminal box for all LT motors shall be diagonally split type and shall have the same degree of protection as motor.



SECTION-I

- 6.07.04 The terminal box shall have sufficient space inside for termination /connection of suitable sized HT cables. Where the specified main cable size demands, adopter/extension box of suitable size shall be provided as a part integral to the motor, for easy termination of the cable.
- 6.07.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.
- 6.07.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- 6.07.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.
- 6.07.08 For HT motor, the terminal box shall be phase segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.
- 6.07.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match Owner's cable. All threads shall be ISO metric thread only.
- 6.07.10 The gland plate for single core cable shall be non-magnetic type.
- 6.08.00 **Grounding**
- 6.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.
- 6.08.02 The grounding connection shall be suitable for accommodation of ground conductors as follows:
- | | |
|------------------------------|-------------------|
| Motor above 90 kW | 50 x 6 mm GI Flat |
| Motor above 30 kW upto 90 kW | 35 x 6 mm GI Flat |
| Motor above 5 kW upto 30 kW | 25 x 3 mm GI Flat |
| Motor upto 5 kW | 8 SWG GI Wire |
- The above sizes shall be superseded by different sizes if so indicated in the relevant clause of the General Electrical Specification.
- 6.08.03 The cable terminal box shall have a separate grounding pad.
- 6.09.00 **Rating Plate**
- In addition to the minimum information required by IS, the following information shall be shown on motor rating plate :
- a. Temperature rise in °C under rated condition and method of measurement.
 - b. Degree of protection.
 - c. Bearing identification no. and recommended lubricant.
 - d. Location of insulated bearings.



SECTION-I

7.00.00 ACCESSORIES**7.01.00 General**

Accessories shall be furnished, as listed below, or if otherwise required by driven equipment specification or application.

7.02.00 Space Heater

7.02.01 Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement.

7.02.02 The space heater shall be rated 240 V, 1 phase 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle.

7.03.00 Temperature Detectors

7.03.01 All HT motors shall be provided with minimum four (4) numbers simplex or two (2) numbers duplex platinum resistance type winding temperature detectors per phase.

7.03.02 Each bearing of HT shall be provided with minimum one (1) duplex or two (2) simplex type temperature detectors.

7.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.

7.04.00 Indicator/Switch

7.04.01 Dial type local indicator with alarm contacts shall be provided for the following: -

- a) HT motor bearing temperature.
- b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.

7.04.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.

7.04.03 Alarm switch contact rating shall be minimum 0.5 A at 220V D.C. and 5A at 240V A.C.

7.05.00 Current Transformer for Differential Protection

7.05.01 Motor above 1000 kW shall be provided with three differential current transformers (PS class) mounted over the neutral leads within the enclosure. Matching three (3) numbers PS class CTs shall be mounted on the switchgear end.

7.05.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later.



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7.06.00 **Accessory Terminal Box**

7.06.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from motor (power) terminal box.

7.06.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner's cable connections.

7.07.00 **Drain Plug**

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

7.08.00 **Lifting Provisions**

Motor weighing 25 kg. or more shall be provided with eye bolt or other adequate provision of lifting.

7.09.00 **Dowel Pins**

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

7.10.00 **Painting**

Motor including fan shall be painted with corrosion proof paints. The paint shade shall be as specified in the Annexure.

8.00.00 TESTS

8.01.00 Upon completion, each HT & LT motor shall be subject to routine tests as per Schedule-C of Section -I. In addition, any special test called for in the driven equipment specification shall be performed.

8.02.00 Unless and otherwise stated, Six (6) copies of routine test certificates shall be submitted for approval prior to the despatch of the motors from works.

8.03.00 The following type test reports shall be submitted for each type and rating of HT motor:

- a) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- b) Fault level withstand test for each type of terminal box.
- c) Lightning impulse withstand test on the sample coil as per IEC 60034, part-15.
- d) Surge withstand test on inter-turn insulation as per clause no. 5.1.2 of IEC 60034, part-15.

8.03.04 The following type tests shall be performed on a representative sample of 11000V and 3300V motor of each type & rating, even if type test certificates of these tests are submitted by the Bidder for Purchaser's approval:





SECTION-I

- a. Measurement of stator resistance (and rotor resistance on slip ring motors).
- b. No load test at rated voltage to determine voltage, current, power input and speeds.
- c. Locked rotor reading of voltage, current, power input and values of torque of motor.
- d. Full load test to determine efficiency, power factor and slip.
- e. Temperature rise test. During heat run test, bearing temperature, Winding temperature, core temperature, coolant flow and its temperature shall be recorded. In case temperature rise test is carried at any load other than rated load, specific approval for test procedure and method has to be obtained.
- f. Momentary overload test.
- g. Test for noise level of motor.

9.00.00 SPARE

Recommended spares for three (3) years operation shall be quoted along with the bid clearly identifying the part numbers with recommended quantities.

10.00.00 DRAWINGS, DATA & MANUALS

Drawings, data & manuals for the motors shall be submitted as indicated below :

10.01.00 Along with the bid

- a) List of the motors
- b) Individual motor data sheet as per Annexures
- c) Scheme & write up on forced lubrication system, if any.
- d) Type test report

10.02.00 After Award of Contract for Information (I)/ Approval (A)

- a) Dimensional General Arrangement drawing (I)
- b) Foundation Plan & Loading (I)
- c) Cable end box details.(I)
- d) Space requirement for rotor removal (I)
- e) Thermal withstands curves hot & cold (I)
- f) Starting and speed torque characteristics at 80%, 100% & 110% voltage (A)
- g) Complete motor data sheet (A)
- h) Erection & Maintenance Manual (I)



ANNEXURE-A

DESIGN DATA

SECTION-I

1.0 AUXILIARY POWER SUPPLY

Supply	Description	Consumer
H.T. Supply	11 kV, 3 ϕ /, 3W, 50 Hz Non-effectively earthed Fault level 40 KA symm. for 3 second.	Motors above 1500 kW
H.T. Supply	3.3 kV, 3 ϕ /, 3W, 50 Hz Non-effectively earthed Fault level 40 KA symm. for 3 second.	Motors above 160kW upto 1500 kW.
L.T. Supply	415V, 3 ϕ /, 3W, 50 Hz Effectively earthed Fault level 50 KA symm. for 1 seconds.	Motors above 200W upto 160 kW
	240V, 1 ϕ /, 2W, 50 Hz Effectively earthed	Motors below 200W Lighting, space heating, A.C. control protective devices
D.C. Supply	220V, 2W, unearthed Fault level 25* KA for 1 second (Min.)	D.C. alarm, control protective devices

* However actual value shall be substantiated by the bidder through calculation.

2.0 RANGE OF VARIATION

A.C. Supply

Voltage	:	$\pm 10\%$
Frequency	:	$\pm 5\%$
Combined Volt & frequency	:	10% (absolute sum)

D.C. Supply

Voltage	:	190 to 240 Volt
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3.0 Paint Shade	:	RAL 7032
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LV MOTORS DATA SHEET-A

**SAGARDIGHI THERMAL POWER PROJECT
1 x 660 MW UNIT NO. 5, PHASE – III**

SPECIFICATION NO.

VOLUME II B

SECTION D

REV NO. 00 DATE 05.04.21

SHEET 1 OF 1

- | | | | |
|------|---|---|--|
| 1.0 | Design ambient temperature | : | 50 °C |
| 2.0 | Maximum acceptable kW rating of LV motor | : | Upto & Including 160KW |
| 3.0 | Installation (Indoors/ Outdoors) | : | As required |
| 4.0 | Details of supply system | | |
| a) | Rated voltage (with variation) | : | 415V $\pm$ 10% |
| b) | Rated frequency (with variation) | : | 50 Hz (Variation: +5% TO –5%) |
| c) | Combined voltage & freq. variation | : | 10% (sum of absolute values) |
| d) | System fault level at rated voltage | : | 50 kA for 1 sec |
| e) | Short time rating for terminal boxes | | |
| | *Above 90 kW upto & including 160kW(Breaker Controlled) | : | 50 KA for 0.25 sec. |
| | * Rated upto & including 90 kW (Contactor Controlled) | : | 50 KA protected by MCCB |
| f) | LV System grounding | : | Solidly |
| 5.0 | Class of insulation | : | Class 'F', with temp rise limited to class B. |
| 6.0 | Minimum voltage for starting | : | 80% of rated voltage |
| 7.0 | Power cables data | : | Shall be given during Detailed engg. |
| 8.0 | Earth Conductor Size & Material | : | Shall be given during Detailed engg. |
| 9.0 | Space heater supply (30KW & ABOVE) | : | 240 V, 1 Φ , 50 Hz |
| 10.0 | Rating up to which Single phase motor | : | Acceptable below 0.20 Kw |
| 11.0 | Locked rotor current | | |
| a) | Limit as percentage of FLC | : | As per IS 12615 |
| 12.0 | Makes | : | BHEL/ Customer approval (Package owner to take care) |
| 13.0 | Paint shade | : | RAL 7032 |
| 15.0 | Additional tests | : | As per QP |
| 14.0 | Degree Of protection for motor/ terminal box | : | IP 55 |

* LT motors of continuous duty shall be energy efficient IE3 class conforming to IS-12615

15.0 TESTING REQUIREMENTS: IN LINE WITH SPECIFICATION

➤ **Also detailed Customer spec. for Motors is to be referred as enclosed with technical spec.**

SECTION-I

ANNEXURE-I**SUB-VENDOR LIST**

The list of approved make of the LT Motors are as mentioned below:

S.No.	LIST OF LT MOTORS
1.	BHARAT BIJLEE LTD.
2.	CROMPTON GREAVES
3.	ASEA BROWN BOVERI
4.	KIRLOSKAR ELECTRIC CO LTD.
5.	NGEF
6.	SIEMENS
7.	MARATHON
8.	GE-POWER
9.	RAJINDRA ELECT INDUSTRIES
10.	LAXMI HYDRAULICS PVT. LTD

However, the final list of makes for the LT Motors is subjected to BHEL/Customer approval, during contract stage, without any commercial implications.

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	TITLE	SPECIFICATION NO.
	HT AND LT MOTOR	VOLUME II B
	DATA SHEET – C	SECTION D
	SAGARDIGHI THERMAL POWER PROJECT 1 x 660 MW UNIT NO. 5, PHASE – III	REV NO.00 DATE
		SHEET 1 OF 2

S. No.	Description	Data to be filled by successful bidder
A.	General	
1	Manufacturer & country of origin	
2	Motor type	
3	Type of starting	
4	Name of the equipment driven by motor & Quantity	
5	Maximum Power requirement of driven equipment	
6	Rated speed of Driven Equipment	
7	Design ambient temperature	
B.	Design and Performance Data	
1	Frame size & type designation	
2	Type of duty	
3	Rated Voltage	
4	Permissible variation for	
5	a) Voltage	
6	b) Frequency	
7	c) Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)	
9	Synchronous speed & Rated slip	
10	Minimum permissible starting voltage	
11	Starting time in sec with mechanism coupled	
12	a) At rated voltage	
13	b) At min starting voltage	
14	Locked rotor current as percentage of FLC (including IS tolerance)	
15	Torque	
	a) Starting	
	b) Maximum	
16	Permissible temp rise at rated output over ambient temp & method	
17	Noise level at 1.0 m (dB)	
18	Amplitude of vibration	
19	Efficiency & P.F. at rated voltage & frequency	
	a) At 100% load	
	c) At 75% load	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

266565/2021/PS-PEM-MAX

	TITLE LV MOTOR DATA SHEET – C SAGARDIGHI THERMAL POWER PROJECT 1 x 660 MW UNIT NO. 5, PHASE – III	SPECIFICATION NO.
		VOLUME II B
		SECTION D
		REV NO.00 DATE
		SHEET 2 OF 2

S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55KW$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

NAME OF VENDOR			SEAL	REV.	
NAME	SIGNATURE	DATE			

266565/2021/PS-PEM-MAX



TITLE :

GENERAL TECHNICAL REQUIREMENTs

FOR

LV MOTORS

SPECIFICATION NO.

PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : D

REV NO. : 00 DATE : 29/08/2005

SHEET : 1 OF 1

GENERAL TECHNICAL REQUIREMENTS**FOR****LV MOTORS****SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00**



GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.

PE-SS-999-506-E101

VOLUME NO. : II-B

SECTION : D

REV NO. : 00 DATE : 29/08/2005

SHEET : 1 OF 4

1.0 INTENT OF SPECIFICATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.



FILE :
GENERAL TECHNICAL REQUIREMENTS
FOR
LV MOTORS

SPECIFICATION NO.
 PE-SS-999-506-E101
 VOLUME NO. : **II-B**
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 SHEET : 2 OF 4

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

- i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.
- ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)
- iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for minimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691 and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

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	FILE : GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS	SPECIFICATION NO. PE-SS-999-506-E101
		VOLUME NO. : II-B
		SECTION : D
		REV NO. : 00 DATE : 29/08/2005
		SHEET : 3 OF 4
4.4.	Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.	
4.5	Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.	
4.6	In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation. In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.	
4.7	Terminals and Terminal Boxes	
4.7.1	Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A. Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".	
4.7.2	unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.	
4.7.3	Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.	
4.7.4	Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.	
4.7.5	Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.	
4.7.6	Degree of protection for terminal boxes shall be IP 55 as per IS 4691.	
4.7.7	Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.	
4.7.8.	Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.	
4.7.9	Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.	
4.8	Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.	
4.9	General	

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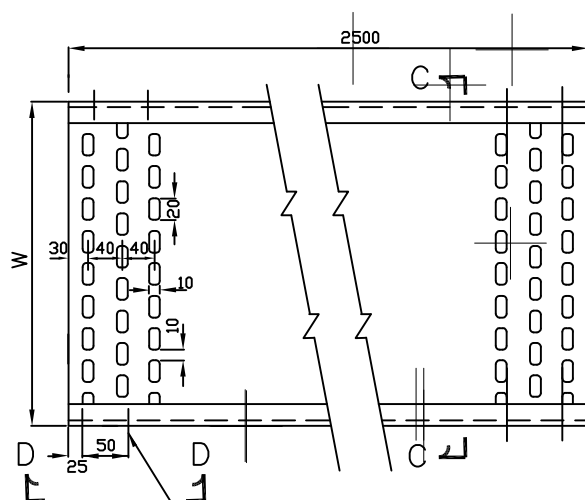


FILE :
GENERAL TECHNICAL REQUIREMENTS
FOR
LV MOTORS

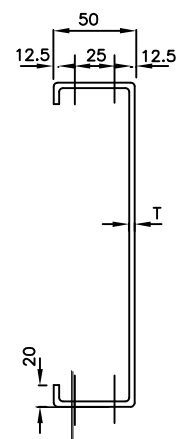
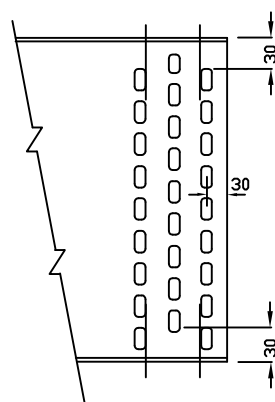
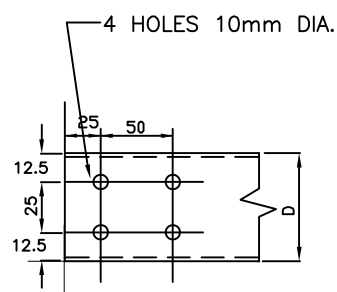
SPECIFICATION NO.
 PE-SS-999-506-E101
 VOLUME NO. : **II-B**
 SECTION : **D**
 REV NO. : **00** DATE : 29/08/2005
 SHEET : 4 OF 4

- 4.9.1 Motors provided for similar drives shall be interchangeable.
- 4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.
- 4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.
- 4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.
- 4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.
- 4.9.6 Name plate with all particulars as per IS: 325 shall be provided
- 4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.
- 5.0 INSPECTION AND TESTING**
- 5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.
- 5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.
- 5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.
- 5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.
- 6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT**
- a) OGA drawing showing the position of terminal boxes, earthing connections etc.
- b) Arrangement drawing of terminal boxes.
- c) Characteristic curves:
(To be given for motor above 55 kW unless otherwise specified in Data Sheet).
- i) Current vs. time at rated voltage and minimum starting voltage.
- ii) Speed vs. time at rated voltage and minimum starting voltage.
- iii) Torque vs. speed at rated voltage and minimum voltage.
 For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
- iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

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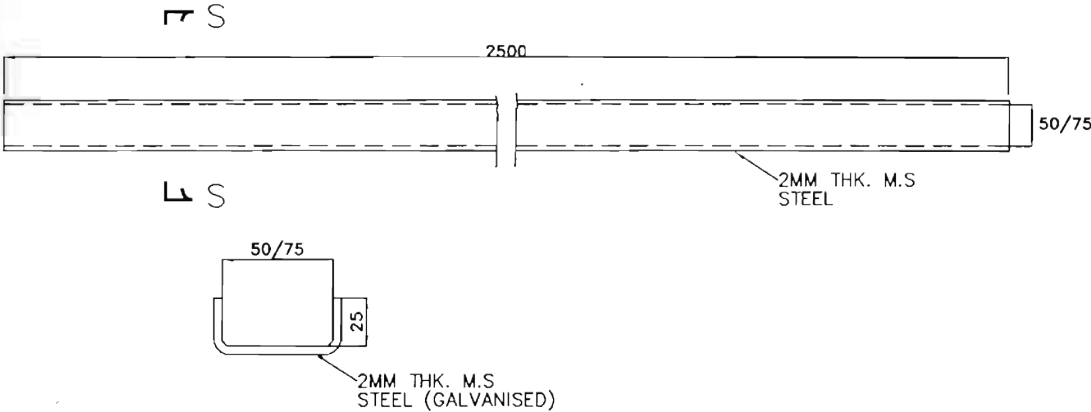


4 HOLES 10mm DIA.

SECTION-CC
(100/50 TRAYS)ARRANGEMENT OF
PERFORATIONSVIEW-DD
(100,50W TRAYS)

TRAY WIDTH W (mm)	100	50
TRAY DEPTH D (mm)	50	50
T (mm)	2	2

PERFORATED TYPE TRAY



SECTION S-S

CABLE TROUGHS



TYPICAL DETAILS OF
CABLE TRAY AND ACCESSORIES

266565/2021/PS-PEM-MAX

	MANUFACTURER/ SUPPLIER NAME & ADDRESS	BIDDER/	STANDARD QUALITY PLAN		SPEC. NO :		DATE:
			CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02		DATE: 17.04.2020
			PROJECT:		PO NO.:		DATE:
			ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II		SHEET 1 of 2

S. NO.	COMPONENT & OPERATIONS	CHARACTERISTICS	CLASS	TYPE OF CHECK	QUANTUM OF CHECK		REFERENCE DOCUMENT	ACCEPTANCE NORMS	FORMAT OF RECORD	AGENCY				REMARKS
1	2	3	4	5	6		7	8	9	*	**			
					M	C/ N				D	M	C	N	
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	-	MFG. SPEC.	MFG. SPEC.	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	VISUAL	100%	-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	LOG BOOK		P	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE	MA	VISUAL	100%	-	MFG.SPEC./	MFG.SPEC.	LOG BOOK		P	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	-	MFG. SPEC/ APPROVED DATASHEET	MFG. SPEC/ APPROVED DATASHEET	LOG BOOK	✓	P	V	-	
3.0	TESTS	1.ROUTINE TEST INCLUDING SPECIAL TEST	MA	VISUAL	100%	-	IS-325 / IS-12615/ APPROVED DATA SHEET	IS-325 / IS-12615/ APPROVED DATA SHEET	TEST/ INSPN. REPORT	✓	P	V*	-	* NOTE -1
		2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	-	APPROVED DRG/ DATA SHEET	APPROVED DRG/ DATA SHEET	TEST/ INSPN. REPORT	✓	P	V*	-	* NOTE -1 & NOTE-2

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

266565/2021/PS-PEM-MAX

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :	DATE:
		CUSTOMER :		QP NO.: PE-QP-999-Q-006, REV-02	DATE: 17.04.2020
		PROJECT:		PO NO.:	DATE:
		ITEM: AC ELECT. MOTORS UPTO 55KW (LV (415V))	SYSTEM:	SECTION: II	SHEET 2 of 2

