

**MAHARASHTRA STATE POWER GENERATION
CORPORATION LIMITED**

1X660 MW BHUSAWAL TPP UNIT 6

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

SPECIFICATION NO.: PE- TS- 415- 555- A001, Rev 01



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR - PROJECT ENGINEERING MANAGEMENT
NOIDA, INDIA**



1x660 MW BHUSAWAL TPP UNIT 6

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REV 01

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COMPRESSED AIR SYSTEM

SECTION – I

(INTENT OF SPECIFICATION)



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



**TECHNICAL SPECIFICATION FOR
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INTENT OF SPECIFICATION

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1.0 INTENT OF SPECIFICATION

- 1.1 The specification is intended to cover 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 (as applicable), 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 / Functional / Demonstration tests at site (As applicable), training of customer/client 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 as specified above, amendment & agreements till placement of order.
- 1.2 The contractor shall be responsible for providing all material, equipment & services, which are required to fulfil the intent of ensuring operability, maintainability, reliability and complete safety of the complete work covered under this specification, irrespective of whether it has been specifically listed herein or not. Omission of specific reference to any component / accessory necessary for proper performance of the equipment shall not relieve the contractor of the responsibility of providing such facilities to complete the supply, erection and commissioning of COMPRESSED AIR SYSTEM.
- 1.3 It is not the intent to specify herein all the details of design and manufacture. However, the equipment shall conform in all respects to high standards of design, engineering and workmanship and shall be capable of performing the required duties in a manner acceptable to purchaser who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgement is not in full accordance herewith.
- 1.4 The extent of supply under the contract includes all items shown in the drawings, notwithstanding the fact that such items may have been omitted from the specification or schedules. Similarly, the extent of supply also includes all items mentioned in the specification and /or schedules, notwithstanding the fact that such items may have been omitted in the drawing.
- 1.5 The general term and conditions, instructions to tenderer and other attachment referred to elsewhere are made part of the tender specification. The equipment materials and works covered by this specification is subject to compliance to all attachments referred to in the specification. The bidder shall be responsible for and governed by all requirements stipulated herein.
- 1.6 While all efforts have been made to make the specification requirement complete & unambiguous, it shall be bidders' responsibility to ask for missing information, ensure completeness of specification, to bring out any contradictory / conflicting requirement in different sections of the specification and within a section itself to the notice of BHEL and to seek any clarification on specification requirement in the format enclosed under **SECTION-III** of the specification within 10 days of receipt of tender documents. In absence of any such clarifications, in case of any contradictory requirement, the more stringent requirement as per interpretation of Purchaser/Customer shall prevail and shall be complied by the bidder without any implication on account of the same. Further in case of any missing information in the



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specification not brought out by the prospective bidders as part of 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 / clarifications, if any, should be very clearly brought out clause by clause in the format enclosed in the specification; otherwise, it will be presumed that the vendor's offer is strictly in line with NIT specification. Each deviation shall be furnished with its cost of withdrawal in both priced and un-priced bid. In case of No-deviation, bidder to furnish the No-deviation / compliance certificate in the format enclosed in SEC-III of this 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, all through the specification, the word contractor shall have same meaning as successful bidder /vendor and Customer/ Purchaser/Employer will mean BHEL and /or MAHAGENCO and /or DCPL.

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SECTION – I

(PROJECT INFORMATION)



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

1.0 INTRODUCTION

The proposed 1x 660 MW Bhusawal Thermal Power Project will be set up by Maharashtra State Power Generation Co. Ltd. (MAHAGENCO) in Dipnagar near Bhusawal, Maharashtra, India.

The Bidder shall acquaint himself by a visit to the site, if felt necessary, with the conditions prevailing at site before submission of the bid. The information given herein under is for general guidance and shall not be contractually binding on the Owner. All relevant site data/information as may be necessary shall have to be obtained /collected by the Bidder.

2.0 APPROACH TO SITE

Deepnagar is well connected by rail and road. By road, it is about 8 Km from Bhusawal city. Nearest railway station is at Bhusawal. The nearest Airport is at Aurangabad. The nearest sea port is at Mumbai. The site is located on the Mumbai-Nagpur Highway.

3.0 LAND

Bhusawal Thermal Power Plant is already having 1x62.5 MW + 2x210 MW Units and Two (2) Units of 500 MW each are under execution stage. About 108.94 Hectares of land is acquired by MAHAGENCO near existing TPS. It is proposed to install 1x 660 MW unit on this land.