		3.NAMEPLATE DETAILS	MA	VISUAL	100%	-	IS-325 / IS-12615 / APPROVED DATA SHEET	SAME AS COL. 7	TEST/ INSPN. REPORT	✓	P	V	-	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MFG. STANDARD / (#)	AS PER MFG. STANDARD / (#).	INSPC. REPORT	✓	P	W	-	(#) REFER NOTE-8

NOTES:

1. Routine tests on 100% motors shall be done by the vendor. However, BHEL/ Customer shall witness routine tests on random samples. The sampling plan shall be mutually agreed upon.
2. For exhaust/ventilation fan motors of rating up to 1.5 KW, only routine test certificates shall be furnished for scrutiny.
3. In case test certificates for these tests on similar type, size and design of motor from independent laboratory are available, the same is valid for 5 years.
4. BHEL reserves the right to perform repeat test, if required.
5. After packing and prior to issue MDCC, photographs of items to be despatched shall be sent to BHEL for review.
6. In case of any changes in QP commented by customer at contract stage, same shall be carried out by bidder without any implication to BHEL/ Customer.
7. Project specific QP to be developed based on customer requirement.
8. For export job, BHEL technical specification for seaworthy packing to be followed.
9. Packing shall be suitable for storage at site in tropical climate conditions.
10. Latest revision/ year of issue of all the standards (IS/ ASME/ IEC etc.) indicated in QP shall be referred.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION,

** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,

P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE

MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL

D: DOCUMENTATION

BHEL						BIDDER/ SUPPLIER		FOR CUSTOMER REVIEW & APPROVAL			
ENGINEERING			QUALITY			Sign & Date		Doc No:			
	Sign & Date	Name		Sign & Date	Name	Seal			Sign & Date	Name	Seal
Prepared by:		HEMA KUSHWAHA	Checked by:		KUNAL GANDHI			Reviewed by:			
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		RITESH KUMAR JAISWAL			Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO. :		DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:		SECTION: II

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	-		FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P	-	-	
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	SAMPLE	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TEST REPORT		P/V	-	-	
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	-		FREE FROM CRACKS, UN-EVENNESS ETC.	TEST REPORT		P	-	-	
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	-	MANUFACTURER'S DRG./SPEC	FREE FROM CRACKS, BLOW HOLES ETC.	LOG BOOK		P/V	-	-	
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	TC		P/V	-	-	HEAT NO. SHALL BE VERIFIED
		3.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	-	MANUFACTURER'S DRG./SPEC	MANUFACTURER'S DRG./SPEC	LOG BOOK		P/V	-	-	

BHEL					
ENGINEERING			QUALITY		
	Sign & Date	Name		Sign & Date	Name
Prepared by:		HEMA KHUSHWAHA	Checked by:		KUNAL GANDHI
Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

FOR CUSTOMER REVIEW & APPROVAL			
Doc No:			
	Sign & Date	Name	Seal
Reviewed by:			
Approved by:			

	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :		DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:	SECTION: II	SHEET 2 OF 9

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.5	SHAFT (FORGED OR ROLLED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	VENDOR'S APPROVAL IDENTIFICATION SHALL BE MAINTAINED
		2. CHEM. & PHYSICAL PROPERTIES	MA	CHEM. & PHYSICAL TESTS	1/HEAT NO. OR HEAT TREATMENT BATCH NO	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG./ STD.	TC		P/V	-		
		3. DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S DRG.	LOG BOOK		P/V	-		
		4.INTERNAL FLAWS	CR	ULTRASONIC TEST	100%	-	ASTM-A388	MANUFACTURER'S STD.	INSPECTION REPORT	✓	P/W	V	-	FOR DIA OF 55 MM & ABOVE
1.6	SPACE HEATERS, CONNECTORS, TERMINAL BLOCKS, CABLES, CABLE LUGS, CARBON BRUSH TEMP. DETECTORS, RTD, BTD'S	1. MAKE & RATING	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	MANUFACTURER'S DRG./STD.	INSPECTION REPORT		P/V	-	-	
		2. PHYSICAL COND.	MA	VISUAL	100%	-	MANUFACTURER'S DRG./STD.	NO PHYS. DAMAGE, NO ELECTRICAL DISCONTINUITY	INSPECTION REPORT		P/V	-	-	
		3.DIMENSIONS (WHEREVER APPLICABLE)	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	INSPECTION REPORT		P/V	-	-	
		4.PERFORMANCE/ CALIBRATION	MA	TEST	100%	-	MANUFACTURER'S DRG./ STD	MANUFACTURER'S DRG. / STD.	TEST REPORT		P/V	-	-	

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	Sign & Date	Name		Sign & Date	Name
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Reviewed by:		PRAVEEN DUTTA	Reviewed by:		R K JAISWAL

BIDDER/ SUPPLIER	
Sign & Date	
Seal	

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	MANUFACTURER/ BIDDER/ SUPPLIER NAME & ADDRESS	STANDARD QUALITY PLAN		SPEC. NO :		DATE:17.04.2020
		CUSTOMER :		QP NO.: PE-QP-999-Q-007, REV-04		
		PROJECT:		PO NO.:		
		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV (415V))		SYSTEM:	SECTION: II	SHEET 3 OF 9

SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
1.7	OTHER INSULATING MATERIALS LIKE SLEEVES, BINDINGS CORDS, PAPERS, PRESS BOARDS ETC.	1. SURFACE COND. ETC.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS	TEST REPORT		P/V	-	-	
		2.DIMENSION/BORE DIA, WALL THICKNESS, BDV AS RECEIVED, BDV AFTER FOLDING AT 180°	MA	TEST	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK AND OR SUPPLIER'S TC		P/V	-	-	
1.8	SHEET STAMPING (PUNCHED)	1. SURFACE COND.	MA	VISUAL	100%	-	-	NO VISUAL DEFECTS (FREE FROM BURS)	LOG BOOK		P	-	-	
		2.DIMENSIONS INCLUDING BURS HEIGHT	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG. .	MANUFACTURER'S DRG.	LOG BOOK		P/V	-	-	
		3. ACCEPTANCE TESTS	MA	ELECT. & MECH TESTS	SAMPLE	-	MANUFACTURER'S DRG./ STD.	MANUFACTURER'S DRG./ STD.	TC		P/V	-	-	
1.9	CONDUCTORS	1. SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		*P/V	-	-	* MOTOR MANUFACTURER TO CONDUCT VISUAL CHECK FOR SURFACE FINISH ON RANDOM BASIS (10% SAMPLE) AT HIS WORKS AND MAINTAIN RECORD FOR VERIFICATION BY
		2.ELECT. PROP. & MECH. PROP	MA	ELECT. & MECH.TEST	SAMPLES	-	MANUFACTURER'S DRG./ SPEC.	MANUFACTURER'S / SPEC.	TC & VENDOR'S TEST REPORTS		P/V	-	-	

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					M	C/N				D	M	C	N	
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	SAMPLES	-	MANUFACTURER'S DRG / SPEC.	MANUFACTURER'S / SPEC.	LOG BOOK		P/V	-	-	
		1.MAKE & TYPE	MA	VISUAL	100%	-	MANUFACTURER'S DRG./ APPROVED DATASHEET	MANUFACTURER'S DRG./ APPROVED DATASHEET			P/V	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	APPROVED DATASHEET	APPROVED DATASHEET/ BEARING MANUF'S CATALOGUES	LOG BOOK		P/V	-	-	
		3.SURFACE FINISH	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P/V	-	-	
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	SAMPLE	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
		4.HV/IR	MA	-DO-	100%	-	MANUFACTURER'S STD./ APPROVED DATASHEET	MANUFACTURER'S STD./ APPROVED DATASHEET	LOG BOOK		P/V	-	-	
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	-	MANUFACTURER'S DRG/SPECS	MANUFACTURER'S DRG / SPECS.	LOG BOOK		P	-	-	
		2.SURFACE COND.	MA	VISUAL	100%	-	-	FREE FROM VISUAL DEFECTS	LOG BOOK		P	-	-	
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	

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					M	C/N				D	M	C	N	
2.0	IN PROCESS													
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-	MANUFACTURER'S DRG	GOOD FINISH	LOG BOOK		P/W	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
2.2	MACHINING	1.FINISH	MA	VISUAL	100%	-	-DO-	GOOD FINISH	LOG BOOK		P	-	-	
		2.DIMENSIONS	MA	MEASUREMENT	100%	-	MANUFACTURER'S DRG	MANUFACTURER'S DRG	LOG BOOK		P	-	-	
		3.SHAFT SURFACE FLOWS	MA	PT	100%	-	MANUFACTURER'S STD./ ASTM-E165	MANUFACTURER'S STD./ APPROVED DATASHEET.	LOG BOOK	✓	P	V	-	
2.3	PAINTING	1.SURFACE PREPARATION	MA	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.SHADE	MA	VISUAL	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	SAMPLE	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	

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1	2	3	4	5	6		7	8	9	*	**			
					M	C/N				D	M	C	N	
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-	MANUFACTURER'S STD.	MANUFACTURER'S STD.	LOG BOOK		P	-	-	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		2.CLEANLINESS	CR	VISUAL	100%	-	MANUFACTURER'S STD./APPROVED DATASHEET	MANUFACTURER'S STD./APPROVED DATASHEET	LOG BOOK		P	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		4.RESISTANCE	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT	✓	P	V	-	
		5.INTERTURN INSULATION	CR	ELECT. TEST	100%	-	IS-325//IS-12615//IEC-60034 PART-1	IS-325//IS-12615//IEC-60034 PART-1	TEST/INSPC. REPORT		P	-	-	
2.6	IMPREGNATION	1.VISCOSITY	MA	PHY. TEST	AT STARTING	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		2.TEMP. PRESSURE VACCUUM	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK		P	-	-	
		3.NO. OF DIPS	MA	PROCESS CHECK	CONTINUOUS	-	MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD	LOG BOOK	✓	P	V	-	THREE DIPS TO BE GIVEN

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SI No.	Component & Operations	Characteristics	Class	Type of Check	Quantum Of check		Reference Document	Acceptance NORMS	FORMAT OF RECORD		AGENCY			
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					M	C/N				D	M	C	N	
2.7	COMPLETE STATOR ASSEMBLY	4.DURATION 1.COMPACTNESS & CLEANLINESS	MA MA	PROCESS CHECK VISUAL	CONTINUOUS 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK LOG BOOK	✓ 	P P	V -	- -	
2.8	BRAZING/COMPRESSION JOINT	1.COMPLETENESS 2.SOUNDNESS	CR CR	VISUAL MALLET TEST & UT	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	MANUFACTURER'S STANDARD MANUFACTURER'S STANDARD	LOG BOOK TEST/INSPC. REPORT	 ✓	P P	- V	- -	
2.9	COMPLETE ROTOR ASSEMBLY	3.HV 1.RESIDUAL UNBALANCE	MA CR	ELECT. TEST DYN. BALANCE	100% 100%	- -	MANUFACTURER'S STANDARD MANUFACTURER'S SPEC./ ISO 1940	MANUFACTURER'S STANDARD MANUFACTURER'S DWG.	TEST/INSPC. REPORT LOG BOOK	✓ 	P P	V -	- -	
2.10	ASSEMBLY	2.SOUNDNESS OF DIE CASTING 1.ALIGNMENT 2.WORKMANSHIP 3.AXIAL PLAY 4.DIMENSIONS 5.CORRECTNESS, COMPLETENESS TERMINATIONS/ MARKING/ COLOUR CODE 6. RTD, BTD & SPACE HEATER MOUNTING.	CR MA MA MA MA MA	ELECT. (GROWLER TEST) MEAS. VISUAL MEAS. MEAS. VISUAL	100% 100% 100% 100% 100%	- - - - -	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S SPEC. MANUFACTURER'S DRG./ MANUFACTURER'S SPEC. MANUFACTURER'S SPEC.	TEST/INSPC. REPORT LOG BOOK LOG BOOK LOG BOOK LOG BOOK	✓ ✓ 	P P P P P	V - - V -	- - - - -	

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					M	C/N				D	M	C	N	
3.0	TESTS	1.TYPE TESTS INCLUDING SPECIAL TESTS	MA	ELECT.TEST	1/TYPE/SIZE	1/TYPE/SIZE	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	W*	-	* NOTE - 1
		2.ROUTINE TESTS INCLUDING SPECIAL TEST	MA	ELECT.TEST	100%	-	IS-325//IS-12615/APPROVED DATASHEET	IS-325/IS-12615/APPROVED DATASHEET	TEST REPORT	✓	P	V [§]	-	§ NOTE - 2
		3.VIBRATION & NOISE LEVEL	MA	ELECT.TEST	100%	-	IS: 12075 / IEC 60034-14 & IS-12065	IS: 12075 / IEC 60034-14 & IS-12065	TEST REPORT	✓	P	V [§]	-	§NOTE - 2
		4.OVERALL DIMENSIONS AND ORIENTATION	MA	MEASUREMENT & VISUAL	100%	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET &	TEST//NSPC. REPORT	✓	P	W	-	
		5.DEGREE OF PROTECTION	MA	ELECT. & MECH. TEST	1/TYPE/ SIZE	-	IEC 60034-5/IS-12615	APPROVED DATASHEET	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		6. MEASUREMENT OF RESISTANCE OF RTD & BTD	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1/IS: 12802	IS-325/IS-12615/IEC-60034 PART-1/IS: 12802	TC	✓	P	V [§]	-	§ NOTE - 2
		7. MEASUREMENT OF RESISTANCE, IR OF SPACE HEATER	MA	ELECT. & MECH. TEST	100%	-	IS-325//IS-12615/IEC-60034 PART-1	IS-325/IS-12615/IEC-60034 PART-1	TC	✓	P	V [§]	-	§ NOTE - 2
		8. NAME PLATE DETAILS	MA	VISUAL	100%	-	IS-325//IS-12615& DATA SHEET	IS-325//IS-12615 & DATA SHEET	TEST//NSPC. REPORT	✓	P	V [§]	-	§ NOTE - 2
		9.EXPLOSION FLAME PROOF NESS (IF SPECIFIED)	MA	EXPLOSION FLAME PROOF TEST	1/TYPE	-	IS 2148 / IEC 60079-1	IS 2148 / IEC 60079-1	TC	✓	P	V	-	TC FROM AN INDEPENDENT LABORATORY, REFER NOTE-3
		10. PAINT SHADE, THICKNESS & FINISH	MA	VISUAL & MEASUREMENT BY ELKOMETER	SAMPLE	SAMPLE	APPROVED DATASHEET	APPROVED DATASHEET	TC	✓	P	W [§]	-	SAMPLING PLAN TO BE DECIDED BY INSPECTION AGENCY § NOTE - 2

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					M	C/N				D	M	C	N	
4.0	PACKING	SURFACE FINISH & COMPLETENESS	MA	VISUAL	100%	100%	AS PER MANUFACT. STANDARD / (#)	AS PER MANUFACT. STANDARD / (#)	INSPC. REPORT	✓	P	W	-	(#): REFER NOTE-8

NOTES:

- 1 DEPENDING UPON THE SIZE AND CRITICALLY, WITNESSING BY BHEL SHALL BE DECIDED.
- 2 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL/CUSTOMER SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON.
- 3 IN CASE TEST CERTIFICATES FOR THESE TESTS ON SIMILAR TYPE, SIZE AND DESIGN OF MOTOR FROM INDEPENDENT LABORATORY ARE AVAILABLE, THE SAME IS VALID FOR 5 YEARS.
- 4 BHEL RESERVES THE RIGHT TO PERFORM REPEAT TEST, IF REQUIRED.
- 5 AFTER PACKING AND PRIOR TO ISSUE MDCC, PHOTOGRAPHS OF ITEMS TO BE DESPATCHED SHALL BE SENT TO BHEL PURCHASE GROUP FOR REVIEW.
- 6 IN CASE , ANY CHANGES IN QP COMMENTED BY CUSTOMER AT CONTRACT STAGE SHALL BE CARRIED OUT BY BIDDER WITHOUT ANY IMPLICATION TO BHEL/ CUSTOMER.
- 7 PROJECT SPECIFIC QP TO BE DEVELOPED BASED ON CUSTOMER REQUIREMENT.
- 8 FOR EXPORT JOB, BHEL TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING TO BE FOLLOWED.
- 9 PACKING SHALL BE SUITABLE FOR STORAGE AT SITE IN TROPICAL CLIMATE CONDITIONS.
- 10 LATEST REVISION/ YEAR OF ISSUE OF ALL THE STANDARDS (IS/ ASME/ IEC ETC.) INDICATED IN QP SHALL BE REFERRED.

LEGENDS:

*RECORDS, IDENTIFIED WITH "TICK"(✓) SHALL BE ESSENTIALLY INCLUDED BY SUPPLIER IN QA DOCUMENTATION.
 ** **M:** SUPPLIER/ MANUFACTURER/ SUB-SUPPLIER, **B:** MAIN SUPPLIER/ BHEL/ THIRD PARTY INSPECTION AGENCY, **C:** CUSTOMER,
P: PERFORM, **W:** WITNESS, **V:** VERIFICATION, AS APPROPRIATE
MA: MAJOR, **MI:** MINOR, **CR:** CRITICAL
D: DOCUMENT

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Reviewed by:			
Approved by:			

	1 X 660 MW SAGARDIGHI TPS EXTN. UNIT#5 COMPRESSED AIR SYSTEM	SPECIFICATION No: PE-TS-445-555-A001	
		VOLUME: II B	
		SECTION : C-4	
		REV. 00	DATE: Mar.21
		SHEET: 1 OF 1	

SECTION: C-4
TECHNICAL SPECIFICATION (C&I PORTION)

**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**SECTION: C
SUB SECTION: C&I**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**

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C&I SPECIFICATION FOR COMPRESSED AIR SYSTEM

SECTION: C
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**C&I SPECIFICATION FOR
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**C&I SPECIFIC TECHNICAL REQUIREMENT
FOR DCS BASED
COMPRESSED AIR SYSTEM**

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	SPECIFICATION FOR CONTROL & INSTRUMENTATION FOR AUX PACKAGES	SPECIFICATION NO.:	
		VOLUME	
		SUB SECTION	
		REV. NO.	DATE :
		SHEET	OF

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 The quantity of instruments for auxiliary system shall be as per tender P & ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold and all the other accessories required for mounting/ erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments; sensors, switches etc for external connection including spare contacts shall be wired out to suitably located junction boxes.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.



C&I SPECIFICATION FOR COMPRESSED AIR SYSTEM

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Specific Technical Requirements (C&I):

1. Compressed Air System (CAS) shall be operated from DCS (BHEL's scope). Operation and control of compressed air system shall be as per design philosophy/customer specification given elsewhere in the specification. Integrated microprocessor based control system shall be provided for each Instrument Air compressor & Service air compressor. All transmitter such as PT, DPT, Dew Point Meter, TE (including winding and bearing temperature of compressor motor) etc. outside the compressor skid shall also be hooked up to this system. Compressors connectivity to DCS shall be provided. The instrument connected to DCS shall be finalised during detailed engineering. Refer Annexure 1 attached.

OPC COMPLIANT MODBUS, TCP/IP PROTOCOL (on RS-485) link on Fibre Optic cable shall be provided between plant DCS & this microprocessor system for monitoring of all the parameters and status feedback of drives of compressed air system.

In addition to the MODBUS link, provision for hardwired START, STOP commands from main plant DCS to all the compressors shall also be provided. All necessary hardware and software at bidder's end shall be under the bidder's scope. The control philosophy for CAS is attached further for detailed specification. All necessary hardware and software at bidder's end shall be under the bidder's scope. Bidder to confirm all the above requirements stated above in their scope of supply. Bidder to furnish the configuration diagram of Microprocessor Based Control System showing communication with the DCS along with the bid. Bidder to furnish write-up & recommended logics for control of Air compressors. Fibre optic cable is not in bidder's scope of supply.

Bidder to furnish signal exchange list between compressed air system and DCS in BHEL format attached further.

2. The Contractor shall provide complete Instrumentation for control, monitoring and operation of entire CAS. The requirements given are to be read in conjunction with detailed Technical specification enclosed in the specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre- bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of BHEL/customer shall prevail without any commercial implication.
3. The instrumentation to be provided for CAS shall be as per the technical specification document / drawings wherever provided for the respective systems as a minimum requirement for bidding purpose. However, for completeness of the system and its associated equipment, Bidder shall also provide all the necessary instruments to the process requirement even if not indicated in the given technical Specification document /drawings. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any technical, commercial and delivery implication to BHEL.
4. The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
5. All the instruments/drives shall be terminated on JB's/Panels in field. JB's/Panels shall be in Bidder's scope. Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 12-15 meter) and trunk cable.
6. For cable scope refer to electrical scope between BHEL and vendor defined in electrical specification.



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7. Bidder to provide mandatory spares as per mandatory spares list.
8. Electrical Actuators with integral starter shall be provided for all on/off and inching type valves along with necessary interface units for linking to corresponding Control System as applicable. The detailed specification is attached elsewhere in the specification.
9. All regulating duty control valves shall be equipped with smart positioner having integral I-P Converter and valve position transmitter.
10. The specifications for instruments mentioned in the specification are minimum requirements. The detail specifications shall be finalized during detail engineering.
11. The bidders shall specifically mention any deviation they would like to take on the C&I specification. In absence of only deviation, a No deviation certificate is to be furnished.
12. Bidder to terminate all instrumentation and control elements in junction boxes. Bidder to provide input/output list, drives list, junction box schedule and termination details, recommended control logics / write-up etc. the list of documents to be submitted after award of contract is to be referred by bidder.
13. All local gauges, transmitters and switches shall be mounted on suitable enclosures, racks subject to owner's approval. All transmitters shall be HART compatible.
14. Bidder to perform tests of C&I items/instruments/systems as per Quality plans/type test attached in the specification. However, if any test not specified in the quality plan but specified in specification Tests for I&C equipment included elsewhere in specification will have to perform by Bidder without any cost implication. The make/model of various instruments/items/systems shall be as per Customer/BHEL approved vendor list. No commercial and delivery implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
15. Instrument installation and accessories required for the same shall be in Bidder's scope and shall be submitted after award of contract. However, any instrument/ analyser installation not covered in the same shall be subject to customer and BHEL approval during detailed engineering.
16. RTD's shall be of duplex type. Both the elements of duplex temperature sensors shall be terminated to junction boxes. Temperature measurement shall have upscale / down scale drive to protect from process upset in case of sensor failure.
17. Bidder to provide JB/Rack & other erection hardware.
18. Bidder to furnish electrical load/UPS load data during detailed engineering.
19. UPS Power supply shall be provided by BHEL at a single point, further distribution to various instruments/equipment of the system shall be in bidder scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/equipment has to be derived by the bidder from the above supply



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& all necessary hardware for the same shall be in bidder scope. Bidder to submit the power requirement along with the bid.

20. Bidder's presence is required for 3 Man days (Excluding travel time) at EDN Bangalore during FAT of DDCMIS for certifying correctness & completeness of implementation of Control logic. Intimation to attained FAT shall be informed in 2 days advance. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.
21. Contractor's C&I representative shall be present at BHEL-PEM for 3 man-days, for preparation of Control scheme of CAS. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.
22. Bidder's presence is required for 15 Man days (in three visit) at site during commissioning of DDCMIS for assistance related to process correctness. Three visit with total 15 Man days (Excluding travel time) in which one visit shall be of 5 Man days each. All the expenses like boarding, lodging and travel, Air fare etc. shall be in bidder's scope.
23. Contractor shall furnish Instrument Schedule, I/O list, Drive list, Cable Schedule, Cable interconnection (DCS end terminal details shall be provided to vendor during detail engineering to incorporate in cable interconnection), JB grouping, Annunciation list, SOE list, List of Instruments/devices for HART in BHEL approved format. Also reusable database format like MS Excel, MS Access etc. of these documents shall also be provided by Contractor in BHEL approved format. Soft copy of the formats shall be provided to the successful bidder.
24. Interface of MCC, HT SWGR, Solenoid valves, field instruments, Actuators etc. with DDCMIS based control system shall be as per Drive Control Philosophy enclosed in specification.
25. Local control panel if any required for operation shall be in bidder scope.
26. The solenoid operated valves/Dampers/Gate shall have a limit switch for open/close feedback. Solenoid Valve shall be rated for 24V DC only.
27. Interface of MCC, HT SWGR, Actuators, solenoid drives, control valves etc. with DCS based control system shall be as per Drive Control Philosophy attached in the specification.
28. All field instruments enclosure shall be IP65. Local panel/cabinet enclosure shall be IP 55, unless otherwise specified.
29. Diaphragm seal shall be provided with Instruments having contact with corrosive media.
30. Primary sensor redundancy for Control/measurement shall be decided as per following general criteria:
 - a. Critical controls & respective measurements, measurements required for protection of auxiliaries & for major CLCS/OLCS- Triple redundant.
 - b. Non-critical but important control & measurements and measurements required for other CLCS/OLCS- Dual redundant.
 - c. Only measurement- No redundancy.
31. In addition to above, 20% wired input/output spare channel shall be



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provided for each I/O module.

32. Double root valve shall be provided for all pressure tapings where the line pressure is 40kg/cm² and above. Single root valve for below 40Kg /sq. cm.
33. Use of process actuated shall be avoided unless unavoidable.
34. Number of pairs to be selected for Screen /Control cable
 - a) F-Type: 2P/4P/8P/12P (Size: 0.5sqmm²)
 - b) G-Type: 2P/4P/8P/12P (Size: 0.5sqmm²)
 - c) Core Cable: 3CX2.5sqmm²/ 5CX2.5sqmm²/ 12CX1.5sqmm²
35. In addition to requirements specified here, all C&I systems/ sub-systems/ equipment/ devices shall also meet other requirements stipulated under other Sub-sections/ parts/ sections of specification.
36. In case of any conflict and repetition of clauses in the specification, BHEL discretion will prevail.
37. Vibration Monitoring System is envisaged for HT motors for Compressed Air System which is in BHEL scope. However, for mounting of vibration sensors/probe, vendor to provide vibration pad (of dimension of 80 mm*80mm*10mm each) for mounting of sensors and a notch/slot for mounting of key phasor. The mounting arrangement/pad shall be made at each DE-X, DE-Y and NDE-X, NDE-Y end both for Compressor and motors.
38. Time synchronization of compressor microprocessor system with the DCS has to be done. Bidder to provide necessary hardware/software at their end.

1X660MW SAGARDIGHI THERMAL POWER EXTENSION PROJECT (UNIT #5)														
CONTROL SYSTEM FOR MECHANICAL AUXILIARY PACKAGES										(DRG. NO. PE-DM-445-145-1900)		Rev02		
Sl. No.	System / Package	Scope of supply (Control system)	Control System		Operation from		Type of interface with main plant DDCMIS		Communication			Time Sync Format	HMI REQUIREMENT	Remarks
			Type	Location of Control cabinet	Local	Remote (CCR)	Link	Purpose	Cable Type	Redundant (Y/N)	Protocol			
Annexure 1														
	Compressed Air system	PEM-VEND	Microprocessor based sys for individual compressors	Compressor house of Phase-II (Unit#3&4)	Y*	Y@	Soft & H/W@	Monitoring	TP/FO	Y	MODBUS/ OPC	NA		1. * Local compressor panel will have GUI with LCD/ LED screen 2. @ The Hardwired interfacing of New IAC & SAC and Air Dryer System to the Unit 5 CER for START/STOP operation from DDCMIS 3. Soft connectivity of individual compressor control systems of New IAC & SAC with Unit#3&4 DDCMIS through OPC/MODBUS soft link and Mark V gateway. 4. U#5 IAC and Unit#3,4 IAC shall be connected to existing ES-6 controller. Unit#5 SAC and Unit#3,4 SAC shall be connected to new Optimizer controller.

Cheklst for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other -----	
5	Master	☐ System maxDNA ☐ Other -----	
6	Redundancy Requirements	Yes / No	
7	Dist.bet.maxDNA System & Device*	☐ ----- Feet ☐ ----- Meters	

B Electrical Specific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ----- ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control	
		☐ Download parameter sets	
2	Analog Points to read	-----Nos. ☐ Details attached ☐ Details not attached	
3	Analog Points to write	-----Nos. ☐ Details attached ☐ Details not attached	
4	Digital Points to read	-----Nos. ☐ Details attached ☐ Details not attached	
5	Digital Points to write	-----Nos. ☐ Details attached ☐ Details not attached	
6	Memory / Flag Points to read	-----Nos. ☐ Details attached ☐ Details not attached	
7	Memory / Flag Points to write	-----Nos. ☐ Details attached ☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable ☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No	
3	Any specific Converter required	☐ Yes ☐ No ☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec. ☐ Operating Manual	

***Notes:**

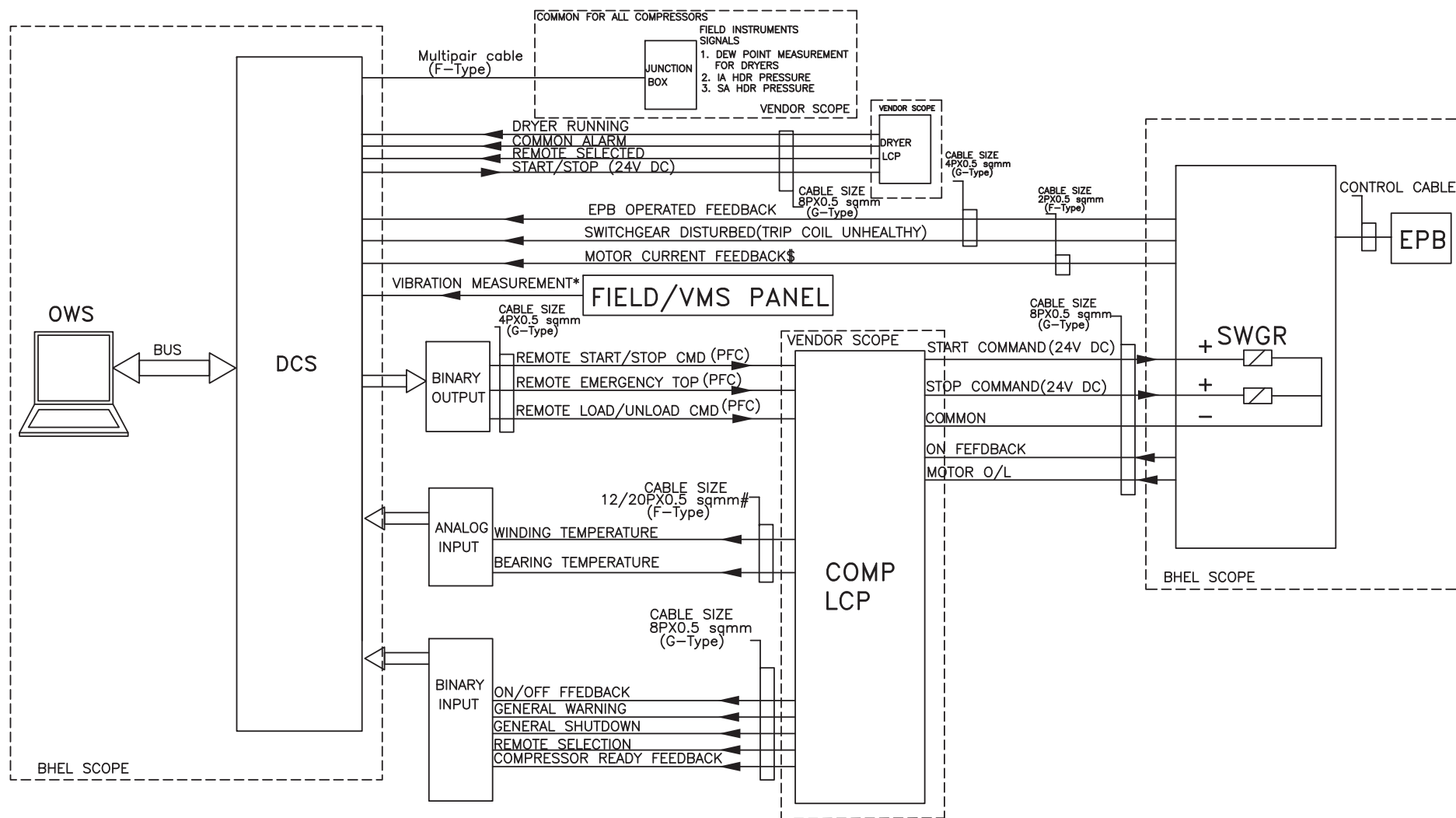
A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

STANDARD HARDWIRED INTERFACE BETWEEN COMPRESSOR CONTROL SYSTEM, DCS AND SWGR



NOTE:

1. *APPLICABLE FOR HT MOTORS (PROJECT SPECIFIC)
2. #12P APPLICABLE IF 'TT' IS ENVISAGED. 20P APPLICABLE IF 'RTD' IS ENVISAGED.
3. \$FOR NTPC PROJECTS MIN 4P(F-TYPE) TO BE USED.
4. CABLE SCOPE SHALL BE AS PER ELECTRICAL SCOPE MATRIX OF PARTICULAR PROJECT



TITLE

DDCMIS/LCP/SWGR INTERFACE FOR
INDIVIDUAL COMPRESSOR/DRYER

C&I TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM								
HARDWIRED SIGNALS BETWEEN COMPRESSOR CONTROL SYSTEM, DCS AND SWGR								
S. NO.	KKS TAG NO.	SOURCE	DESTINATION	DESCRIPTION	STATUS	I/O TYPE	SIGNAL TYPE	REMARKS
1	QEB10AN001	COMPRESSOR-1 LCP	DCS PANEL	COMPRESSOR-1 REMOTE SELECTION FEEDBACK	TRUE	DI	NO	
2	QEB10AN001			COMPRESSOR-1 GENERAL WARNING FEDABCK	TRUE	DI	NO	
3	QEB10AN001			COMPRESSOR-1 GENERAL SHUTDOWN FEDABCK	TRUE	DI	NO	
4	QEB10AN001			COMPRESSOR-1 ON/OFF (RUN) FEDABCK	TRUE	DI	NO	
5	QEB10AN001			COMPRESSOR-1 READY FEEDBACK	TRUE	DI	NO	
6	QEB10CT001-6*			COMPRESSOR-1 MOTOR WINDING TEMPERATURE (3/6nos.)*	--	AI	RTD/4-20mA***	
7	QEB10CT007-10			COMPRESSOR-1 MOTOR BEARING TEMPERATURE(4nos.)	--	AI	RTD/4-20mA***	
8	QEB10VT001-8**	FIELD/VMS PANEL	DCS PANEL	COMPRESSOR-1 MOTOR VIBRATIONS(8nos.)**	--	AI	4-20mA	As applicable
9	QEB10AN001	DCS PANEL	COMPRESSOR-1 LCP	COMPRESSOR-1 REMOTE LOAD/UNLOAD COMMAND	CMD	DO	NO	Maintained Type PFC
10	QEB10AN001			COMPRESSOR-1 REMOTE START/STOP COMMAND	START/STOP	DO	NO	Maintained Type PFC
11	QEB10AN001			COMPRESSOR-1 REMOTE EMERGENCY STOP	EMERG STOP	DO	NO	
12	QEB10AN001	COMPRESSOR-1 LCP	COMPRESSOR-1 SWGR	COMPRESSOR-1 START COMMAND	START	DO	NO	
13	QEB10AN001			COMPRESSOR-1 STOP COMMAND	STOP	DO	NO	
14	QEB10AN001	COMPRESSOR-1 SWGR	COMPRESSOR-1 LCP	COMPRESSOR-1 ON FEEDBACK	ON FB	DI	NO	
15	QEB10AN001			COMPRESSOR-1 MOTOR O/L	MTR O/L	DI	NO	
16	QEB10AN001	COMPRESSOR-1 SWGR	DCS PANEL	COMPRESSOR-1 EPB OPERATED	EPB OPTD	DI	NO	
17	QEB10AN001	COMPRESSOR-1 SWGR	DCS PANEL	COMPRESSOR-1 SWGR DISTURBED FEEDBACK	SWGR DIST	DI	NO	
18	QEB10CE001	COMPRESSOR-1 SWGR	DCS PANEL	COMPRESSOR-1 MOTOR CURRENT	--	AI	4-20mA	
19	QEB20AT001	DRYER-1 LCP	DCS PANEL	DRYER-1 REMOTE SELECTED	REMOTE	DI	NO	
20	QEB20AT001			DRYER-1 RUNNING	ON	DI	NO	
21	QEB20AT001			DRYER-1 COMMON ALARM	ALARM	DI	NO	
22	QEB20AT001	DCS PANEL	DRYER-1 LCP	DRYER-1 START/STOP COMMAND	START/STOP	DO	24V DC	
23	QED20DM001	JB	DCS PANEL	DEW POINT MEASUREMENTS FOR DRYERS	--	AI	4-20mA	
24	QED25CP001			IA HEADER PRESSURE	--	AI	4-20mA	
25	QED35CP001			SA HEADER PRESSURE	--	AI	4-20mA	
NOTE:				LEGENDS:				
1. *3nos. Of winding temperature applicable for NTPC projects.				DI-DIGITAL INPUT				
2. **Vibration signals are project specific & quantity/type depends upon VMS panel/Field outputs.				DO-DIGITAL OUTPUT				
3. ***If temp transmitter envisaged then 4-20mA applicable for winding/bearing temperature.				NO-NORMALLY OPEN				
4. This signal list is for one compressor & one dryer. Simillar signal list shall be applicable for other compressors/dryers also.				NC-NORMALLY CLOSED				



WBPDCL

EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

Compressed Air Plant

- 2.02.01 Control, protection & interlocking system for individual compressors shall be achieved through skid mounted proprietary microprocessor based controllers with colored Graphic User Interface (GUI) with LCD/ LED screen based display unit, control switches and other operational keys. The control system together with the power supplies and other accessories shall be located within the local panel.
- 2.02.02 Control panels for the Compressors shall house the following:
- Local push button switches for the compressors and cooling water line valves to start or stop manually, local load selector switch for selecting the base load compressor and standby compressor, ammeter, indicating lamps, bearing and winding temperature scanner for the compressor drivers, fault wise annunciation for each compressor etc.
- 2.02.03 Individual Compressor control systems of Unit#5 shall be interfaced with the Unit #3 & 4 DCS. Since, the compressors of Unit #5 shall be connected to existing compressed air header, any loss of header pressure for what so ever reason, including failure of Unit#5 compressors, shall automatically start the standby compressor with the help of existing control system of Units #3&4. However, the status of all compressors including the same of Unit#3&4 shall be available at unit#5 control room.
- 2.02.04 New Instrument Air Compressor (IAC) shall be connected to the existing **ES-6** controller for regulating the net pressure within programmable limits by starting and stopping, loading and un-loading of the connected compressors.
- Moreover, a separate **ES-6** controller for the new & existing Service Air Compressors (SAC) shall be provided.
- The Existing **ES-6** controller shall be dedicated for IACs use only.
- The cable and accessories for connection between each Compressor control system & **ES-6** controller shall be provided by the Bidder.
- 2.02.05 Bidder shall provide required Hardware interface with Unit#5 DCS for remote operation, monitoring & alarm.
- Also Bidder shall provide required soft connectivity with Unit#3&4 DCS through existing **Combox** for remote monitoring & alarm. i.e, the existing daisy chain network shall be extended to include the new IAC & SACs.





WBPDCCL

EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

2.02.06 Electrical/SWGR interface with DCS shall be as per "Typical Drive Control Philosophy". However, extent of signal interfaces between Compressor control systems and SWGR for the operations of compressors shall be finalized during detail engineering stage as per Owner's approval. Commands shall be directly wired from Compressor control panel to SWGR. Command from DCS shall also be executed through Compressor control system. One signal from SWGR i.e. "Electrical Trip" shall be directly wired to compressor control panel. Balance signals from SWGR shall be directly wired to DCS.

2.02.07 Local control panel for Air Drying Plant shall house the start/stop push button switch of dryer, temperature indicator for dry air line and annunciation system. Required hardwired signal interfaces with Unit#5 DCS shall also be provided for remote operation & monitoring of parameters.