4.0 SOURCE OF COAL

Indian coal would be sourced from Machaakata coal blocks in Orissa state. The Coal will be received at Plant site directly by rail. The coal from the railway wagons would be unloaded by means of wagon tipplers and will be either bunkered or stacked in the stock pile at site.

5.0 SOURCE OF WATER

The main source of water is considered Ozerkheda Reservoir which is located at around 18 km from plant site.

6.0 ASH DISPOSAL AREA

The ash generated from 1 x 660 MW unit shall be disposed off in slurry form to the existing Ash Pond located at Velhala, approx. 12 Km from the site.

7.0 PROJECT INFORMATION

- | | | | |
|------|-------------------------|---|---|
| 7.1 | Client / Owner | : | Maharashtra State Power Generation Co. Ltd. |
| 7.2 | Consultant | : | Procon Engineers, Navi Mumbai
(Division of Nimoto Consulting Engineers Pvt. Ltd.) |
| 7.3 | Project Title | : | BHUSAWAL T.P.S. UNIT – 6 : 1X660 MW |
| 7.4 | Location | : | Dipnagar, Near Bhusawal, Maharashtra, India |
| 7.5 | Nearest railway station | : | Bhusawal |
| 7.6 | Nearest Airport | : | Aurangabad |
| 7.7 | Nearest Harbour | : | Mumbai |
| 7.8 | Access Roads | : | NH 6 (Mumbai-Nagpur Highway) |
| 7.9 | Elevation above MSL | : | 210 M |
| 7.10 | Longitude/latitude | : | 75° 51' 10" East / 21° 02' 30" North |
| 7.11 | Seismic Zone | : | Zone III as per IS:1893 |

7.12 AMBIENT TEMPERATURE

- | | | | |
|--------|-----------------------------------|---|------------------------|
| 7.12.1 | Mean of daily maximum temperature | : | 48.25 °C (during May) |
| 7.12.2 | Mean of daily minimum temperature | : | 18 °C (during January) |
| 7.12.3 | Highest temperature recorded | : | 48.7°C |

7.12.4	Lowest temperature recorded	: 13°C
7.13	Wet bulb temperature	: 27°C (Maximum)
7.14	Rainfall	: 112 mm average annually
7.15	Wind Speed	: 0 to 39 Km/hr
7.16	Wind direction	: East North East to West South West
<u>ELECTRICAL</u>		
7.17	<u>MAIN POWER SOURCE FROM GRID</u>	
7.17.1	Rated Voltage	: 400kV
7.17.2	Voltage variation	: ± 10 %
7.17.3	Frequency Variation	: ± 5 %
7.17.4	Rated Short Circuit Level	: 50 kA, Three Phase Symmetrical
7.18	<u>AUXILIARY POWER SUPPLY</u>	
	Auxiliary electrical equipment shall be suitable for operation on the following supply system:	
7.18.1	Motors above 1000 kW & other Power devices	: 11kV, 3Ph, 3wire, 50Hz system
7.18.2	Motors below 1000 kW & above 160kW & other power devices	: 3.3kV, 3 ph, 3 wire 50 Hz, Non Effectively earthed
7.18.3	Motors upto 160 kW & other power devices	: 415V, 3 ph, 4 wire 50 Hz
7.18.4	Motor Starting Methods	: Direct on Line
7.18.5	(a) Lighting fixtures, Space heaters, and single Phase motors	: 240V, 1 phase, 50 Hz Supply through suitably rated transformers to limit the short circuit level to 9kA – 1 sec.

	(b) Control & Instrumentation : 240V, 1 Phase, 50 Hz from UPS
7.18.6	Short circuit levels of 11kV, 3.3 kV and 415V system equipments The equipment shall be suitable for the following short circuit levels (a) 11kV Switchgears : 44 kA/3 sec (b) 3.3kV Switchgears : 40 kA/3sec (c) 415V PCC/ PMCC/ MCC : 50 kA/1sec (d) Lighting Distribution Boards & 240V A.C. supply : 9 kA/1sec
7.18.7	Auxiliary DC supply The auxiliary DC supply will be used for control, indication & protection, Turbine lube oil system, AVR, Emergency DC lighting of power plant and Control & Instrumentation etc. (a) Voltage : (i) 220V DC for utility purpose (ii) 24V DC for Control and Instrumentation (b) Voltage variation : + 10 %, - 15 %
7.18.8	Emergency power supply (a) Purpose : (i) Standby power to normal incomer of emergency MCC (ii) Alternate power source to Fire water Pumps (b) Rated voltage and frequency : 415 V, 3 phase, 3 wire, 50 Hz.