Following minimum indication lamps shall be provided on the Dryer Control panel:

- a) Power On.
- b) Dryer Trouble.
- c) Power Supply Failure.

2.02.08 Necessary & Suitable Instrumentation as required to achieve the operation philosophy indicated in Volume II-J1/Section -II of the specification and as illustrated below & relevant tender flow diagram shall be provided as minimum requirement for the system. All necessary instruments like Pressure indicators, temperature indicators, pressure transmitters, temperature switches, etc. shall be envisaged for trouble free operation of compressors.

Compressor integral instruments shall be as per P&ID approved by Owner. Each Compressor's winding temp RTD signals, bearing temp RTD signals and VMS signals (For Motor both ends i.e DE & NDE) shall be hardwired to DCS directly from field/VMS panel. The vibration data shall be coming in VMS only (placed at Unit Control Equipment Room). Analysis & diagnostic functions shall be carried out in Centralized VMAS.

Signals from Winding RTD/phase and compressor/motor Bearing RTD (DE & NDE) shall be hardwired to Compressor Control Panel directly. One element shall be connected to Compressor local controller and other element shall be connected to DCS. Further complete trip/protection signals (contact signals) related to winding temperature, and bearing temperature, shall be wired to Compressor Control Panel from Local Temperature Scanner accordingly.

For Vibration very high & high signals, DO may also be provided from DCS to each compressor panel for annunciation.



**WBPDCCL**

EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

Following Field Instruments in addition to the compressor/ air dryer integral instruments shall be provided:

- a) Pressure transmitter and vortex flow meter at discharge of each compressor for monitoring in local control system and DCS.
- b) Water flow switch on each compressor cooling water outlet.
- c) Dew point cum moisture measurement system with 4-20 mA DC output to Air Dryer panel & DCS.
- d) Local pressure gauges on individual air receiver & common air headers.
- e) One.(1) No. additional pressure transmitter dedicated for new ES-6 controller on the common service air header shall be provided and erected.
- f) Pressure transmitters at each air receiver shall be provided and the same shall be connected to the DCS for remote monitoring and alarm.
- g) Auto Drain trap for the air dryer, moisture trap and air- receiver shall be timer based solenoid operated. The power for the solenoid valve shall be 230V AC UPS supply.
- h) If in case any new Instrument or Service header is envisaged, then pressure transmitters for monitoring pressure on instrument service air header to ensure availability in each header shall be provided.

2.02.09 The following Minimum signals shall be indicated in DCS:

- a) Status of each compressor
- b) Instrument air pressure Low / High
- c) Service air pressure Low / High
- d) Dew point of compressed air
- e) Status of each ADP
- f) Compressor header pressure
- g) Receiver Pressure
- h) Instrument Air Flow
- i) Service Air Flow





WBPDCCL

EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

2.02.10

The following Trip / Annunciations shall be provided in individual compressor panel:

- a) Motor Overload
- b) Compressor Discharge Air Temperature High for each stage.
- c) Lube Oil Temperature High.
- d) Lube Oil Pressure Low.
- e) Control Supply Failure.
- f) Compressor Cooling Water Flow Low.
- g) Compressor Motor Winding Temperature High / High High.
- h) Compressor Motor Bearing Temperature High / High High.
- i) Compressor Tripped
- j) Compressor Emergency Stopped

All pressure and temperature conditions used for tripping the compressor shall be provided with pre-trip annunciation in the local control panel.

2.02.11

Bidder shall provide all control equipment, accessories, all instrumentation cables including laying and termination of cables, erection hardware for safe, efficient and reliable operation of the plant instruments (*As per Technical Specification Volume IIE/Section -VI*).

2.03.00

Cooling Water (CW) & Aux. Cooling Water (ACW) System

2.03.01

Control of CW & ACW shall be realized in remote extended node of Unit#5 DCS. CW pumps & ACW pumps shall be operated from OWS located at Unit Control Room as well as from two (2) nos. of operator workstations provided at the local control room in CW pump house. Operator cum Engineering Stations shall have 23" colour LED monitor, keyboard, mouse etc.

2.03.02

Operation of CW pumps shall be suitably interlocked with the opening and closing of discharge butterfly valves. The standby pump shall start automatically in case of tripping of any of the running pumps.

2.03.03

For ACW system, the standby pump shall start automatically in case of tripping of any of the running pumps.

2.03.04

The following safety interlocks shall be provided in the system which shall initiate tripping of the CW and ACW pumps:

- a) Water level in CW sump : Very low



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- f) Field wiring for contact interrogation or device control shall be protected such that a fault on the cable does not cause loss of more than a minimum tolerable functionality of the system.

6.08.02 Measurement & Channel Redundancy

To meet the failure and self checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters. Throughout the control system, the security and validity of signals are to be ensured based on the following design principles.

- a) Where a plant measurement is to be duplicated or triplicated such signals shall be separately fed to the different input modules.
- b) Signals, after due security and validity checking by means of voting, averaging, median, difference monitoring or similar technique shall be used for control functions.
- c) Where duplex measurements are used, provision shall be there for selecting any one as the duty signal. Continuous monitoring of Deviation between the signals shall be made in the system.
- d) For binary and analog inputs required for protection of SG , TG and major auxiliaries whose non availability may result in loss of generation triple sensing devices shall be provided . Binary and analog inputs , which are required for protection of more than one equipment as well as protection signals for important auxiliaries and HT drives etc. triple sensing devices shall be provided .Also other binary and analog inputs required for CLCS dual sensing devices shall be provided . However,for those binary and analog inputs which are also required for protection in addition to CLCS, triple sensing devices shall be provided.
- e) Measurement system, CLCS and OLCS shall all be configured with redundancy at processor modules,communication modules, data bus and power supply modules.Triple redundancy shall be followed as described elsewhere in the specification. All servers shall be dual redundant.
- f) Both CLCS & OLCS shall be configured with Redundant I/O channels for each sensor/signals. Where redundant sensors are provided redundant I/O channels shall be provided for each sensors/signals.
- g) Redundant sensors shall be provided for all control applications. For all major closed loop controls (CLCS) triple redundant sensors shall be provided. For other CLCS loops dual redundant sensors shall be provided.
- h) Similarly for critical protection logic requirements triple redundant sensors for 2 out of 3 logic shall also be provided to avoid spurious tripping. For all other control application dual redundant sensors shall be provided. Dual and Triple redundant sensors shall also be provided as described elsewhere in the specification.



- i) Signals shall be verified against cable failure / non coincidence monitoring for critical trip signals.

6.08.03 Redundancy in input / output modules

1. Redundancy
 - a) Redundancy in input / output modules for close loop control systems, open loop control system, protection, interlocking and sequential control shall be provided as follows:
 - i) Wherever redundant sensors are employed each sensor shall be wired to a separate input module so that even if one input module fails, the parameter will be available from the other input module.
 - ii) Redundancy in output module shall be provided for all HT (11KV & 3.3 KV) drives, critical LT drives and all modulating control drives so that any single failure of the output module shall not lead to the failure/disturbance of process. critical LT drives will be finalized by the owner at the time of Detail engineering.
 - iii) For BMS / FSSS and Turbine Trip system relevant sections elsewhere shall be referred. Refer clause nos. 4.29.02 and 4.30.01 of section -I for FSSS and Turbine trip redundancy.
 - iv) In addition to above, 20% wired input/output spare channel shall be provided for each I/O module.
 2. Bidder to note that all I/O, Processor, network interface, communication modules etc., shall be sourced from their Original Principal's works.
 3. The system shall be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble shooting shall be a primary consideration in equipment selection.
 4. The system shall provide inherently safe operation under all plant disturbances and component failures so that under no circumstances safety of the plant personnel nor equipment is jeopardized.. The DCS hardware shall be suitably sized to ensure that the implemented scheme meets the desired requirements. The Bidder through detailed calculations shall establish the adequacy of the system selected and demonstrate the same during shop testing and site testing.

6.08.04 Data highway Redundancy

There shall be Redundancy in the system for high reliability of communication. The redundant buses shall work continuously. All communication modules, bus couplers, bus interfaces etc. shall also be hot redundant.

Communication between the operator station and the functional groups of control microprocessors shall be by means of hot redundant data highways.





Redundancy failure shall also be indicated in operating station.

All soft links amongst DCS and various PLC / proprietary control systems shall be redundant bidirectional OPC link.

6.08.05 Redundancy for Power supply unit

All power supply feeders from UPS (in parallel mode having 50% load sharing) or 24 V DC system (in parallel mode having 50% load sharing) shall be redundant with auto changeover in each ACDB/DCDB panel. Any kind of bulk power supplies if used shall be redundant.

6.08.06 Redundancy in Operator Console

Operators' 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 and LVS.

6.08.07 Design Of Enclosures

- i) Design of outdoor enclosures shall be weather proof, dust-tight, drip-proof and shall take into account the environmental conditions.
- ii) Enclosures shall be adequately sized so that the maximum permissible temperature rise above 50 Deg C ambient is 10 Deg C (maximum).
- iii) Enclosures design shall also take into account greatest possible personnel safety.

6.09.00 Electrical Noise Control

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

6.09.02 Bidder shall be responsible for implementation of the shielding, input balancing, ripple filtration and grounding for field inputs to achieve installation with minimum noise coupling.

6.09.03 Radiated immunity test shall be in accordance to IEC 801.3.

6.10.00 Surge-Protection For Solid State Equipment

6.10.01 All solid-state equipment shall be able to withstand the surges inherent in a powerhouse environment. Equipment shall be designed to successfully withstand surges 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".

6.10.02 To immunize the system against surge, coupling free wheeling diodes, surge suppressors, opto / galvanic isolators shall be used as required.





6.11.00 Burn-In And Elevated Temperature Test

Solid-state equipment / system shall be certified to be tested for a minimum period of 168 hours continuously under power. Solid-state logic systems shall be subject to the elevated temperature test and burn-in test as complete assemblies.

6.12.00 Elevated Temperature Test

- a) During the first 48 hours the ambient temperature shall be maintained at 50^o C and the equipment shall be made to repeatedly perform 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.
- b) The 48 hours test period shall be continuous but shall be divided into four 12-hour segments. The power supply 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.
- c) During the elevated temperature test the cubicle doors shall be kept closed and inside temperature in the zone of highest heat dissipating

component /module shall be monitored. Temperature rise inside the cubicle shall not exceed 10 Deg.C above the ambient temperature of 50 Deg.C.

6.13.00 Burn in Test

The 48 hours elevated temperature test shall be followed by 168 hours of burn in test at normal operating temperature. This test shall also be conducted as per above procedure.

6.14.00 Panels, Cubicles and Enclosures

6.14.01 General

- a) All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.
- b) Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.
- c) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the CRCA steel for UCP / backup panel and other panels/cabinets shall be as described in Section VII of this volume of the specification. 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.

- d) Panel /cabinet shall have eyebolt on top for lifting.
- e) 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 Bidder ,this shall include freeissue items furnished by Owner.

6.14.02 Surface Preparation and Painting

Sheet metal exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

- a) 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. Oil, grease and salts etc. shall be removed from by one or more solvent cleaning methods prior to blasting.
- b) Two spray coats of epoxy primer □urface shall be applied to all exterior and interior surfaces, each coat of primer □urface 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 Min. Paint shade thickness at exterior & Interior shall be 80 to 100 Microns.The finish colors for exterior and interior surfaces shall conform to the following shades:
 - i) Exterior : RAL 7032
 - ii) Interior – Brilliant White (Preferred) / RAL 7032.
- c) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections shall not be acceptable.

6.14.03 Wiring

Wiring 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. Features shall not be limited to the following :

- a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks.
- b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.
- c) 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.





- d) Internal wiring shall be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low mili volt or micro volt shall be electrically and physically isolated from other AC and DC wiring.
- f) All low-level signal cables shall be separately bundled from control cable.
- g) Wires shall be dressed and run in troughs with clamp-on type covers. Wirings shall 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.
- h) Shield wires shall be terminated on separately.
- i) Common connections shall be limited to two wires per terminal. Looping of wires for power distribution in the panel to be avoided. Busbars to be provided for Power distribution".
- j) 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 to the conductor.
- k) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without 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.
- l) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- m) Panels /cabinets /desks shall be provided with removable gasketted cable gland plates and cable glands. Split type grommets shall be used for prefab cables.
- n) Wire shall be multistranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.
- o) Wire sizes used for internal wiring shall not be lower than the followings :

Control wiring (switches, : 1.5 Sq.mm
pushbuttons etc.)

Power supply /illumination wiring /receptacle : 2.5 sq. mm or higher as per
load





4-20mA DC current and low : 0.5 Sq. mm
voltage signal upto 48V DC

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

6.14.04 Grounding

- a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.
- b) Panels and cabinets shall be provided with a continuous tinned copper ground bus bar 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.
- c) 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.
- d) Circuits requiring grounding shall be individually and directly connected to the panel ground bus.
- e) For electronic system cabinets, the electronic system ground bus shall be similar but insulated from the cabinet and shall be separately connected to the system ground. Signal cable shields shall be grounded at the panel end only and shall not be left open. The ground in between panels of a shipping section shall be firmly looped.
- f) Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

6.15.00 Panel / Cabinet/ Desk/ Enclosures / junction boxes & instruments Environmental Protections

- a) Panels, cabinets, desks, distribution boxes, racks ,junction boxes, terminal boxes , instruments and all other field mounted equipment / enclosures shall suit the environmental condition of the area and shall not be inferior 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-32 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-65 with anticorrosion coating.
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

- b) 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.

6.16.00

Terminal Blocks

- a) Terminals shall be chromated galvanized DIN rail mounted screwless 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.
- b) 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
- c) Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screwless 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.
- d) Terminals shall be of non flammable suitable thermoplastic material such as polyamide.



- e) 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.
- f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- g) 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.
- h) Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- i) 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.
- j) Other requirements of the terminal blocks are as follows:
 - i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
 - ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
 - iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
 - iv) 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.
 - v) Where more than one connection to a terminal block is required, two tier terminals shall be used.
 - vi) The terminal blocks for Power, control and signal cable terminal block shall be separate with separate colour coding for ease in recognition..

7.00.00 METERING BASES AND CHART UNITS

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

- i) Pressure : Kg/cm²
Differential Pressure : mm of H₂O column / Kg/cm²
- ii) Draught : mm of H₂O column
- iii) Vacuum : Kg/cm² (abs)/mm of Hg column





- i) Conduit sealing and fittings shall be provided as required and shall be consistent with the area and equipment with which they are installed.
- ii) 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.

12.01.01 Junction Box

01. Type of Enclosure : Dust tight & weatherproof conforming to IP 65
02. Material : 2 mm sheet steel
03. Type of Cover : Solid Hinged Door with steel handle and IP lock
04. Paint : 631 IS 5 Epoxy Powder Coated
05. Mounting : Surface
06. Cable Entry : 3 mm (min) Gland plate
07. Gasket : Neoprene
08. Grounding : Brass earth lug with green screw head
External-2 nos , Internal-1no.M6.
09. Number of Drain Holes : Two at bottom capped.
10. Identification : Label for JB and Tags for cable
11. Accessories : a) Rail mounted cage clamp type screwless terminals with markers
b) Cable gland
c) Ferrules
d) Canopy at top

12.01.02 Cable Gland

01. Type : Double compression
02. Entry Thread : NPT
03. Material : Brass
04. Finish : Cadmium Plated.
05. Protection : IP 65 or better



**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**SECTION: C
SUB SECTION: C&I**LIST OF DOCUMENTS/DELIVERABLES**

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C&I SPECIFICATION FOR COMPRESSED AIR SYSTEM

SECTION: C
SUB SECTION: C&I

LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT#

Sl. No.	DRAWING NO.#	DRAWING/DOCUMENT TITLE#	CATEGORY #
#	#	#	#
1#	PE-V1-445-145-I901#	CONTROL & OPERATIONAL WRITE-UP FOR THE # SYSTEM WITH SET POINTS#	A#
2#	PE-V1-445-145-I902#	CONTROL SCHEME/LOGIC DIAGRAM (TO BE # IMPLEMENTED IN DDCMIS)#	A#
3#	PE-V1-445-145-I903#	HMI PICTURES/PLANT SCHEMATICS#	A#
4#	PE-V1-445-145-I904#	INSTRUMENT SCHEDULE WITH SET POINTS#	A#
5#	PE-V1-445-145-I905#	I/O LIST (ANALOG & BINARY)#	A#
6#	PE-V1-445-145-I906#	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST # WITH LOCATION DATA#	A#
7#	PE-V1-445-145-I907#	FIELD JB/LIE/LIR,DRIVES TERMINATIONS#	A#
8#	PE-V1-445-145-I908#	DATASHEETS FOR INSTRUMENTS, JB's, etc.#	A#
9#	PE-V1-445-145-I909#	QUALITY PLANS (INSTRUMENTS, VMS, etc.)#	A#
10#	PE-V1-445-145-I910#	INSTRUMENT HOOK-UP DRAWING#	A#
11#	PE-V1-445-145-I911#	THERMOWELL SIZING CALCULATION#	A#
12#	PE-V1-445-145-I913#	CABLE SCHEDULE & INTERCONNECTION#	A#
13#	PE-V1-445-145-I914#	ANNUNCIATION & SOE LIST#	A#
#			

NOTES:#

ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.#

CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL, MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST, FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.#
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.#



**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**

SECTION: C
SUB SECTION: C&I

**MEASURING INSTRUMENTS
(PRIMARY & SECONDARY)
&
SPECIFICATION FOR ELECTRONIC
TRANSMITTERS**

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6.00.00 DESIGN CRITERIA

This section lays down the general design criteria to be adapted in designing the Control & Instrumentation system of the plant.

6.01.00 General Requirements

6.02.00 Instrumentation, control and automation devices and accessories shall be designed with the following considerations:

- a) Stable in spite of temperature fluctuations.
- b) Able to withstand high humidity.
- c) Weather proof.
- d) Dust proof.
- e) Corrosion resistant.
- f) Erosion resistant.
- g) Able to withstand high vibration.
- h) Easily accessible for operation & maintenance.

6.03.00 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.

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

6.05.00 Instrument Accuracy, Standard Scales and Ranges

6.05.01 Instrument Accuracy

Instruments shall meet the following general requirements.

- a) Pressure measurement shall be linear with respect to the measured pressure.
- b) Flow meter shall meet the specified accuracy criteria when operating between 25 and 100 % of full-scale flow. The accuracy shall include the effect of errors in the differential head measuring device, square root converter and signal generator.
- c) Level measurement shall be linear with respect to the measured level based on a water specific gravity of 1.00.
- d) Wherever the measured parameter is influenced by process pressure & temperature, required compressibility correction shall be introduced.





6.05.02 Instrument Scale Displays

- a) 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.
- b) Pressure instrument shall have the unit suffixed with 'a' or 'g' to indicate absolute or gauge pressure, respectively.
- c) Scales and charts of all instruments shall have linear graduations

6.05.03 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 80% for flow measurements. Deviation indicators shall have the null position at mid scale. The normal operating parameter shall be identified with a clear green mark.

6.06.00 Operability & Maintainability

6.06.01 The system shall be designed such that any 'single-failure' shall not lead to loss of availability of the plant, alteration in operating routine or degradation of performance. This shall be achieved by judicious introduction of redundancy at all critical levels. The plant operator remains totally transparent to 'single-failures'.

6.06.02 The system and operator interfaces / consoles shall be designed for the operation of the unit with minimum operational manpower deployment . Bidder shall ensure proper operability and also take into account protections to achieve no accidental maloperations .

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

- a) Standardization of parts.
- b) Minimum use for special tools.
- c) Modular and hot replacement.
- d) Logical grouping of functions.
- e) Separate and non-interactive adjustability.
- f) Malfunction identification facility through self-diagnostics.
- g) Easy removal, replacement and repair.
- h) Easy assembly and disassembly.