7.18.9	UPS power supply (a) Purpose : (i) Vital process loads (ii) Critical lighting (iii) Control and Instrumentation (iv) Office for LAN power supply/Server etc. (b) Rated Voltage : 415V, 3 ph, neutral/240V single phase, 50Hz
7.19	The variation in voltage and frequency may be $\pm 10\%$ and $\pm 5\%$ respectively. The combined voltage and frequency variation may be $\pm 10\%$. All devices shall be suitable for continuous operation over the entire range of voltage variation without any change in their performance
7.20	Power socket shall be 415V AC, 50 Hz, 4 pin 32/63 Amps. Power socket outlets for portable tools, hand lamps etc shall be 240 volts, single phase, 3 pin, metal clad industrial type
7.21	All electrical equipment shall be designed for the following ambient conditions (a) Maximum ambient temperature : 50°C (b) Minimum Ambient temperature : 13°C

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SECTION I-A

SPECIFIC TECHNICAL REQUIREMENT -MECHANICAL



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



COMPRESSED AIR SYSTEM
1X 660MW BHUSAWAL TPP UNIT 6

DOCUMENT NO.: PE-TS-415-555-A001

SCOPE OF SUPPLY, EXCLUSION & TP.

SECTION-IA

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1. SCOPE OF SUPPLY AND SERVICES:

The scope of work under this specification shall be as below.

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.

- 1.1 Total lump sum for Equipment & Services as specified, comprising of design & engineering, manufacture, inspection & testing at manufacturer's works, painting at manufacturer's works, duly packed for transportation, delivery to site, unloading storage & handling at site, erection & commissioning, carrying out performance/acceptance tests at site & final painting of complete Compressed Air System consisting of following equipment:
 - 1.1.1 Three (3) Nos. Instrument Air Compressors (Oil Free Screw) each of minimum 40.5 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.2 Three (3) Nos. refrigerant type Air Drying Plants of minimum 45.0 Nm³/min capacity (1.1 times the IA compressor capacity) with all instruments, control panels and other accessories as specified.
 - 1.1.3 Three (3) Nos. Service Air Compressors (Oil Free Screw) each of minimum 40.5 NM³/Min capacity at 8.5 Kg/sqcm (g) discharge pressure with suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories.
 - 1.1.4 Seven (7) Nos. Air Receivers of 20 cum capacity each adjacent to compressor house and one (1) no of 10 cum capacity in TG hall. Each air receiver shall be complete with instruments, relief valve, drain connection with electronic timer controlled solenoid operated automatic trap stations and other accessories as specified.
 - 1.1.5 Three (3) Nos. Electronic Dew point meters and six (6) numbers flow meters.
 - 1.1.6 Pipes and fittings for compressed air line & interconnecting airline, cooling water line including hanger/supports, auxiliary structural members etc. inclusive of all cu-tubing for control air piping, fittings, valves, Counter flanges, bolts, nuts, gaskets etc. at all piping terminals, base plates, support plates, anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts etc and other accessories as required including drain piping - Lot.
 - 1.1.7 All airline and water line valves – Lot.
 - 1.1.8 Field instruments as specified in technical specification, all instruments necessary for performance testing of compressors as well as air drying plants – Lot.
 - 1.1.9 Microprocessor/PLC based integrated control system for each compressor and dryer. – Lot.
 - 1.1.10 Cables as specified – Lot.
 - 1.1.11 Maintenance and erection tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot
 - 1.1.12 Any other item not included above or in specification but required for Compressed Air System.
 - 1.1.13 All commissioning spares & consumables for trouble free operation shall be in scope of bidder.
 - 1.1.14 Civil works:- Minor dressings of foundation blocks, equipment grouting, supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.



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1.1.15 Erection and commissioning of compressed air system.

2.0 TERMINAL POINTS:

- 2.1 Bidder will terminate compressed air piping at common IA header and common SA header downstream of air receiver with isolation valve as per enclosed tender drawing.
- 2.2 200 Nb Cooling water supply pipeline connection will be provided by the purchaser outside the compressor house (at 10.0 m from compressor house building). The return hot water shall be terminated by the contractor at the same location. Further interconnection from these terminal points shall be in bidder's scope. Refer enclosed tender drawing.