WBPDC

EPC Bid Document
Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

- i) Fool-proof design to preclude improper mounting and installation.
 - j) Redundancy of critical parts.
 - k) Unique process equipment vis a vis hardware identifiability by assigning sub-racks / sub-rack sections to specific plant areas.
- 6.06.04 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.
- 6.06.05 Adequate test facility shall be incorporated in the design.
- 6.07.00 Established Reliability & Availability
- 6.07.01 The minimum target reliability of each component/module shall be established by taking into consideration its Mean time between failure (MTBF) and Mean time to repair (MTTR), so that availability of the complete system is assured for 99.7%.
- 6.07.02 In order to establish 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 processes, quality controlled components and parts, adequate derating of electronic components and parts shall be ensured to meet the reliability and life expectancy goals.
- 6.07.03 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.
- 6.08.00 Security and Failure Philosophy
- 6.08.01 General

It is essential that interlock, protection, supervision and automatic control systems shall have high integrity. Control & Instrumentation system shall meet the following requirements:

 - a) No single failure shall cause failure of the control.
 - b) No single fault shall cause the protection system to operate spuriously or cause the protection system to become inoperative.
 - c) Grouping of the control functions into system blocks shall be such that failure of any one block will only partly degrade the overall system.
 - d) Control system shall be structured with redundancy so that no single failure within the control system can cause the failure of plant on duty and at the same time cause the standby plant to be unavailable.
 - e) Due to control system failure if a final control element or plant item does not respond then the control element shall go into a fail safe status.





- f) Field wiring for contact interrogation or device control shall be protected such that a fault on the cable does not cause loss of more than a minimum tolerable functionality of the system.

6.08.02 Measurement & Channel Redundancy

To meet the failure and self checking criteria for the control system, measurement redundancy shall be provided for all the critical parameters. Throughout the control system, the security and validity of signals are to be ensured based on the following design principles.

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- i) Signals shall be verified against cable failure / non coincidence monitoring for critical trip signals.

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 - a) Redundancy in input / output modules for close loop control systems, open loop control system, protection, interlocking and sequential control shall be provided as follows:
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 2. Bidder to note that all I/O, Processor, network interface, communication modules etc., shall be sourced from their Original Principal's works.
 3. The system shall be provided with extensive diagnostic features so that a system failure can be diagnosed down to the module level giving location and nature of fault. Ease of maintenance and trouble shooting shall be a primary consideration in equipment selection.
 4. The system shall provide inherently safe operation under all plant disturbances and component failures so that under no circumstances safety of the plant personnel nor equipment is jeopardized.. The DCS hardware shall be suitably sized to ensure that the implemented scheme meets the desired requirements. The Bidder through detailed calculations shall establish the adequacy of the system selected and demonstrate the same during shop testing and site testing.

6.08.04 Data highway Redundancy

There shall be Redundancy in the system for high reliability of communication. The redundant buses shall work continuously. All communication modules, bus couplers, bus interfaces etc. shall also be hot redundant.

Communication between the operator station and the functional groups of control microprocessors shall be by means of hot redundant data highways.





Redundancy failure shall also be indicated in operating station.

All soft links amongst DCS and various PLC / proprietary control systems shall be redundant bidirectional OPC link.

6.08.05 Redundancy for Power supply unit

All power supply feeders from UPS (in parallel mode having 50% load sharing) or 24 V DC system (in parallel mode having 50% load sharing) shall be redundant with auto changeover in each ACDB/DCDB panel. Any kind of bulk power supplies if used shall be redundant.

6.08.06 Redundancy in Operator Console

Operators' 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 and LVS.

6.08.07 Design Of Enclosures

- i) Design of outdoor enclosures shall be weather proof, dust-tight, drip-proof and shall take into account the environmental conditions.
- ii) Enclosures shall be adequately sized so that the maximum permissible temperature rise above 50 Deg C ambient is 10 Deg C (maximum).
- iii) Enclosures design shall also take into account greatest possible personnel safety.

6.09.00 Electrical Noise Control

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

6.09.02 Bidder shall be responsible for implementation of the shielding, input balancing, ripple filtration and grounding for field inputs to achieve installation with minimum noise coupling.

6.09.03 Radiated immunity test shall be in accordance to IEC 801.3.

6.10.00 Surge-Protection For Solid State Equipment

6.10.01 All solid-state equipment shall be able to withstand the surges inherent in a powerhouse environment. Equipment shall be designed to successfully withstand surges 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".

6.10.02 To immunize the system against surge, coupling free wheeling diodes, surge suppressors, opto / galvanic isolators shall be used as required.





6.11.00 Burn-In And Elevated Temperature Test

Solid-state equipment / system shall be certified to be tested for a minimum period of 168 hours continuously under power. Solid-state logic systems shall be subject to the elevated temperature test and burn-in test as complete assemblies.

6.12.00 Elevated Temperature Test

- a) During the first 48 hours the ambient temperature shall be maintained at 50^o C and the equipment shall be made to repeatedly perform 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.
- b) The 48 hours test period shall be continuous but shall be divided into four 12-hour segments. The power supply 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.
- c) During the elevated temperature test the cubicle doors shall be kept closed and inside temperature in the zone of highest heat dissipating

component /module shall be monitored. Temperature rise inside the cubicle shall not exceed 10 Deg.C above the ambient temperature of 50 Deg.C.

6.13.00 Burn in Test

The 48 hours elevated temperature test shall be followed by 168 hours of burn in test at normal operating temperature. This test shall also be conducted as per above procedure.

6.14.00 Panels, Cubicles and Enclosures

6.14.01 General

- a) All panels, cubicles and enclosures shall be furnished complete with integral piping, internal wiring, convenience outlets, internal lighting, grounding, ventilation, space heating, vibration isolating pads and other accessories.
- b) Unless otherwise specified cable entry for panels / desks / cabinets shall be through bottom via glanding plate. Fireproof seal shall be used to seal the bottom to prevent entry of dust.
- c) Panels and cabinets shall be constructed from steel sheet reinforced as required to provide true surface and adequate support for devices mounted thereon. Thickness of the CRCA steel for UCP / backup panel and other panels/cabinets shall be as described in Section VII of this volume of the specification. 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.

- d) Panel /cabinet shall have eyebolt on top for lifting.
- e) 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 Bidder ,this shall include freeissue items furnished by Owner.

6.14.02 Surface Preparation and Painting

Sheet metal exterior steel surfaces shall be sand blasted, ground smooth and painted as specified below:

- a) 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. Oil, grease and salts etc. shall be removed from by one or more solvent cleaning methods prior to blasting.
- b) Two spray coats of epoxy primer □urface shall be applied to all exterior and interior surfaces, each coat of primer □urface 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 Min. Paint shade thickness at exterior & Interior shall be 80 to 100 Microns.The finish colors for exterior and interior surfaces shall conform to the following shades:
 - i) Exterior : RAL 7032
 - ii) Interior – Brilliant White (Preferred) / RAL 7032.
- c) Paint films, which show sags, cheeks, blisters, teardrops, fat edges or other painting imperfections shall not be acceptable.

6.14.03 Wiring

Wiring 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. Features shall not be limited to the following :

- a) All spare contacts of relays, switches and push buttons shall be wired up to the terminal blocks.
- b) Each wire shall be identified at both ends with wire designation as per approved wiring diagram. Heat shrinkable type ferrules with indelible computerized print shall be used with cross- identification.
- c) 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.





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- d) Internal wiring shall be terminated uniformly on one side of the terminal block leaving the other side available for termination of outgoing cables.
- e) Thermocouple lead wires, analyzer measuring lead wires, or any other lead wires carrying measuring signal of the order of low mili volt or micro volt shall be electrically and physically isolated from other AC and DC wiring.
- f) All low-level signal cables shall be separately bundled from control cable.
- g) Wires shall be dressed and run in troughs with clamp-on type covers. Wirings shall 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.
- h) Shield wires shall be terminated on separately.
- i) Common connections shall be limited to two wires per terminal. Looping of wires for power distribution in the panel to be avoided. Busbars to be provided for Power distribution".
- j) 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 to the conductor.
- k) Wiring shall be arranged to enable instruments or devices to be removed and/or serviced without 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.
- l) Panel internal wiring shall follow distinct color-coding to segregate different voltage levels viz. 24V DC, 48V, 110V AC, 240V AC, 220V DC etc.
- m) Panels /cabinets /desks shall be provided with removable gasketted cable gland plates and cable glands. Split type grommets shall be used for prefab cables.
- n) Wire shall be multistranded annealed flexible high purity copper conductor with heat resistant FRLS PVC insulation and shall pass vertical flame test per IPCEAS-1981.
- o) Wire sizes used for internal wiring shall not be lower than the followings :

Control wiring (switches, : 1.5 Sq.mm
pushbuttons etc.)

Power supply /receptacle : 2.5 sq. mm or higher as per
/illumination wiring load





4-20mA DC current and low : 0.5 Sq. mm
voltage signal upto 48V DC

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

6.14.04 Grounding

- a) System cabinet AC and DC ground shall be electrically isolated from each other and also electrically isolated from the Instrumentation signal ground. All the above ground shall be individually connected to the single point on the ground pit. Dedicated redundant earth pit shall be provided which shall be away from the HV equipment. This earth pit shall not be shared with other electrical equipment ground and shall also be insulated from other electrical system ground to ensure single point grounding of the system. Grounding resistance shall be better than 1.0 ohm. IEEE guideline shall be followed while designing the grounding system.
- b) Panels and cabinets shall be provided with a continuous tinned copper ground bus bar 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.
- c) 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.
- d) Circuits requiring grounding shall be individually and directly connected to the panel ground bus.
- e) For electronic system cabinets, the electronic system ground bus shall be similar but insulated from the cabinet and shall be separately connected to the system ground. Signal cable shields shall be grounded at the panel end only and shall not be left open. The ground in between panels of a shipping section shall be firmly looped.
- f) Electrical meters, relays, transmitters and switching devices, operating at a voltage less than 50V may be grounded through the steel structure.

6.15.00 Panel / Cabinet/ Desk/ Enclosures / junction boxes & instruments Environmental Protections

- a) Panels, cabinets, desks, distribution boxes, racks ,junction boxes, terminal boxes , instruments and all other field mounted equipment / enclosures shall suit the environmental condition of the area and shall not be inferior 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-32 with suitable canopy at top to prevent ingress of dripping water.
4.	Outdoor type in non-hazardous areas	IP-65 with anticorrosion coating.
5.	Outdoor in hazardous areas	As per requirements of the NEC Code for the location

- b) 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.

6.16.00

Terminal Blocks

- a) Terminals shall be chromated galvanized DIN rail mounted screwless 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.
- b) 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
- c) Material of the clamping yoke of screwed terminals shall be electroplated, chromated, case hardened steel with high strength clamping screw. For screwless 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.
- d) Terminals shall be of non flammable suitable thermoplastic material such as polyamide.



- e) 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.
- f) Terminal blocks shall be provided with white marking strips / self-adhesive marker cards. Power terminals shall have protection covers.
- g) 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.
- h) Bottom of the terminal block shall be at least 200 mm above the cable gland plate for bottom entry type panels.
- i) 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.
- j) Other requirements of the terminal blocks are as follows:
 - i) The last terminal in a rail-mounted assembly shall be closed with an end plate and end bracket.
 - ii) For visual and electrical separation of terminal groups, partition plates shall be provided, which can be push fitted after forming an assembly.
 - iii) Design shall permit testing of incoming and outgoing signals by using suitable test plug and socket without disconnecting the cable connections.
 - iv) 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.
 - v) Where more than one connection to a terminal block is required, two tier terminals shall be used.
 - vi) The terminal blocks for Power, control and signal cable terminal block shall be separate with separate colour coding for ease in recognition..

7.00.00 METERING BASES AND CHART UNITS

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

- i) Pressure : Kg/cm²
Differential Pressure : mm of H₂O column / Kg/cm²
- ii) Draught : mm of H₂O column
- iii) Vacuum : Kg/cm² (abs)/mm of Hg column





SECTION-VI

TECHNICAL SPECIFICATION

CONTROL AND INSTRUMENTATION SYSTEMS

1.00.00 FIELD INSTRUMENTS

This section provides general guidelines for field instruments and equipment to be supplied under this specification. All measuring instruments/equipment and subsystems offered by Bidder shall be from reputed experienced manufacturer of specified type and range of equipment, whose guaranteed and trouble free operation has been established. All instruments/equipment shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance and comply with the acceptable international standards. All instruments/equipment and accessories shall be supplied as per technical specifications, ranges, make as approved by Owner.

- i) HART management system shall be integral feature of the DDCMIS and shall be provided for centralised configuration, maintenance, diagnostics & record-keeping for all electronic transmitters.
- ii) Bidder shall provide following facilities as a minimum through software:
 - a) Constant scanning to monitor faults of changes to instrument configuration.
 - b) Owner-defined and standard calibration and configuration procedures for all transmitters.
 - c) Constant signal data collection facilities to maintain continuously updated records.
 - d) Automatic tracking of configuration changes made in the field, such as may be introduced by hand-held communicator. All configuration function associated with hand-held communicators shall be available in the system.
 - e) Event and log reports on screen as well as on printer.
 - f) Any addition/deletion of transmitter will be reported on printer and logged in hard disk.

1.01.00 PRESSURE TRANSMITTER

01. Type : Microprocessor based Smart, HART protocol compatible
02. Transmission : 2 - Wire





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- | | | | |
|------|---------------------|---|--|
| 03. | Output Signal | : | Simultaneous transmission of digital and 4-20 mA DC signal. |
| 04. | Signal Processing | : | Silicon solid state electronic circuitry |
| 05. | Sensor type | : | Capsule / Diaphragm |
| 06. | Element material | : | AISI-316 or better |
| 07. | Static Pressure | : | 150 % of maximum span continuously, without affecting the calibration. |
| 08. | Turn-down ratio | : | 10 : 1 for vacuum/very low pressure application ; 30 : 1 minimum for other applications. |
| 09. | Span and Zero | : | Locally adjustable non-interacting. Facility for elevation and suppression by 100% of span |
| 10. | Enclosure Class | : | Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required) |
| 11. | Output Indicator | : | Backlit LCD type |
| 12. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 13. | Body | : | Forged Carbon Steel (SS for DM Water & corrosive service). |
| 14. | Power supply | : | 16 - 48 Volts D.C. |
| 15. | Load | : | 500 Ohms (min.) at 24 Volts D.C. |
| 16. | Ambient Temperature | : | 0 - 50°C |
| 17. | Performance : | | |
| i) | Accuracy | : | ± 0.075% of Span or better |
| ii) | Repeatability | : | ± 0.05% of Span or better |
| iii) | Response time | : | 100 msec or better |
| iv) | Stability | : | ± 0.1% of Calibrated Span for 6 months up to 70 Kg/cm ² and ± 0.25% of Calibrated Span for more than 70 Kg/cm ² |
| v) | Zero and span drift | : | ± 0.015% per deg. C at max span and 0.11% per deg. C at min span |
| 18. | Sealing/Isolation | : | Extended diaphragm with 5 meters SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator |





diaphragm shall be as per application. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application

- | | | | |
|-----|-------------|---|--|
| 19. | Diagnostics | : | Self indicating feature |
| 20. | Accessories | : | <ul style="list-style-type: none"> a) Universal mounting bracket suitable for 2" 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) ½" NPT 2-valve stainless steel manifold for pressure transmitters constructed from SS316 bar stock. In case it becomes necessary to use a DP transmitter for gauge pressure measurement then a 2-valve manifold should be used in place of 5-valve manifold. f) Companion flange with nuts, bolts and gaskets. g) Hand held configurator kit for calibration of Smart Transmitter. |

1.02.00 Differential Pressure Transmitter

- | | | | |
|-----|------------------------|---|---|
| 01. | Type | : | Microprocessor based Smart, HART protocol compatible |
| 02. | Transmission | : | 2-Wire |
| 03. | Output signal | : | Simultaneous transmission of digital and 4-20 mA DC signal. |
| 04. | Signal Processing Unit | : | Silicon solid-state electronic circuitry |
| 05. | Sensor type | : | Capsule/Diaphragm |
| 06. | Element material | : | AISI-316 (Stainless Steel) or better |
| 07. | Static Pressure/ | | |





- | | | |
|----------------------------------|---|---|
| Overload Pressure | : | Maximum line (or static) pressure on either side without permanent deformation or loss of accuracy |
| 08. Turn-down ratio | : | 10 :1for vacuum/very low pressure application; 30 : 1 minimum for other applications. |
| 09. Span and Zero | : | Locally adjustable, non-interacting |
| 10. Enclosure class | : | Weather proof as per IP-65 with durable corrosion resistant epoxy coating (Explosion proof for NEC Class-1, Division 1 area wherever required)) |
| 11. Zero suppression / elevation | : | At least 100% of Span |
| 12. Output Indicator | : | Backlit LCD type |
| 13. Nameplate | : | Tag number and Service engraved in stainless steel tag plate |
| 14. Body | : | Forged Carbon Steel (SS for DM Water) |
| 15. Ambient temperature | : | 0 - 50° C |
| 16. Power supply | : | 16 - 48 Volts DC |
| 17. Load | : | 500 Ohms (min.) at 24 Volts DC |
| 18. Performance :- | | |
| i) Accuracy | : | ±0.2 % of span or better |
| ii) Repeatability | : | ± 0.05 % of span or better |
| iii) Response time | : | 100 msec or better |
| iv) Stability | : | ± 0.1% of Calibrated Span for 6 months up to 70 Kg/cm ² |
| v) Zero and span drift | : | ± 0.015% per deg. C at max span and 0.11% per deg. C at min span |
| 19. Sealing/Isolation | : | Extended diaphragm with 5 meters. SS armored capillary for corrosive, viscous and dirty fluid applications. Material for separator diaphragm, depending on application. |
| 20. Diagnostics | : | Self indicating feature |
| 21. Accessories | : | a) Universal mounting bracket suitable for 2" 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) ½" NPT 5-valve stainless steel manifold, constructed from SS316 bar stock.
- f) Companion flange with nuts, bolts and gaskets.
- g) Hand held configurator kit for calibration of Smart Transmitter.

1.02.00 DISPLACER TYPE LEVEL TRANSMITTERS

- | | | | |
|-----|--------------------------------------|---|---|
| 01. | Type | : | SMART |
| 02. | Stages of operation | : | Continuous |
| 03. | Material - | | |
| | i) Displacer | : | AISI 316 SS |
| | ii) Suspension wire | : | AISI 316 SS |
| | iii) Torque tube housing application | : | Carbon steel or SS as per application |
| | iv) Torque tube | : | Inconel |
| | v) Displacer chamber | : | Carbon steel or SS as per process application |
| | vi) Transmitter Housing | : | Die cast aluminium or better |
| 04. | Power supply | : | 16-48 Volts D.C. |
| 05. | Transmission | : | 2-wire |
| 06. | Output Signal | : | Simultaneous transmission of digital and 4-20 mA DC signal. Standard HART protocol. |
| 07. | Signal processing | : | Solid-state electronic circuitry |
| 08. | Static / overload pressure | : | Maximum static pressure without permanent deformation or loss of accuracy. |
| 09. | Turn-down ratio | : | 10 : 1 or better |





10. Zero & Span : Easily accessible (local zero & span adjustment and non-interactive type)
11. Enclosure Class : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
12. Output Indicator : Yes, Backlit LCD type
13. Nameplate : Tag number and Service engraved in stainless steel tag plate
14. Ambient Temperature : 0 - 50°C
15. Load Impedance : 500 Ohms at 24 Volts (minimum)
16. Process Connection : 2" Companion flange with nuts, bolts and gaskets
17. Performance -
 - Accuracy : $\pm 0.2\%$ of span or better
18. Accessories :
 - a) Counter Flange, nuts, bolts, gaskets etc.
 - b) Weights for 5 point calibration of instruments.
 - c) Vent and drain plugs
 - d) Special calibration tool/configurator, if any.
19. Preferred Features :
 - a) Test plug connection and cutout terminals physically separated from other electronics.
 - b) Electronic Damping facility (adjustable).