3.0 EXCLUSIONS:

- 3.1 HT motors for Air compressors. HT motors are not in bidder's scope of supply, bare motors only shall be supplied as free issue by BHEL to successful bidder based on motor inputs furnished by bidder, like motor rating and TS (Torque - Speed) curve. The responsibility for satisfactory operation for combined performance of compressors & motors shall rest with the bidder only as if, the drive motors also have been supplied by the bidder. Couplings, base plate, foundation bolts, any other fittings, etc. as required shall be supplied by the bidder only. BHEL shall supply motors to successful bidder works for shop testing of compressors with job motors. All other motors (mandatory spare) shall be dispatched by BHEL directly to project sites.
- 3.2 MCC/Switchgear for power supply to Air Compressors and other drives and panels.
- 3.3 Civil works including construction of compressor house, foundation of all compressor, air dryer and air receiver, pipe / cable trenches.
- 3.4 Lighting and ventilation of compressor house.
- 3.5 Monorail hoists/Cranes as necessary for handling of equipment after erection.
- 3.6 Compressed Air Distribution Piping running from isolation valve of the IA & SA header after the air receivers outside the compressor house.

4. SUB-VENDOR ITEMS

The tentative make of Sub-vendor items shall be generally as per Annexure-I, Section IA enclosed which is subject to customer approval during detail engineering.

5. 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 Section IIIA. Any documents other than those indicated in Section IIIA will not be reviewed and will not form part of contract.

6. DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

List of drawing / document required to be submitted during detail engineering is attached in Annexure-III, Section IA. 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 implication shall be entertained by BHEL.



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7. DRAWINGS DISTRIBUTION SCHEDULE

Drawing/document needs to be submitted by successful bidder during detail engineering shall be as per Annexure-II, Section IA.

8. DRAWINGS ENCLOSED WITH THE SPECIFICATION

Drawings as per Annexure-IV, Section IA enclosed will form part of the specification.

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.

9. MANDATORY SPARES

General requirement of mandatory spares will be as per the list enclosed under Annexure-V, Section IA. The successful bidder immediately after approval of PID, Layout & equipment/ instrument data sheets /GA will prepare detailed list of mandatory spares with regard to their exact quantities, applicability/ non applicability; supply of alternate items against non-applicable items etc. This list will be submitted to customer for getting their approval. The successful bidder will proceed for ordering only after approval of the list. BHEL reserves the right to buy any or all the mandatory spares parts as mentioned in the list.

10. GUARANTEED POWER CONSUMPTION

Bidder to furnish the Guaranteed power consumption (GPC) as per the format attached at Section IIIF of this specification. Bidder to furnish GPC along with its technical bid and not in sealed priced bid.

11. OTHER REQUIREMENTS

- Detailed erection manual for each of the equipment as well as complete system supplied under this contract at least 2 months before the scheduled erection of the concerned equipment / component or along with supply of concerned equipment / component whichever is earlier.
- The O&M Manual to be submitted by the successful bidder will necessarily address the following:
 - a. Complete System Description along with PIDs, write up on electrical philosophy and safety/process interlocks etc.
 - b. Instructions for plant operation
 - c. Commissioning procedure of the system
 - d. Chapter on precautions to be taken during:
 - Operation
 - Idle time
 - Long shutdown
 - e. Chapter on trouble shooting during plant operation covering:



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- Safely aspects
 - Do's and do not's
 - Maintenance schedule
 - Schedule of lubricants & consumables
- f. O & M instruction for all individual equipment which shall invariably contain but not necessarily limited to the following:
- Equipment description/interdiction
 - Data sheet, Equipment GA & Cross Section Drawing
 - Catalogue of each equipment
 - DO's & DON'T's
 - Duty Conditions
 - Installation & Safety Recommendation
 - Start-up & shut down procedure
 - Instructions for testing and adjustment of system parameters
 - Disassembly & Assembly Instructions giving sequence no. of each component
 - List of Replacement/ Spare parts along with their drawing and catalogues and procedure for ordering spares.
 - Reason & Remedy Chart for any problem
 - Maintenance Schedules- Daily, Weekly, Monthly, Half Yearly and Annual indicating clearly the spares part and man-hour requirement for each stage.
 - Detailed specification/ Schedule of all the consumables including lubricant oils, greases, chemicals etc. required for the complete system
 - Commission procedure for equipment.
- Document approval by customer under Approval category or information category shall not absolve the vendor of their contractual obligations of completing the work as per specification requirement. Any deviation from specified requirement shall be reported by the vendor in writing and require written approval. Unless any change in specified requirement has been brought out by the vendor during detail engineering in writing while submitting the document to customer for approval, approved document (with implicit deviation) will not be cited as a reason for not following the specification requirement.
 - In case vendor submits revised drawing/doc after approval of the corresponding drawing/doc, any delay in approval of revised drawing shall be to vendor's account and shall not be used as a reason for extension in contract completion. However, in case changes are necessitated due to any constraints at customer end, delay in review/ approval of such revised drawing beyond one month will be to customer's account.
 - Bidder to note that during detail engineering, successful bidder to submit the drg/doc through web based Document Management System in addition to hard copies to be submitted as per dwg/ document distribution schedule. Bidder would be provided access to the DMS for drg/doc approval and adequate training for the same. Detailed methodology would be finalized during the kick-off meeting. Bidder to ensure following at their end.



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- Internet explorer version – Minimum Internet Explorer 7
 - Internet speed – 2 mbps (Minimum preferred)
 - Pop ups from our external DMS IP (124.124.36.198) should not be blocked
 - Vendor's Internal proxy setting should not block DMS application's link (<http://124.124.36.198/wrenchwebaccess/login.aspx>)"
- DMS user manuals to be used by BHEL PEM vendors for uploading, viewing, revising, commenting and tracking documents on PEM's DMS have been uploaded on PEM internet website (www.bhelpem.com) under the Vendor session.
For quick access bidder may refer the link <http://bhelpem.com/DMSManuals/DMSManuals.html>
- Final Electrical Load list will be submitted by the successful bidder as per agreed drawing/ doc submission schedule. Thereafter any change in the electrical load list shall be entertained only subject to its feasibility, and BHEL reserves the right to debit the vendor cost of any changes necessitated in the switch gear /MCC on account of changed loads.
 - Wherever CIVIL works is excluded from the bidder's scope, successful bidder shall furnish civil assignment drawings. The corresponding CIVIL drawing prepared by BHEL / CIVIL agency, based on civil assignment drawing of bidder will be furnished to the successful bidder for concurrence. In case any modification is required in the civil work already carried out based on final civil inputs given by vendor, BHEL reserves the right to debit cost of such rework to vendor".
 - If any deviation is there then same to be indicated separately under the heading "Schedule of Technical Deviation" enclosed as per Volume III of the Technical Specification along with Cost of Withdrawal. In case nothing is mentioned under the column Cost of withdrawal then during bid evaluation no price implication will be admissible for withdrawal of deviations. Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexure or elsewhere in the offer) and same shall not be considered for review/evaluation purpose/comments and it would be assumed that the system/material/equipment has been offered strictly in line with specifications/requirements.

12 BIDDER TO NOTE THE FOLLOWING INFORMATION:

- 12.1 Bidders to indicate offered model in their offer and to submit backup document (e.g. performance test, etc.) matching FAD calculation along with the catalogue of the offered model to justify selection.
- 12.2.1 Compressor and air dryer shall be designed for cooling water (clarified water) with inlet temp of thermal 36 deg C and terminal pressure 10 kg/sqcm(g). Bidder to restrict the temperature rise to 10 deg C and pressure drop across Compressed Air System within terminal points to 10 MWC. Qty of cooling water shall be 220 cum/hr (Maximum) considering working equipment only.
- 12.3 Design Inlet conditions for Compressor
 - a) Temp : 45.0 Deg C
 - b) Relative humidity : 85%
 - c) Altitude : 210.0 m above MSL
- 12.4 Design, all calculations, equipment selection criterion, layout drawings/schemes/G.A. drg and documents like data sheet/Technical particulars etc. shall be prepared by successful bidder and shall be subjected to Customer & BHEL approval during detail engineering stage.



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- 12.5 The maximum velocity to be considered in compressed air shall be 20.0 m/s (under Average pr. & Temp. Conditions).
- 12.6 All drawings and documents shall be computer based.
- 12.7 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.
- 12.8 Bidder to clearly note that the instruments, valves etc as shown in the P&I Diagram is the bare minimum and any additional instruments/valves required to complete the system in terms of safety, trouble free operation of equipment's & system as a whole and isolation of individual equipment for maintenance, then same shall be supplied by the bidder without any commercial implication to BHEL.
- 12.9 Grouting of equipment's, like Air receiver, Air dryer & foundation bolts etc. are in the scope of the bidder.
- 12.10 Performance test (capacity and power consumption) for compressors shall be carried out at shops with job motor only.
- 12.11 All the instruments as required for performance testing shall be arrange by bidder. Instrument for testing shall be calibrated from government certified labs & this is in the bidder scope. Bidder to ensure validity of such reports before the performance tests.
- 12.12 The height of unit air receiver shall be limited to 4M.
- 12.13 Access platform required for the maintenance of instruments/valves on the air receivers shall be in bidder's scope of work.
- 12.14 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.