1.03.00 MASS FLOW METER

A. Sensor

01. Measuring Principle : Coriolis Mass flow.
02. Primary Element : Flow Tube of 316SS or better
03. Temperature Control : To be provided for heavy fuel oil application.
Heating arrangement shall be integral.
For Heating
04. Process Connection : Flanged and rating as per process requirement.
05. Drain : Self-draining facility





- | | | | |
|----------------|-------------------------|---|---|
| 06. | Enclosure | : | Stainless steel |
| 07. | 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 with HART protocol, selectable from four measured quantities & field bus output for softlink with DCS |
| 05. | Load | : | < 750 ohms. |
| 06. | Power supply | : | "UPS", (if the external power supply is 230V AC, 50 HZ). |
| 07. | Turn Down | : | 100:1 |
| 08. | Accuracy | : | ± 0.2% of measured value |
| 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, prfab cable etc. |

1.04.00 Turbine Flow meter

- | | | | |
|-----------|------|---|---|
| A. Sensor | | | |
| 01. | Type | : | Turbine (in line full-bore, based on magnetic pick up pulses) |





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02. Output Signal : Pulse
03. Material of Construction :
 - a) Body : AISI 316
 - b) Rotor: AISI 431 or 410
 - c) Bearings: Tungsten Carbide / Stellite Sleeve
04. Flow rate range : As required.
05. Linearity : $\pm 0.25\%$ or better.
06. Repeatability : $\pm 0.02\%$ or better.
07. Ambient temperature : 50°C
08. Mounting : On-Line, flanged
09. Enclosure : IP 65
- B. Transmitter
 01. Electronics : Solid State
 02. Power Supply : "UPS", if the external power supply is 230V AC, 50 HZ.
 03. Input : Input from Sensor
 04. Display : Backlit LCD
 05. Output : Isolated 4-20mA DC with HART protocol.
 06. Measuring Accuracy : $\pm 0.5\%$ of full scale range
 07. Totalized Value : Required
 08. Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
 09. Nameplate : Tag number, service engraved in stainless steel tag plate
 10. Accessories :
 - a) Clamping strip, bracket, prefab cable etc.
 - b) Calibration or configurator kit.

1.05.00 Vortex Flow meter

A. Sensor

01. Type : Vortex



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02. Output Signal : Pulse
 03. Material of Construction : AISI 316
 04. Sensor Seal : PTFE / higher based on temperature
 05. Flow range : As required.
 06. Linearity : $\pm 1\%$ or better.
 07. Repeatability : $\pm 0.2\%$ or better.
 08. Ambient temperature : 50°C
 09. Mounting : On-Line, flanged.
 10. Enclosure : IP 65
 11. Accessories : Nuts, bolts, gaskets etc.
- B. Transmitter
01. Electronics : Solid State-remote mounting
 02. Power Supply : 24 V DC.
 03. Input : Input from Sensor
 04. Display : Backlit LCD
 05. Output : Isolated 4-20mA DC.
 06. Protocol : HART
 07. Totalized Value : Required
 08. Housing : IP-65 (Explosion proof for NEC Class-1, Division 1 area)
 09. Nameplate : Tag number, service engraved in stainless steel tag plate
 10. Accessories :
 - a) Clamping strip, bracket, prefab cable etc.
 - b) Special tool kit for calibration/ configuration .



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1.06.00

Rotameter

- | | | | |
|-----|--------------------------|---|--|
| 01. | Type | : | Online upto 2" and Bypass above 2" line size" |
| 02. | Metering tube | : | Borosilicate glass |
| 03. | Float | : | AISI 316-SS unless the process fluid demands some other material. |
| 04. | Body MOC | : | SS as per fluid condition. |
| 05. | Scale | : | Aluminium Graduated - Engraved black on white background. |
| 06. | Process connection | : | Flanged to line size or threaded for connection size ½" or less. |
| 07. | Accuracy | : | ± 2% of full scale detection or better for on-line type and ±4% of full-scale detection or better for by-pass type. |
| 08. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 09. | Accessories | : | Slip-on orifice plate of 316-SS and taps of / SS as per application. Applicable SS Isolation valves and SS Range Orifice - for bypass type rotameters. |
| 10. | Housing protection class | : | IP- 65. |

1.07.00

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.. |
| 05. | Bezel Material | : | SS 304. |
| 06. | Socket Material | : | SS 316 |
| 07. | Enclosure | : | IP-65. |
| 08. | Dial Size | : | 150 mm |



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WBPDC

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Sagardighi Thermal Power Project
1x660 MW Unit No. 5, Phase - III

- | | | | |
|-----|-------------------------------|---|---|
| 09. | Scale | : | Black lettering on white background in 270 Deg. arc. |
| 10. | Window | : | Shatterproof glass |
| 11. | Range Selection | : | Normal process pressure – 50 ~ 70 % of range (approximately). |
| 12. | Over-range Protection | : | 125% of maximum range by internal stop. External stop at zero |
| 13. | Adjustment | : | Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.

External zero adjustment for glycerine filled gauges. |
| 14. | Element Connection | : | Argon welding |
| 15. | Process Connection | : | 1/2" NPT(M) Bottom connection for local mounting, back connection for panel mounting. |
| 16. | Performance | : | Accuracy of ± 1.0 % of span or better. |
| 17. | Operating ambient temperature | : | 0 - 50°C |
| 18. | Safety Feature | : | Blow out disc./diaphragm at the back |
| 19. | Accessories | : | <ul style="list-style-type: none"> a) Snubbers and Glycerin filled for pulsating fluid applications and at pump discharge. b) Stainless steel Diaphragm chemical seals for corrosive, viscous and solid-bearing or slurry type process fluids. diaphragm chemical seal shall be provided with the following: <ul style="list-style-type: none"> 1) Top chamber : SS 304 2) Bottom Chamber: SS 316 3) Sealing fluid: Silicon DC 200 4) Diaphragm: SS 316 c) 3-way SS gauge cock/ 2-Valve SS-316 barstock manifold for pressure gauges with 1/2" NPT process connection.. |





- 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.

20. Applicable standard : IS-3624 / 1996 , EN-837-1

21. Nameplate : Tag number, service engraved in stainless steel tag plate

1.08.00 Temperature Gauge

- 01. Type : Inert gas filled remote mounting system.
- 02. Sensing Element Material : Bourdon - AISI-316 SS
- 03. Capillary Armoring : 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.





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15. Range : Normal temperature – 50 ~ 70% of range approximately.
16. Zero adjuster : Micrometer screw adjustable from front.
17. Window : Shatterproof glass.
18. Accuracy : $\pm 1\%$ 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). Material of construction of thermowell:
 - 1) SS 316: in general
 - 2) Inconel: For flue gas application
 - 3) Tungsten carbide: For coal mill application
 - b) Installation accessories as required.
23. Nameplate : Tag number, service engraved in stainless steel tag plate

1.09.00

Thermocouples

01. Type :
 - a) Type-K (Chromel Alumel) / Type-R (Pt.-Rhodium Pt.) / Type-E (Chromel Constantan) [As per application]
 - b) Duplex (Triplex incase of turbine/Generator/excitor bearing temperature may be used)
 - 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%)



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05. Response time with Thermowell : a) Less than 20 seconds for measurement.
b) Less than 10 seconds for control.
06. Accuracy : $\pm 1.1^{\circ}\text{C}$ upto 300°C & 0.4% of measured temperature range above 300°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 : $\frac{1}{2}$ " NPT to well
 - iv) Cable connection : $\frac{1}{2}$ " NPT gland and grommet.
 - v) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
08. Accessories : a) Adjustable nipple-union-nipple [$\frac{1}{2}$ " Sch 80 X $\frac{1}{2}$ " NPT (M)] with thermowell connection
b) Compression fittings/unions
c) Flanges etc. (for flanged connections only)
d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.
- Process connection M33x2 (M) in general or $1\frac{1}{2}$ " flanged for flue gas/Furnace/air etc. application.
- Material of construction of thermowell:
- 1) SS 316: in general
 - 2) Inconel: For flue gas application
 - 3) Tungsten carbide: For coal mill application.



09. Nameplate : Tag number, service engraved in stainless steel tag plate

1.10.00 Passing condition of various drain valves shall be monitored by measuring drain pipe metal temperature at the downstream of the drain valves. Also Drum, SH, RH metal temperature measurement shall be provided. Necessary thermocouples shall be provided as per the following specification.

01. Measuring medium : Metal temperature
02. Metal of thermocouple element : Chromel-Alumel Type-K
03. Type of thermocouple : Duplex with separate hot junctions, ungrounded type.
04. Insulation : Mineral insulation Magnesium Oxide
05. Thermocouple wire gauge : 16 AWG
06. Protective Sheath : SS 321
07. Protective Sheath Dia : 8 mm O.D.
08. Characteristics of thermocouple : Special limits of error as in ANSI MC 96.01.1975
09. Mounting Accessories : 1/2" BSP SS sliding end connector, weld pad, weld on clamps of heat resistant steel SS 310.
10. Cold end sealing : SS pot seal with colour coded PTFE headed sleeve insulated flexible tails. Sealing compound - Epoxy resin
11. Minimum Bending Radius : 30 mm
12. Length of T/C : 30 mtrs. (minimum)

1.11.00 Resistance Temperature Detector

01. Type : Platinum (Duplex), Ungrounded
02. Resistance : 100 ohm at 0°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 : $\pm 0.5\%$ of range
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 : $\frac{1}{2}$ " NPT gland and grommet.
 - v) Others : Terminal head cover with SS chain and suitable gasket. All thermowells in the high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safe size and design of thermowells"
10. Accessories :
- a) Adjustable nipple-union-nipple [$\frac{1}{2}$ " Sch 80 X $\frac{1}{2}$ " NPT (M)] with thermowell connection
 - b) Compression fittings/unions
 - c) Flanges etc. (for flanged connections only)
 - d) Barstock thermowell of stepless tapered design as per ASME PTC19.3 code.
- Process connection M33x2 (M) in general or $1\frac{1}{2}$ " flanged for flue gas/Furnace/air etc. application.
- Material of construction of thermowell:
- 1) SS 316: in general
 - 2) Inconel: For flue gas application



3) Tungsten carbide: For coal mill application.

11. Nameplate : Tag number, service engraved in stainless steel tag plate

1.12.00 Pressure Switch

01. Type : i) Piston for high pressure application (above 40 bar)
ii) Bellow /Diaphragm for low pressure application (below 40 bar)
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. Elect connection : Plug in socket
13. Enclosure Class : IP-65 weather and dust proof (Explosion proof for NEC Class-1, Division 1 area).
14. Performance : a) Repeatability $\pm 0.5\%$ of full range
b) Accuracy of Setting Indication of $\pm 1.5\%$
15. Ambient temperature : 0 – 50°C



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|-----|-------------|---|---|
| 16. | Nameplate | : | Tag number, service engraved in stainless steel tag plate |
| 17. | Accessories | : | <p>a) Remote diaphragm seal with SS-316 capillary for viscous & corrosive application. MOC of seal material shall be as per process fluid requirement.</p> <p>b) Snubbers for pulsating fluid application.</p> <p>c) Syphons for steam and hot water services.</p> <p>d) Retention ring and screws for surface mounting.</p> <p>e) 1/2" NPT 2 Valve SS-316 manifold constructed from barstock</p> <p>f) Brass cable gland</p> |

1.13.00 Differential Pressure Switch

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|-----|--------------------------|---|---|
| 01. | Type | : | Bellows / Diaphragm / Piston actuated |
| 02. | Sensing element material | : | AISI SS-316. For all other wetted part SS 316 |
| 03. | Case Material | : | Die-cast aluminum alloy with neoprene gasket. |
| 04. | Setter Scale | : | Black graduation on white scale with 0-100% graduation and provided with red pointer for set point adjustment |
| 05. | Over range | : | Static pressure on any one side, the other side being open to atmosphere. |
| 06. | Adjustments | : | <p>a) Internal set point adjustment</p> <p>b) Differential adjustment</p> |
| 07. | Process Connection | : | 1/2" NPT (M) bottom connected / back connected. |
| 08. | Switch configuration | : | Two SPDT |
| 09. | Switch rating | : | 240V, 5A AC/220V, 0.5A DC. |
| 10. | Switch type | : | Snap acting type contacts, shock and vibration proof. |





11. Terminal Blocks : Suitable for full ring lugs for cable connection.
12. Elect connection : Plug in socket
13. Performance :
 - a) Repeatability $\pm 0.5\%$ of full range
 - b) Accuracy of set point Indication: $\pm 1.5\%$
14. Operating Ambient Temperature : $0 - 50^{\circ}\text{C}$
15. Enclosure : IP-65 (Explosion proof for NEC Class-1, Division 1 area).
16. Accessories :
 - a) Snubbers for pulsating fluid application.
 - b) Syphons for steam and hot water services.
 - c) Retention ring and screws for surface mounting.
 - d) $1/2"$ NPT 3-Valve SS-316 manifold constructed from barstock
17. Nameplate : Tag number, service engraved in stainless steel tag plate
18. Remote Seal type for special application :
 - a) Silicone oil / fluorolube filled remote diaphragm seal for dirty / viscous / corrosive fluid.
 - b) SS armoured capillary at least 3 meters each.
 - c) Adapter flanges with nuts, bolts and gaskets for instrument and process side.

1.14.00 Temperature Switch

01. Type : Inert gas filled-in
02. Sensing Element Material : Bellow / Bourdon AISI SS-316
03. Bulb Material : AISI SS-316
04. Capillary : Stainless steel armoured
05. Movement Material : AISI SS-304
06. Case material : Epoxy coated steel plate or die-cast aluminum alloy with neoprene gasket and





clear glass where applicable cover conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).

07. Scale : Black lettering on white background
08. Over range Protection : 120 %
09. Instrument connection : Bottom
10. Switch configuration : Two SPDT
11. Switch rating : 240V, 5A AC/220V, 0.5A DC
12. Switch type : Snap acting, shock and vibration-proof.
13. Adjustability : Internal Set point adjustable over span range
14. Elect connection : Plug in socket
15. Compensation :
 - a) Capillary compensation with invar wire throughout the capillary length.
 - b) Case compensation
16. Performance :
 - i) Scale Accuracy : ± 1.0 % of full scale
 - ii) Repeatability : < 0.5 % of full range
 - iii) Response time : Less than 40 seconds with thermowell
17. Capillary length : 5 meters (minimum) for local mounting/15 meters for local panel mounting.
18. Nameplate : Tag number, service engraved in stainless steel tag plate
19. Accessories : Thermowell from SS barstock, Mounting accessories, $\frac{1}{2}$ " NPT cable gland.

1.15.00 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.

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|-----|------------------------------|---|---|
| 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 |

1.16.00 Conductivity Type Level Switch

- | | | | |
|-----|--------------|---|--|
| 01. | Type | : | Conductivity discrimination. |
| 02. | Application | : | Drain pots viz. on CRH line |
| 03. | Mounting | : | Flanged – on external cage. |
| 04. | Probe MOC | : | Stainless steel with high purity ceramic. |
| 05. | Probe rating | : | > Maximum design pressure of vessel. |
| 06. | Input | : | Four independent channel with selectable switching threshold for water conductivity. |
| 07. | Relay Output | : | Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo. |





08. Contact type & rating : 2SPDT or 1 DPDT @ 5A 30V DC.
09. Local Display : Coloured LEDs for Hi, Lo, Hi-Hi, Lo-Lo, Power & fault.
10. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
11. Enclosure : IP-65, corrosion resistant & wall mounting type (Explosion proof for NEC Class-1, Division-1 area).
12. Accessories :
 - a) PTFE cable from probe to electronics
 - b) Mounting accessories
 - c) External cage
 - d) Washer & gasket
13. Test pressure : Two times rated pressure
14. Elect connection : Plug in socket

1.17.00 Capacitance Type Level Switch

01. Type : Capacitance type
02. Probe :
 - a) Rod or suspended electrode
 - b) Rope type probes may be used only where required probe length is greater than 1.5 meters.
 - c) Reference rod for non grounded tank.
03. Probe Mounting : 1-1/2" Flanged
04. Material of construction : 316 SS and to suit fluid type
05. Insulation : PTFE/PP/Kynar Part/Full as required
06. Enclosure : Powder coated Die cast aluminium. with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
07. Ambient temperature : 0-60°C.
08. Mounting : Top Mounting
09. Supply voltage : 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC





10. Relay output : 2 SPDT
11. Contact rating : 5A min. at 240V AC on resistive load
12. Response time : 100 msec or better
13. Elect connection : Plug in socket
14. Accessories : Counter flange, cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

1.18.00 RF Type Level Switch

- Sensing Probe :
01. Type : Rigid
 02. Material : SS-316
 03. Mounting : Threaded
 04. Probe Head Housing : Cast Aluminium
 05. Protection : IP-66
- Electronic Controller :
01. Supply Voltage : 240V AC (UPS)
 02. Relay Output : 2 nos. SPDT
 03. Contact Rating : 240V AC, 5A/ 220V DC, 0.25A
 04. Housing Material : Cast Aluminium
 05. Protection : IP-65
 06. Local LED Indication : Power On, Alarm Level, Probe Healthy
 07. Switching Repeatability : $\pm 0.5\%$
 08. Accessories : Coaxial cable probe connection to controller
 $\frac{1}{2}$ "NPT Cable Gland

1.19.00 Ultrasonic Level Switch

01. Principle of operation : Ultrasonic contact level technology
02. Input Power : 24V DC/ 240V AC





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|-----|--------------------|---|---|
| 03. | Output Contact | : | 2 SPDT (240V AC, 5A/ 220V DC, 0.25A) |
| 04. | Switch Mounting | : | Integral |
| 05. | Sensor Material | : | SS-316 |
| 06. | Enclosure | : | Cast Aluminium (IP-65) |
| 07. | Process Connection | : | 2" Flanged |
| 08. | Repeatability | : | 2 mm |
| 09. | Power supply | : | 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC |
| 10. | Cable connection | : | ½" NPT with cable gland |
| 11. | Accessories | : | Cable gland, cable, companion flange, bolts & nuts, gaskets etc. along with all mounting hardware |

1.20.00 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 | : | 240V AC, 50 Hz, 1Ph UPS supply/ 24V DC |
| 10. | Signal Output | : | 4-20 mA DC (isolated) - 500 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- 0 to 50° C and Sensor 0 to 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.

1.21.00 Conductivity Type E lectronic Level Indicator

01. Type : Conductivity discrimination.
02. Application : Separator drum Level .
03. No. of Probes : As per manufacturer standard.
04. Probe Mounting : Flanged – on standpipe.
05. Probe MOC : Stainless steel with high purity ceramic.
06. Probe rating : > Maximum design pressure of vessel.
07. Input : Independent channel with selectable switching threshold for water conductivity.
08. Relay Output : Four isolated output relays for Hi, Lo, Hi-Hi, Lo-Lo.
09. Contact type & rating : 2 SPDT or 1 DPDT @ 5A 30V DC.
10. Current output : Isolated 4-20 mA DC
11. Local Display : a) Coloured (Red & Green) LEDs for level.
b) Flashing LEDs for fault.
12. Remote Display : Red, Green & flashing yellow LEDs for steam, Water & Fault indication respectively.





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13. Power supply : Dual 240V AC, 50 Hz, 1Ph UPS supply.
14. Enclosure : a) IP-65, corrosion resistant & wall mounting type for local electronics.
b) IP-42 for remote indicator
15. Accessories : a) PTFE cable from probe to electronics
b) Mounting accessories.
c) Standpipe
d) Washer & gaskets
e) Double isolation valves on each connection, double drain valves & double vent valves with mechanical lock.
f) 1/2" NPT cable gland
16. Test pressure : Two times design pressure

1.22.00

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.

1.23.00

SOLENOID VALVE

01. Operating Principle : Electromagnetic (noiseless)
02. Coil voltage rating : 24V DC (in general) other 220V DC /240V AC /110V AC as required





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| 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 energization |
| 09. | Sealing | : | Airtight and leak proofing with nitrile (NBR) and polyurethane (PUR) material |
| 10. | Ambient Temperature | : | 0 - 50° C |
| 11. | Fluid Temperature | : | 0-150° 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. | Response time | : | 4-7msec |
| 16. | Mounting | : | On pipe or on panel |
| 17. | Cable Connection | : | ½" NPT cable gland |
| 18. | Accessories | : | Mounting brackets, nuts and bolts |
| 19. | Special feature | : | (i) LED indication for power

(ii) Double coil type for open & close operation of valve / damper.

(iii) Solenoid valve directly integral to actuator body shall have NAMOOR interface for uniformity |

1.24.00 ORIFICE PLATE

- | | | | |
|-----|-------------------|---|---|
| 01. | Application | : | Low fluid velocity flow measurement |
| 02. | Design Standard | : | Concentric as per ASME PTC-19.5 (Part –II), ISA RP-3.2 or BS-1042, Part-I |
| 03. | Number of Tapings | : | As required plus one additional pair of taps |
| 04. | Diameter Ratio | : | Between 0.34 to 0.7 |



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|-----|----------------|---|---|
| 05. | Thickness | : | 3mm for main pipe of diameter upto 250mm, 6mm for main pipe of diameter above 250mm and 10mm for diameter above 500 mm |
| 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 (1" 316 SS globe) jack screw, meter run pipe, Drain & vent hole as per application etc. |

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.25.00 FLOW NOZZLE

- | | | | |
|-----|-----------------|---|--|
| 01. | Application | : | High fluid velocity flow measurement |
| 02. | Design Standard | : | ASME PTC 19.5 |
| 03. | Tapings | : | D and D/2 (Numbers as required plus one additional pair of taps) |
| 04. | Diameter Ratio | : | Between 0.4 and 0.7 |
| 05. | Material | : | 316 SS (321 SS for high temperature) |
| 05. | Document | : | Beta ratio calculation, assembly drawing and Flow vs. DP curve. |
| 06. | Meter run pipe | : | Same as pipe material |
| 07. | Accessories | : | Meter run pipe, nipples and root valves (1" 316 SS globe).(Inspection port assembly for nozzles used in plant performance purpose) |

NOTE: One flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

1.26.00 GAUGE GLASS

- | | | | |
|-----|-----------------|---|--|
| 01. | Type | : | Reflex |
| 02. | Glass | : | Toughened borosilicate. Resistant to mechanical and thermal shocks. |
| 03. | Body material | : | Carbon steel / stainless steel- As per process requirements (Flanged Connection) |
| 04. | Pressure rating | : | Twice the maximum working pressure |





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- 05. Temperature rating : 300° C
- 06. Bolts and nuts : Rust proof alloy steel
- 07. Accessories : Suitable ball check valves of SS-304/316 body, gaskets, companion flange etc.

1.27.00 LEVEL GAUGE (FLOAT & BOARD)

- 01. Type : Float and Board
- 02. Float & Tape MOC : AISI 316
- 03. Pulley and Pulley Housing material : SS 304
- 04. Guide wire : SS 316 Stainless steel
- 05. Accuracy : +/- 2 mm
- 06. Indication : Vertical dial
- 07. Rating : Twice the design pressure
- 08. Spring tension assembly : SS 304
- 09. Anchor plate : SS304
- 10. Calibrated scale board: Aluminium with black graduation

Note: The measuring rope/tape shall be passed through conduits

1.28.00 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 / Cm².
- 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 integral I-P convertor, feedback position Transmitter (4-20 mA DC output), Input & Output pressure gauges, local keypad & display.
 - g) Solenoid Valve
 - h) Junction box with cable gland
07. Fail-safe operation : Stay put for regulating duty.
08. Repeatability : Better than 0.5% of full travel.
09. Hysterisis : Less than $\pm 1\%$ of full travel
10. Operating Temp. limit : 80°C (min.)

1.29.00

SIGHT GLASS

01. Type : Flap-type
02. End connection : Screwed / Flanged
03. Material :
- a) Body : SS-304
 - b) Cover Plate : SS-304
 - c) Indicator : SS-316
04. Sight Glass : Toughened Borosilicate
05. Gasket : Neoprene
06. Bolts & Nuts : High tensile steel
07. Hydraulic Test
- Pressure : 1.5 times maximum working pressure
08. Accessories : As required

1.30.00

SMOKE DENSITY ANALYZER

01. Type : Insitu dry visible light (through LED)
02. Principle of





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- | | | | |
|-----|---|---|--|
| | Measurement | : | Transmission & absorption (Dual beam type) |
| 03. | Sensor type | : | Luminiscence |
| 04. | Display | : | Back Lit LCD |
| 05. | Measurement range | : | 0-999 mg/m ³ , 0-999 mg/Nm ³ , 0-100% opacity |
| 06. | Measurement averaging | : | Selectable 10 sec to 60 minutes |
| 07. | Accuracy | : | 0.2% of F.S |
| 08. | Resolution | : | 0.1% of F.S / 1mg/m ³ whichever is better |
| 09. | Linearity | : | 1.0% of F.S |
| 10. | Repeatability | : | < 0.5% of Span |
| 11. | Response time
(upto 90% of full scale) | : | 5 sec |
| 12. | Flue gas temperature | : | 90°C (When FGD in operation)
135°C (When FGD not in operation)
Max 600°C (at APH outlet) |
| 13. | Ambient temperature | : | 0 - 60°C |
| 14. | Operating
temperature | : | Transmitter & receiver- 0-90°C, Electronic
unit – 0-70°C |
| 15. | Mounting | : | Transceiver on opposite side of the duct |
| 16. | Analog output | : | 4-20mA DC (in 500 ohm resistance) to DCS |
| 17. | Alarm output | : | 2 SPCO potential free rated at 230 VAC, 5A |
| 18. | Power Supply | : | 240V AC, 50 Hz, 1 Phase UPS |
| 19. | Automatic misalignment
detection | : | Required |
| 20. | Automatic compensation
of lens contamination | : | Required |
| 21. | Purge air Failure | : | Purge air to be provided from Blower unit and
to be monitored for failure. |
| 22. | Span and Zero Check | : | Automatic periodic with manual override |





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23. Housing : Corrosion resistant painted aluminium rated at IP-65
24. Fail safe shutter : Automatic fail safe shutter against power and air failure
25. Input normalisation : Correction for temperature, pressure, oxygen and water vapour to be provided.
26. Preferred Features : "Power Supply On" LED visible from front
27. Accessories :
 - a) Mounting pads suitable for mounting projector and receiver units on duct, flanges, etc.
 - b) Blower unit (Purging System) with purge fail alarm at CCR
 - c) Enclosure for electronic units & indicators
28. Application : At chimney
At each ESP outlet

1.31.00

SO_x & NO_x ANALYZER

As per Protocol for Real time (Emission & Effluent) Data Management from Insudtries Version-1.2 (10.06.2015); Instruments/Analysers/Equipments (each model) individually certified from Institutions like TUV, MCERTs, USEPA etc. as notified by CPCB.

01. Type : Insitu Probe/ Cross duct type analyser
02. Gases to be measured : SO_x, NO_x
03. Principle of measurement : Infrared absorption/ UV Spectroscopy
04. Flue gas Temperature : As per process requirement
05. Mounting/Application : Flanged/ On chimney
06. Measurement range : Fully selectable as per process requirement
07. Units of measurement : PPM, mg / Nm³ and %
08. Power Supply : 240V, 50 Hz, 1 Phase UPS
09. Local Display : Back lit LCD / LED
11. Accuracy : 2% of measured value





12. Repeatability : 1% of full scale
13. zero & Span drift : 2% per month
14. Calibration : Zero and Span calibration in manual and automatic mode. Automatic calibration interval shall be fully selectable. Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided).
15. Analog output : 4-20 mA DC (in 500 ohm resistor) to DCS for each channel
16. Alarm output : (1NO + 1NC) for each measured parameter and self diagnostic failure. All contacts rated at 230V AC, 5A
17. Input normalisation : Required—online with pressure and temperature sensor and also provision for key pad entry of inputs
18. Probe material : Stainless Steel 316L
19. Enclosure : Corrosion resistant epoxy painted aluminium housing & enclosure rated to IP-65.
20. Accessories :
 - a) Compressor/Blower unit, tubes & fittings for calibration and purging, purge fail alarm in CCR
 - b) Calibration gas cylinders for SO₂, Nox & N₂ (for Zero Calibration) filled in 10 Ltrs. of WC carbon cylinder with necessary SS regulators with pressure & flow gauges, solenoid valve & SS tubings and SS fittings etc. as required.
 - c) Mounting flanges, gasket etc.
 - d) control unit for interface with PC based data logger to be provided.

1.32.00 OXYGEN ANALYZER

01. Type : In-situ, Zirconium sensor, micro-processor-based transmitter,
02. Range : 0.1-10% / 0.25-25% by volume
03. Output : 4-20 mA DC linear





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04. Probe Length /
Material : 1800 mm (approximate depending on duct size) / SS 316
05. Process Temperature : As per Process Requirement.
06. Measurement
Reference : Instrument Air
07. Accuracy : $\pm 1\%$ of F.S.
08. Response Time : Less than 5 (five) sec for 90% of full scale
09. Amplifier Housing : IP-65
10. Calibration : Manual or Automatic periodic-operator selectable
11. Power Supply : 240V, 50 Hz, 1 Phase UPS
12. Material for Gas Carrying Components : Stainless Steel
13. Read Out : Backlit LED/LCD
14. Protection : Automatic cell protection against reducing atmosphere
15. Alarm Facility : 1 HI and 1 LO independently adjustable over span. Contact rating 500 mA at 220 V DC (minimum).
16. Preferred Features : a) HI and LO alarm LED visible from front.
b) Power Supply On/Failure LED visible from front
17. Accessories : a) Mounting flanges, adaptor plate and protection shield (protection/abrasive shield shall be SS 316)
b) Gasket, nuts and bolts
c) Cable with conduit from cell to amplifier (as required) and other special cables (if any)
d) Automatic calibration kit (complete with all accessories and standard Gas Cylinders)





- e) Solenoid valve, Pressure regulator with Filter and Flow indicator
18. Application : a) At economizer outlet
b) At each air preheater inlet and outlet
- 1.33.00 H2 + CO2 + AIR ANALYZER
01. Type : Thermal Conductivity
02. Range Selection : 3 ranges.
03. Range : As required
04. Output : 4-20mA DC (Isolated)
05. Operating ambient temp. : 10° C to 50° C
06. Power Supply : 240V AC, 50Hz UPS
07. Sample gas flow control : Required
08. Reference gas flow : Required
09. Reference gas pressure regulator : Required
10. Cell response : 95% of change in 30 Sec.(Appox.)
11. Accuracy : 2% of full scale
12. Repeatability : 1% of full scale
13. Local Indicator : Indicating meter of 1% accuracy Backlit LCD/LED display
14. Alarm facility : Dual (High & Low) independently adjustable.
15. Contact rating : 0.5A at 220 V AC
16. Enclosure : Flame Proof
17. Accessories : Calibration gas, mounting accessories and others as required to be provided
18. Application : Generator Gas Purity.
- 1.34.00 CO ANALYZER
01. Operating Principle : NDIR



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- | | | | |
|-----|-----------------------|---|---|
| 02. | Type | : | In-situ, microprocessor based probe type at economiser. In-situ, microprocessor based Cross duct/Probe type at chimney |
| 03. | Range | : | As per process requirement |
| 04. | Accuracy | : | 1% Full Scale |
| 05. | Linearity | : | ±1% of Full Scale |
| 06. | Repeatability | : | <1% of span\ |
| 07. | Calibration | : | Automatic & Manual (Zero & Span) |
| 08. | Power Supply | : | 240V AC |
| 09. | Output Signal | : | 4~20 mA DC |
| 10. | Alarm annunciation | : | Four relay contacts, dual alarm set points (240V AC, 5A) |
| 11. | Enclosure | : | Cast Aluminium (IP-65) |
| 15. | Indication | : | LCD Display |
| 16. | Op. Temperature Range | : | At Economiser (350 Deg C) and at Chimney (100 Deg C) |
| 17. | Accessories | : | Interconnection cable (as required) in flexible conduits

Tube / fittings, mounting brackets/ pads as required

Purge system for cleaning

Surge Arrester |
| 18. | Location | : | At Economizer and Chimney |
| 19. | Additional Feature | : | Remote Calibration and configuration facility from the remote location shall be possible. (i.e, the hardware and software required for Remote Calibration and configuration from Remote location to be provided). |

1.35.00

MERCURY ANALYZER

- | | | | |
|-----|----------------------|---|--------------------------------|
| 01. | Operating Principle | : | Atomic absorption spectroscopy |
| 02. | Range | : | 0-100 µg/Nm3 |
| 03. | Measuring Parameters | : | Total gaseous mercury |
| 04. | Output | : | 4~20 mA DC |



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- | | | | |
|-----|---------------------|---|---|
| 05. | Alarm/ Annunciation | : | Four Relay contacts, dual alarm set points (240V AC, 5A) |
| 06. | Indication | : | LCD Display |
| 07. | Sampling System | : | Extractive |
| 08. | Enclosure | : | IP-65 |
| 09. | Power Supply | : | 240V AC (UPS) |
| 10. | Location | : | On Chimney |
| 10. | Accessories | : | a) Inbuilt calibration facility through calibrator. Inbuilt cell for Zero & Span calibration to be provided. Handling of Liquid Mercury to be avoided.
b) Remote calibration facility to be provided.
c) The Mercury analyser cabinet to be placed inside an enclosed AC environment. |

1.36.00 DEW POINT METER

- | | | | |
|-----|------------------------|---|---|
| 01. | Type | : | Direct mounting capacitance type with change in output proportional to moisture present |
| 02. | Sensing Element | : | Ceramic/ Aluminium Oxide sensor |
| 03. | Service | : | Dry Air |
| 04. | Range | : | -90 Deg.C to 10 Deg.C Dew point temperature |
| 05. | Sensor Accuracy | : | ±2 Deg.C Dew point |
| 06. | Repeatability | : | 0.5 Deg.C Dew point |
| 07. | Op.Ambient Temperature | : | -40 Deg.C to 50 Deg.C |
| 08. | Op. Pressure | : | 0-10 Kg/cm ² |
| 09. | Display | : | Combined enclosure with 5 digit seven segments LED display |
| 10. | Element Filter | : | 80 micron sintered stainless steel |
| 11. | Output | : | 4~20 mA DC loop powered |
| 12. | Power Supply | : | 24V DC nominal |



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- 13. Enclosure Class : IP-65
- 14. Interchangeability : Fully Interchangeable Transmitters
- 15. Accessories : Sampling System, cables, sensor holder, dessicant chambers, souble compression fittings, ¾" cable gland, mounting fixture etc.

1.37.00 DENSITY METER

- 01. Operating Principle : Vibration Density measurement
- 02. Wetted Part Material : SS-316L
- 03. Case Material : Cast Aluminium
- 04. Output : 4~20 mA DC
- 05. Electrical connection : ½" NPT
- 06. Enclosure Class : IP-65
- 07. Local Display : Digital 5 digit, density display with temp. compensation
- 08. Accuracy : ±1.0 %
- 09. Power Supply : 240V AC (UPS)
- 10. Location : At the discharge of Gypsum bleed pump in FGD system.

1.38.00 RADAR TYPE LEVEL MEASUREMENT

- 01. Type : Radar based on Time Domain Reflectometry
- 02. Antena : 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





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10. Transmitter Beam
 - Angle : 10 degree or less
11. Blocking distance : less than 300 mm
12. Electronic Housing : Epoxy painted Die-Cast aluminium alloy
13. Antenna / Flange
 - assembly : 316 SS or Hest alloy (as required)
14. Output Indicator : Digital Integral Display (Backlit LCD/LED)
15. Accuracy : 5 mm or 0.1% of probe length
16. Accessories :
 - a) Programming tool kit
 - b) Gasket

1.39.00 CHLORINE LEAK DETECTOR

01. Type : Electrochemical
02. Resolution : 0.1 ppm
03. Display Type : Digital Indicating Meter
04. Operating Temperature : 0~45°C
05. Alarm Contacts : Dual Alarm setpoints (240V AC, 5A)
06. Enclosure Class : IP-65
07. Mounting : Wall mounting
08. Power Supply : 240V AC
09. Output : 4~20 mA DC (600 Ω load)

1.40.00 RESIDUAL CHLORINE ANALYZER

01. Type : Amperometric
02. Electrode : Platinum/ Gold and copper electrode shall be provided with cell cleaning system
03. Display Type : LCD in Analyzer Panel
04. Range : 0 to 20.0 mg/L (ppm)
05. Accuracy : 2% or better . The measurement accuracy shall not be affected by presence of treatment chemicals as chromates,





phosphates, de-former highly polluted water, change in temperature etc.

- | | | | |
|-----|-----------------|---|---|
| 06. | Sensitivity | : | 0.01 mg/L |
| 07. | Alarm Contacts | : | Dual Alarm setpoints (240V AC, 5A) |
| 08. | Enclosure Class | : | IP-65 |
| 09. | Power Supply | : | 240V AC |
| 10. | Output | : | 4~20 mA DC (600 Ω load) |
| 11. | Calibration | : | Zero & Span adjustment. Final calibration adjustments of the analyzer to be done at site and duly verified by titration. Temperature compensation range 0-50°C. |
| 12. | Mounting | : | Field mounting conform to IP-65 |
| 13. | Accessories | : | Chemical reagents, sample drain, pumping system (if required) etc. |

1.41.00 ELECTRIC TO PNEUMATIC (E/P) CONVERTERS

- | | | | |
|-----|----------------------|---|--|
| 01. | Air Supply | : | 1.5 kg/cm ² |
| 02. | Max. supply Pressure | : | 7 kg/cm ² |
| 03. | Input Signal | : | 4-20 mA DC (as required by the design of control system). |
| 04. | Output Signal | : | 0.2 to 1.0 kg/cm ² |
| 05. | Control Action | : | Air to Close, Air to Open and Fail freeze-field selectable |
| 06. | Response Time | : | 5 seconds for 0 to 90% output pressure |
| 07. | Repeatability | : | +/- 0.1% span typical |
| 08. | Accuracy | : | +/- 0.25% span typical |
| 09. | Linearity | : | 0.5% of span or better |
| 10. | Hysteresis | : | 0.1% of span or better |
| 11. | Ambient Temp. | : | |
| | effect | : | Less than 0.02% of span per °C between |





-20 °C to +60 °C

12. Supply pressure effect: less than 1%
13. Span and zero adjustment : screw
14. Mounting : Close to Actuator (but not on the actuator)
15. Output Capacity : To suit the actuator
16. Protection Class : IP 65
17. Allowable Drift Rate : $\pm 2\%$ of set point / hour maximum

On loss of control signal, the last set point pressure shall be maintained so that the associated control valve remains in stay put condition.

1.42.00 SMART POSITIONER

01. Type : Universal design (linear or rotary application)
02. Input Signal : 4-20mA DC , 2 wire loop with 24V DC.
03. Output Signal (position F/B) : i) 4-20mA
ii) Configurable end position switch
04. Supply Pressure : Single acting 1.2 to 7.0 bar
Double acting 1.2 to 10.5 bar
05. Air Delivery : Single acting 10.0 SCFM at 2.1 bar supply
Double acting 7.2 SCFM at 2.1 bar supply
06. Housing : IP 65
07. Repeatability : $\pm 0.3\%$ of span or better
08. Accuracy : $\pm 0.1\%$ of span or better
09. Communication : Hart protocol
10. Power-up with position : < 150 ms or better control
11. Power interruption without reset : <100ms or better
12. Body Material : Aluminium
13. Response Time : Less than 10 sec





14. Features :
- i) Noncontact position feedback sensor
 - ii) Integral Electro-Pneumatic convertor
 - ii) Self calibration with tunable response time
 - iii) Online diagnostics
 - iv) Pressure guages to be provided on positioner (I/P & O/P pressure)

1.43.00 MAGNETIC LEVEL INDICATOR

- 01. TYPE : Magnetically coupled level indicator
- 02. Display : Coloured flags
- 03. Chamber material : Stainless steel
- 04. Wetted part material : Stainless steel
- 05. Process connection : Side Side Flanged
- 06. Drain & Vent : Flanged
- 07. Scale : Standard, Stainless steel
- 08. Accessories : Counter flange, gaskets

1.44.00 FLOW SWITCH

- 01. Type : Paddle /Piston/Disk
- 02. Wetted part material : Stainless steel or Hastelloy for acidic application
- 03. End connection : i) Threaded upto 1" line size with integral Tee
ii) Flanged for line size > 1 ½"
- 04. Enclosure material : Die cast aluminium
- 05. Enclosure class : IP 65
- 06. Switch configuration : 2 SPDT
- 07. Contact rating : 240V AC 15A
- 08. Repeatability : 2%
- 09. Cable connection : ½"NPTF





10. Accessories : Tee, counter flange

1.45.00 ULTRA SONIC TYPE FLOW METER

- a) Ultrasonic Flow meter shall be dual path transit time clamp-on type.
- b) 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.
- c) CW flow shall be measured by redundant Ultrasonic Flow meter.
- d) 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.
- e) 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.
- f) Technical Requirements
 01. Type : Transit time Clamp On Ultrasonic meter
 02. Mounting Style : Dual path with two sets of transducers on the same pipe
 03. Flow measurement : Instantaneous Flow rate as well as totalized flow
 04. Power supply : 240V AC, 50Hz with built –in battery back up.
 05. Analog Outputs : Isolated 4-20mA linear outputs for each path
 06. Binary Output : Contact relay outputs, 2 NO + 2 NC for alarm
 07. Communication ports : RS 232 C digital
Hand held terminal port
 08. 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.
 09. 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.
10. Software features : Compensation for any cross path errors Programming, configuration, shall be possible from front panel.
11. Diagnostics : False signal tolerance , power supply failure etc.
12. Protection Class : IP-65 or better, Weather protection against direct sunlight, rain etc for Flow meter and suitable for Cooling water for Transducer.
13. Accuracy : $\pm 1\%$
14. Electrical connection : Plug and socket
15. 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 SS 316
- g) Bidder shall submit certified flow calculation and differential pressure Vs. flow curves for each element for Owner's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Owner's approval.