1X660 MW BHUSAWAL TPP UNIT 6

COMPRESSED AIR SYSTEM

SECTION IA

(TECHNICAL REQUIREMENT - MECHANICAL)



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



1X660 MW BHUSAWAL TPP, UNIT 6

COMPRESSED AIR SYSTEM

Spec. No: PE-TS-415-555-A001

REV 01

DATE 30.01.2020

SECTION: IA

1. CODES AND STANDARDS

- 1.1** The design, manufacture, inspection, testing, site calibration and installation of all equipment and items covered under this system shall conform to the latest editions of codes and standards mentioned below:
- 1.1.1** ISO 1217 Annexure C: Displacement compressors – Acceptance test.
 - 1.1.2** IS 2825: Code for unfired pressure vessels.
 - 1.1.3** IS 1239 Part 1: Mild steel tubes, tubulars and other wrought steel pipes.
 - 1.1.4** IS 1239 Part 2: Mild steel tubes, tubulars and other wrought steel fittings.
 - 1.1.5** ASTM A312: Standard specification for seamless, welded and heavily cold worked austenitic stainless steel pipe.
 - 1.1.6** ANSI B 16.5: Steel pipes flanges and fittings.
 - 1.1.7** ANSI B36.19: Carbon, Alloy and Stainless steel pipes – Dimensions.
 - 1.1.8** IS 7938: Air receivers for compressed air installation.
 - 1.1.9** IS 11989: Compressed Air Dryers.
 - 1.1.10** ISO 7183: Compressed air dryers - specification and testing.
 - 1.1.11** ISO 7183 (part II): Compressed air dryers – performance rating.
 - 1.1.12** IS 2062: Steel for General Purpose – Specification.

2. SYSTEM DESCRIPTION

- 2.1.1** Compressed air system is provided in the power plant to supply compressed air through the distribution network to various user points.
- 2.1.2** The compressed air system is comprised of the instrument air system and the plant/service air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services.
- 2.1.3** The compressed Air plant shall be located inside the air compressor building. Air receivers shall be located outdoor.
- 2.2** Compressed Air System includes the following
 - 2.2.1** Three (3) nos. (2 working + 1 standby) Instrument air compressors and three (3) nos. Plant air compressor (2 working + 1 standby), including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories.
 - 2.2.2** Three (3) nos. (2 working + 1 standby) air-drying plants (ADP) each suitable for connecting to individual instrument air compressor.
 - 2.2.3** Intake air filters.
 - 2.2.4** Seven (7) nos. air receivers, (4 nos. for instrument air service and 3 nos. for plant air service) near compressor house. One (1) no as Unit air receiver in TG Hall (instrument air service).
 - 2.2.5** Interconnecting piping, valves, fittings, supports/hangers, control air tubing (complete with valves and fittings between air receivers, compressor and local panel for each compressor), cooling water piping & valves for safe and satisfactory operation of air compressors.

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2.2.6

Instruments including the electronic on line dew point meter with suitable sampling connection and isolation valve at the outlet of each Air Drying Plant shall be provided.

3.

DESIGN INPUTS/ CRITERIA

4.1

AIR COMPRESSORS

3.1.1

The capacity of each instrument air compressor shall be 40.5 NM³/min. Delivery pressure will be 8.5 Kg/cm² (g) at compressor outlet while 8.0 Kg/cm² (g) at ADP outlet. Each compressor will be designed to deliver the nominal capacity at the required delivery pressure.

3.1.2

The capacity of each plant air compressor shall be 40.5 NM³/Min. Delivery pressure will be 8.5 Kg/cm² (g) at outlet of SA compressor.

3.1.3

Air compressors will be multi stage oil free, screw type complete with necessary inter coolers, after coolers, piping valves, instrument and other accessories with built-in control panel.

3.1.4

The compressors' capacity will be designed for 45^o C DBT and 85% RH at atmospheric pressure at site & at 210.0m above mean sea level (MSL).

3.1.5

Testing of compressor shall be as per ISO 1217.