2.00.00 NOT USED

3.00.00 CONTROL PANEL/DESK MOUNTED INSTRUMENTS AND ELECTRICAL SYSTEM ACCESSORIES.

(For electrical System's Meter and for synchronisation, bidder shall refer to Electrical volume of specification)

3.01.00 Digital Indicator (If required)

01. Type : Five and half digit LED seven-segment display with sign.
02. Display Character : 13.8 mm, RED (LED)
03. Accuracy : 0.1% of reading, ± 2 digit



**C&I SPECIFICATION FOR
COMPRESSED AIR SYSTEM**SECTION: C
SUB SECTION: C&I**DATA SHEETS FOR MOTORISED VALVE
ACTUATOR**

|

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		DOCUMENT NO.: PE-ID-445-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE:27/03/2020
			SHEET 1	OF 5
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL *	* PROJECT	1 X 660 MW SAGARDIGHI STPP		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	☐ ON / OFF ☐ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF -20 to 70 DEG C AND RELATIVE HUMIDITY OF 0-95% IN HOT HUMID AND TROPICAL ATMOSPHERE AND HIGHLY POLLUTED AT PLACES OF COAL DUST AND FLY DUST		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
	CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, DUST TIGHT SUITABLE FOR OUTDOOR USE WITHOUT CANOPY, NEMA6/IP:68	
MECHANICAL POSITION INDICATOR		TO BE PROVIDED FOR 0-100% TRAVEL		
BEARINGS		DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION		METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
SIZING		OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM as per IEC60034-1		
HANDWHEEL as per standard EN 12570:2000	* REQUIRED	☒ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW) (REFER NOTE NO. 6 & 7)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF I.S. TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☒ ENCLOSED (BIDDER TO CONFIRM) A: ☒ DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐ ☒ TO BE DECIDED DURING DETAILED ENGINEERING		
	PAINT TYPE	☐ ENAMEL ☒ EPOXY CONFIRMING TO CORROSION CATEGORY C5-I		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		DOCUMENT NO.: PE-ID-445-145-I902	
			VOLUME II B	
			SECTION D	
			REV. NO. 01	DATE:27/03/2020
			SHEET 2	OF 5
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 67 ☒ IP 68 ☐ FLAME PROOF		
	@MOTOR BEARING WITH 2 EARTH TERMINALS	DOUBLE SHIELDED; GREASE LUBRICATED ANTI FRICTION		
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B		
	@ WINDING TEMP PROTECTION	☒ THERMOSTAT (3 Nos.,1 IN EACH PHASE)		
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED (THERMISTOR PTC)		
	INTEGRAL STARTER	INTEGRAL STARTER	☒ REQUIRED ☐ NOT REQUIRED	
TYPE OF SWITCHING DEVICE		☒ CONTACTORS ☐ THYRISTORS		
TYPE		☒ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)		
IF SMART (REFER BELOW POINT a – h)				
a) SERIAL LINK INTERFACE		☐ INTEGRAL ☐ FIELD MOUNTED		
b) SERIAL LINK PROTOCOL		☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐		
c) SERIAL LINK MEDIA		☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC		
d) HAND HELD PROGRAMMER		☐ REQUIRED ☐ NOT REQUIRED		
e) TYPE OF HAND HELD PROGRAMMER		☐ BLUETOOTH ☐ INFRARED ☐		
f) MASTER STATION		☐ REQUIRED ☐ NOT REQUIRED		
g) MASTER STN INTRFACE WITH DCS		☐ MODBUS ☐ TCP/IP		
h) DETAILS OF SPECIAL CABLE		☐ ENCLOSED ☐ NOT REQUIRED		
STEP DOWN CONT. TRANSFORMER		☒ REQUIRED		
OPEN / CLOSE PB		☒ REQUIRED ☐ NOT REQUIRED		
STOP PB		☒ REQUIRED ☐ NOT REQUIRED		
INDICATING LAMPS		☒ REQUIRED ☐ NOT REQUIRED		
LOCAL REMOTE S/S		☒ REQUIRED ☐ NOT REQUIRED		
STATUS CONTACTS FOR MONITORING		☒ REQUIRED ☐ NOT REQUIRED		
INTEGRAL STARTER DISTURBED SIGNAL(Refer Note 14)		REQUIRED MOTOR THERMOSTTTRIP O/L RELAY OPTD, CONT./POWER SUPPLY FAILED, S/S IN LOCAL/REMOTE/OFF MODE, TORQUE SWITCH OPEN/CLOSE CUT OFF/STOP PB OPTD, VALVE JAMMED ETC)		
ACTION ON LOSS OF EXTERNAL ELECTRIC POWER		☒ STAYPUT ☒ FAIL SAFE TO BE DECIDED DURING DETAILED ENGINEERING		
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter) DATASHEET & WIRING DIAGRAM OF ISOLATION DEVICE TO BE PROVIDED	TYPE OF ISOLATING DEVICE	☒ INTERPOSING RELAY ☐ OPTO COUPLER TO BE DECIDED DURING DETAILED ENGINEERING		
	QUANTITY	☐ 2 NOs. ☒ 3 NOs.		
	DRIVING VOLTAGE	☒ 20.5 – 24V DC ☐ _____ V DC		
	DRIVING CURRENT	☒ 125mA MAX ☐ _____ mA MAX		
	LOAD RESISTANCE	☒ > 192 ohms - <25 k ohms ☐ > _____ ohms - < _____ ohms		

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DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
TORQUE SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN / CLOSE	☐ 1 No. ☐ 2Nos. / ☐ 1 No. ☐ 2Nos		
	CONTACT TYPE	2 NO + 2 NC		
	RATING	5A 240V AC AND 0.5A 220V DC		
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE		
	ACCURACY	+3% OF SET VALUE		
LIMIT SWITCH (Not Applicable for Smart Actuator) (\$\$ Refer Notes)	MFR & MODEL NO.	BIDDER TO SPECIFY		
	OPEN : INT : CLOSE	☐ 1 No. ☐ 2 Nos.	2 Nos. (ADJ.)	☐ 1 No. ☐ 2Nos.
	CONTACT TYPE	2 NO + 2 NC		
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC		
	ACCURACY	2% OF SET VALUE		
POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications**)	☒ REQUIRED ☐ NOT REQUIRED		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ☒ ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	☒ 24V DC ☐		
	OUTPUT	☒ 4-20mA		
	ACCURACY	± 1% FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz		
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY		
	@ RATING			
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED		
	ENCL CLASS ACTUATOR/MOTOR T.B.	@ ☒ IP 68 @ ☐		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET	☐ REQUIRED ☒ NOT REQUIRED		
	NO. OF PINS REQUIRED(TO BE CHECKED AS PER SIGNALS IN DRIVE CONTROL PHILOSOPHY)			
	NOS. OF PLUG & SOCKET	☐ 1 Nos. for ON/OFF ☐ 2 NOS.(for inching duty) ☐ OTHER (TO BE SPECIFIED INLINE WITH DRIVE CONTROL PHILOSOPHY)		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	CONTROL CABLE GLANDS-1	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 4P X 1.5 SQMM		
	CONTROL CABLE GLANDS-2	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 8P X 0.5 SQMM		
	CONTROL CABLE GLANDS-3 (Additional for inching duty)	CABLE GLAND SUITABLE FOR INSTRUMENTATION CABLE SIZE OF 2P X 0.5 SQMM		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY _____ Kg.		



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Data Sheet A & B

DATA SHEET-A
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY BIDDER)

NOTES:

- SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
- CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH: IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS-4722, IEC 60947-5-1 AND EN 15714-3 :2010 OR LATEST VERSION.
- TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
- CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
- THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
- THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
- THE MOTOR SHALL BE CAPABLE OF STARTING AT 85 PERCENT OF RATED VOLTAGE RUNNING AT 80 PERCENT OF RATED VOLTAGE AT RATED TORQUE AND 85 PERCENT RATED VOLTAGE AT 33 PERCENT EXCESS RATED TORQUE FOR A PERIOD OF 5 MINUTES EACH.
- IN ADDITION TO ABOVE REQUIREMENTS FOR LIMIT/TORQUE SWITCH, **MECHANICAL END STOP** WITH ACCURACY OF 2% SHALL BE SUPPLIED.
- IT SHOULD BE POSSIBLE TO OPERATE THE ACTUATOR LOCALLY. LOCKABLE LOCAL/REMOTE SELECTION SHALL BE PROVIDED ON THE ACTUATOR.
- LOCAL POSITION INDICATOR SHALL BE PROVIDED FOR 0 TO 100 % TRAVEL.
- CONTROL WIRING SHALL BE SUITABLE VOLTAGE GRADE COPPER WIRE 1.5 SQ. MM.
- ENDURANCE: RATED TORQUE RANGE SHOULD BE BASED ON ISO 5211, ISO5210.
- TAG PLATE SHALL BE CONFIRMING TO STANDARD BS-15714.
- THE ACTUATORS SHALL BE DESIGNED TO BE SELF-LOCKING UPON LOSS OF POWER. MOTOR SHALL BE DESIGNED TO CLOSE IN 30 SECS. FROM FULL OPEN POSITION AND SHALL HAVE ADEQUATE CAPACITY TO OPEN AND CLOSE UNDER FULL UNBALANCED DESIGN PRESSURE.
- AUTOMATIC PHASE CORRECTION FACILITY AND POTENTIAL FREE CONTACT FOR ANNUNCIATION OF POWER FAILURE SHALL BE PROVIDED.
- LIMIT SWITCHES SHALL BE SILVER PLATED WITH HIGH CONDUCTIVITY AND NON-CORROSIVE TYPE. CONTACT RATING SHALL BE SUFFICIENT TO MEET THE REQUIREMENT OF CONTROL SYSTEM SUBJECT TO A MINIMUM OF 60 V, 6 VA RATING. PROTECTION CLASS SHALL BE IP67.
- THE TERMINAL BOX SHALL BE WEATHER PROOF WITH REMOVABLE FRONT COVER & CABLE GLANDS FOR CABLE CONNECTION.IT SHALL BE SUITABLE FOR 2.5 SQ MM COPPER CONDUCTOR.
- ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT).
- ** VALVES WITH 10 DEGREE/20DEGREE FEEDBACK REQUIREMENT FOR APPLICATIONS SUCH AS CW/ACW/PLANT WATER SYSTEM SHALL BE CONSIDERED AS INCHING DUTY VALVES. ACCORDINGLY, POSITION FEED BACK TRANSMITTER, PLUG & SOCKET REQUIREMENT SHALL BE CONSIDERED.**

\$\$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME	ANJALI RAMAN	VIPUL KUMAR VERMA	SURESH CHAND SHARMA	NAME
SIGNATURE				SIGNATURE
DATE	27.03.2020	27.03.2020	27.03.2020	DATE

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY).

@ BE FILLED BY ES

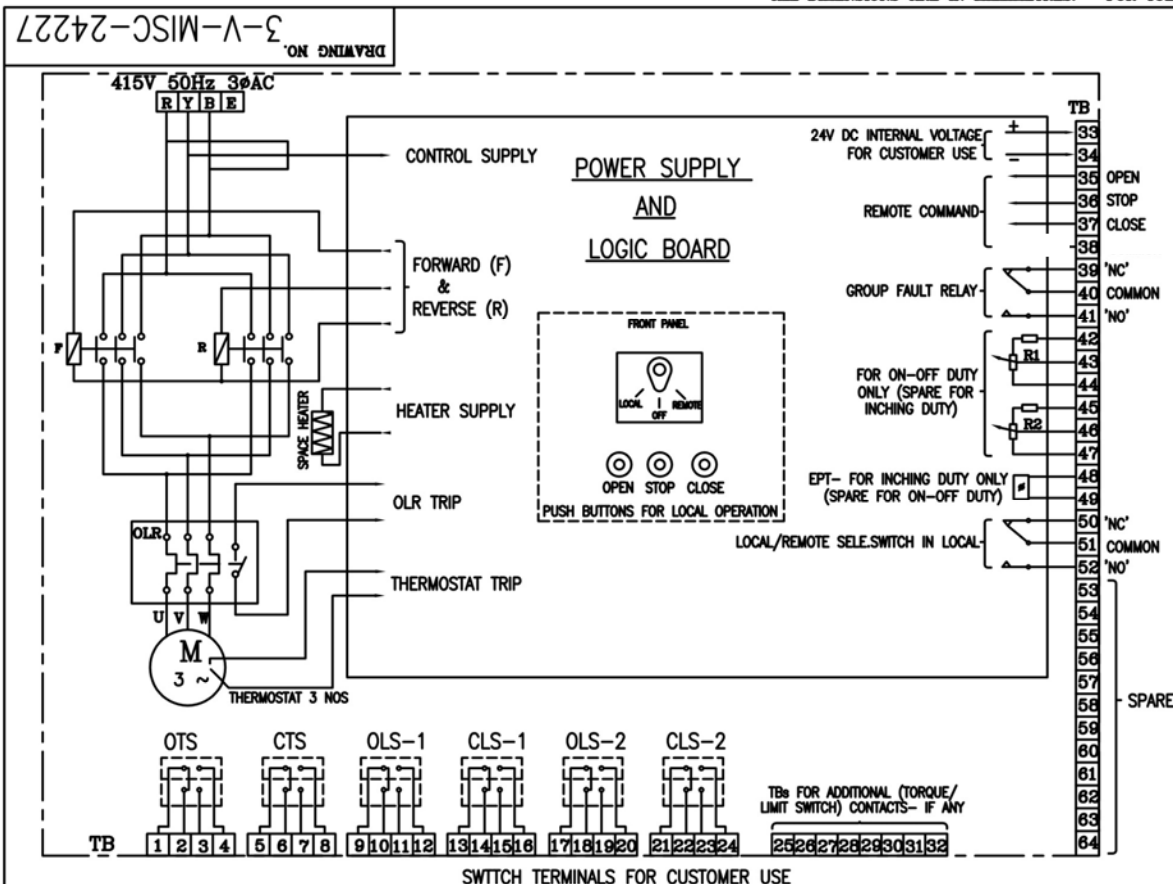
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ADDITIONAL NOTES FOR SAGARDIGHI PROJECT:

- TEST WITNESS: TESTS SHALL BE PERFORMED IN THE PRESENCE OF OWNER/PURCHASER'S REPRESENTATIVE SO DESIRED BY THE OWNER/ PURCHASER. THE CONTRACTOR SHALL GIVE AT LEAST FIFTEEN (15) DAYS ADVANCE NOTICE OF THE DATE WHEN THE TESTS ARE TO BE CARRIED OUT.
- ADVANCE NOTICE SHALL BE GIVEN TO THE OWNER AS AGREED IN THE CONTRACT, PRIOR TO THE STAGE OF MANUFACTURE BEING REACHED, AND THE PIECE OF PLANT MUST BE HELD AT THIS STAGE UNTIL THE OWNER HAS INSPECTED THE PIECE, OR HAS ADVISED IN WRITING THAT INSPECTION IS WAIVED, IF HAVING CONSULTED THE OWNER AND GIVEN REASONABLE NOTICE IN WRITING OF THE DATE ON WHICH THE PIECE OF PLANT WILL BE AVAILABLE FOR INSPECTION, THE OWNER DOES NOT ATTEND, THE SUCCESSFUL BIDDER MAY PROCEED WITH MANUFACTURE HAVING FORWARDED TO THE OWNER DULY CERTIFIED COPIES OF HIS OWN INSPECTION AND TEST RESULTS.
- ACTUATOR SHALL ATTAIN FULL SPEED OPERATIONS BEFORE VALVE LOAD IS ENCOUNTERED AND IMPART AN UNSEATING BLOW TO START THE VALVE IN MOTION (HAMMER BLOW EFFECT).
- A SPACE HEATER SHALL BE INCLUDED IN THE LIMIT SWITCH COMPARTMENT SUITABLE FOR 240V, 1 PHASE, 50 HZ SUPPLY.

ALL DIMENSIONS ARE IN MILLIMETRES. FOR TOLERANCES OF UNTOLERANCED DIMENSIONS DURING MANUFACTURE REFER RELEVANT QCP / QP.



Separate wire (no common wire) to be used for signal exchange between DCS and actuator. Additionally, separate TBs are to be used at actuator end. Please refer attached dwg 12A05-DWG-I0021 for the same.

CONTACT DEVELOPMENT DIAGRAM			
OTS	1-2	OPEN AT OVER TORQUE DURING OPENING TRAVEL	
	3-4	CLOSE AT OVER TORQUE DURING OPENING TRAVEL	
	5-6	OPEN AT OVER TORQUE DURING CLOSING TRAVEL	
CTS	7-8	CLOSE AT OVER TORQUE DURING CLOSING TRAVEL	
	9-10		
OLS-1	11-12		
	13-14		
CLS-1	15-16		
	17-18		
OLS-2	19-20		
	21-22		
CLS-2	23-24		
SWITCH	TERMINAL NO.	FULL OPEN	FULL CLOSE
		a	b
VALVE POSITION			
INDICATES CONTACT CLOSED			
INDICATES CONTACT OPEN			
CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC			

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH				
VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS *	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS *	CTS	#
# - CLS NOT TO BE CONNECTED IN TRIP CIRCUIT				
* - BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)				

NOTE:-

- ALL TORQUE AND LIMIT SWITCHES (OTS, CTS, OLS1&2, CLS1&2) ARE WITH 2NO+2NC CONTACTS '1NO+1NC' IS TERMINATED IN TBS 1-24, REMAINING CONTACTS ARE FOR INTERNAL USE.
- ANY SPARE CONTACTS WHICH ARE NOT USED INTERNALLY ARE TO BE TERMINATED IN TBS 25-32
- CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE)
- OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN)
- OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN
- CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE
- EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)
- R1-R2-POTENTIOMETER 2 x 100 OHMS (FOR ON-OFF DUTY)
- FOR COMMANDS & EPT EITHER INTERNALLY GENERATED 24 VDC OR EXTERNAL SUPPLY OF 24VDC CAN BE USED
- M - MOTOR 3 ϕ 415V 50 Hz AC SUPPLY

REV	DATE	ALTERED
		CHD & APPD

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TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT		ELECTRICAL VALVE ACTUATORS (AC) WITH INTEGRAL STARTERS (DRAWN FOR INTERMEDIATE POSITION OF VALVES)						
		BHARAT HEAVY ELECTRICALS LTD., UNIT: HIGH PRESSURE BOILER PLANT. TIRUCHIRAPALLI-620014.		DRN CHD APPD	NAME N.P.ESWAR D.DINAKARAN K.ARUNACHALAM	SIGN N.P D.D K.A	DATE 07.10.04 07.10.04 07.10.04	NO.OF VAR.
DEPT VL			SCALE	WEIGHT (KG).	REFERENCE INFORMATION			NO. OF ITEMS
CODE								
TITLE WIRING DIAGRAM (TERMINAL PLAN) FOR ACTUATOR WITH INTEGRAL STARTER				CARD CODE U 01	DRAWING NO. 3-V-MISC-24227			REV 0

Size A3