3.1.6

Air compressors will be designed for continuous operation with high efficiency to satisfy the performance requirement.

3.1.7

The maximum continuous motor ratings shall be arrived at considering 15% margin over the duty point input.

3.1.8

Satisfactory operation in parallel will be ensured without any uneven load sharing, undue vibration, noise etc.

3.1.9

Noise level shall not exceed 85 dBA plus tolerances as per ISO standard when measured at a distance of 1.5 meter above the floor and 1.0 meter from the compressor under free field conditions. Acoustic enclosure, if required, shall be provided to meet the above condition.

3.1.10

The compressed air velocity shall be limited to 20 m/s.

3.1.11

The material of construction for the Air Compressor shall be as mentioned in the specification.

3.1.12

The delivered air from compressor shall not contain any trace of oil, grease or any other impurity and size of the particle in delivered air shall not exceed one micron.

3.2

ROTOR.

3.2.1

Rotors will be one-piece construction with a suitable forged steel coated with corrosion resistant material to minimise leakage and wear.

3.2.2

The rotors will have an asymmetric profile, so as to keep leakage losses to a minimum and ensure high efficiency.

3.2.3

Highly precise timing gears will be mounted on the rotor shafts to maintain the rotors in correct relative position.

3.2.4

These gears will be designed to counteract the axial forces incurred in compression.

3.2.5

Rotors shall be dynamically balanced.

3.2.6

Shaft sealing and retainers shall ensure non mixing of oil with air.

3.2.7

Gaskets shall be of asbestos free material.

3.2.8

Lubrication oil shall be ISO VG32 or equivalent.

3.3

AIR DRYING PLANT.

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3.3.1	The air drying plant shall be refrigerant type. The capacity of ADP shall be 45 NM ³ /Min each.
3.3.2	Atmospheric pressure dew point shall (–) 20 deg C. Dryers shall be suitable for part load operation while maintaining the outlet air dew point as specified.
3.3.3	Line pressure dew point shall be (+) 3 deg C.
3.3.4	The material of construction for the Air drying plant shall be mentioned in specification.
3.4	AIR RECEIVER.
3.4.1	The capacity of 07 nos. air receivers provided near to compressor house shall be 20 m ³ (nominal) each, for 01 no air receiver provided in TG hall as unit air receiver shall be 10 m ³ (nominal).
3.4.2	The air receivers shall be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.
3.4.3	Design Pressure & Temperature for the air receiver shall be 10.0 kg/cm ² (g) & 80 ^o C respectively. Air receivers shall be designed as per ASME Section VIII or IS: 2825.
3.4.4	The material of construction of shell, dished ends, flanges etc. of the air receivers shall be of carbon steel as per IS: 2002 / SA 516 Gr 70 / equivalent.
3.4.5	Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge, minimum 500 mm dia. manhole for inspection.
3.5	INTAKE FILTER
3.5.1	Dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the compression chambers of compressors. The filtering efficiency shall be 99 %, down to 3 microns. Sound suppressing characteristics will be considered in the filter design.
3.6	PIPING AND VALVES (WITHIN COMPRESSOR HOUSE)
3.6.1	All interconnecting compressed air piping shall conform to ASTM A-312 grade 304. Thickness shall be schedule 40S as per ANSI B 36.19 for size 40 Nb and below and for size greater than 40 Nb thickness shall be 10S as per ANSI B 36.19. All cooling water piping will be IS-3589 Gr.410/ IS-1239 Heavy grade. Oil Piping shall be API 5L. The fittings shall be conforming to relevant BIS standard and Grade equivalent that of parent pipe Grade. Compressed air piping handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg. C. The compressed air pipe joints will be screwed type for sizes up to 80 NB and above 80 NB the same will be butt welded. Cooling water lines of 50 Nb and above shall be joined by butt welding and 40 Nb and below by socket welding.
3.6.2	Necessary auto drain shall also be provided at strategic points in compressed air line.
3.6.3	VALVES
3.6.3.1	Compressed Air service.
a)	All airline valves shall be ball valve type. For compressed air application, valve material shall conform to A351 CF8M for Cast Stainless Steel body, A182 F304 for forged body. Valve shall be forged body upto 50 mm NB and Cast body above that size.
3.6.3.2	Water service
a)	Cooling water / drain water application valve shall be gate / globe / ball valve type. Valve material shall be Cast iron for size 65 Nb and above; gun metal / forged carbon steel for sizes 50 Nb and below.
3.6.3.3	End connections shall be screwed or flanged as required.

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3.6.4

The velocity of compressed air in pipe shall be as under:
a) For pipe size 50 Nb and below: 20 m/s.
b) For pipe size above 50 Nb: 20 m/s.

3.7

LAYOUT CONSIDERATION

3.7.1

Air compressors will be located indoor in a separate compressor room.

3.7.2

The air receivers will be located outdoors and adjacent to the compressor room.

3.7.3

Complete ADP equipment shall be preferably mounted on a skid and located indoor.

3.7.4

Compressor house building has already been finalised, refer the layout attached, bidders have to accommodate the equipments in that allocated space.

4.

OPERATION & CONTROL PHILOSOPHY

4.1

The necessary instrumentation and control has been provided for safe and trouble free operation of compressed air system.

4.2

Individual compressor control shall be through microprocessor based control system meeting specification requirements.

4.3

Overall controls of the Compressed Air System shall be through DCS.

4.4

Depending upon operational requirement each compressor can be selected and operated in following mode:

4.4.1

Local mode: Individual compressor is operated from Local Integral Control System. This mode of operation shall be selected through individual microprocessor. During this mode the individual compressor start / stop command shall be executed by respective microprocessor. Required application / operational software with logic for start permissive / start / stop / run etc. are pre-loaded in the microprocessor, which in turn control the compressor as the case may be. Loading & unloading of the compressor shall be as per the operating pressure band setting in the individual microprocessor. Logic built in compressor's individual microprocessor based control system shall take care the signals from transducers with in the compressor.

4.4.2

Remote mode: Individual compressor is operated through DCS. This mode of operation shall be selected through individual microprocessor. However during this mode individual compressor start / stop command shall be executed by DCS, before giving start / stop command from OWS the compressor "Remote selected" shall be ensured from the compressor room. As in local mode microprocessor with pre-loaded application / operational software consisting of logic for start permissive / start / stop / run etc. will control the individual compressor. During this mode also loading & unloading of the compressor shall be as per the operating pressure band setting in the individual microprocessor.

4.4.3

Logics for the external signals out of the compressor shall be taken care by DCS for overall control, operation and monitoring of complete compressor plant.

4.5

Operation of Compressed Air System.

4.5.1

Instrument air system consists of 3 numbers of Compressors (02 working + 01 standby), 03 numbers of Air Drying Plant (02 working + 01 standby), air receivers and distribution network of piping and valves.

4.5.2

The compressors are operated in cascade mode of operation. The operation of compressors is carried out as under, say of IA compressors:

➤ Initially, the pressure setting in all 03 numbers compressors is set in cascading mode, with higher pressure settings (say for Compressor No.01 - 8.5 kg/cm² for unloading & 8.1 kg/cm² for loading, For Compressor No.02- 8.3 kg/cm² for unloading



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& 7.9 kg/cm² for loading) for working and lower pressure settings (say 8.0 kg/cm² for unloading & 7.4 kg/cm² for loading) for the standby compressor.

- To ensure auto start-up of standby compressor, all the three compressors are started together.
- The pressure starts building up in the system. Once the header pressure crosses the unloading pressure of standby compressor, the standby compressor unloads and then subsequently goes into idle / standby mode.
- Then the header pressure is maintained by unloading / loading of working compressors.
- In case of trip/failure of working compressor, the header pressure starts dropping.
- As soon as the header pressure reaches the loading pressure of standby compressor (say 7.4 kg/cm²), the standby compressor automatically starts by sensing the header pressure.

4.5.3 Operating procedure of plant air compressors is same as IA compressors described in 4.5.2 above.

4.5.4 For ensuring IA at all the time, intermediate IA and plant air headers are connected through check valve and a motor operated valve such that compressed air can flow from plant air to IA intermediate header. For this purpose, an analogue signal from PT mounted on IA header shall be taken to DCS and from DCS this MOV would be operated. In case of low pressure in IA header, MOV shall be opened to ensure availability of IA upstream of air drying plant. For actuating MOV, following pressure setting may be done: less than or equal to 7.0 kg/cm² – MOV to open, & pressure greater than or equal to 7.5 kg/cm² – MOV to close.

4.5.5 All the process inputs (digital or analog), other than specific to compressors are taken directly to compressed air system DCS for monitoring the system.

4.5.6 DCS shall have soft link interfacing with each individual compressor's microprocessor based control system, and HW signals required for start / stop, load / unload commands, local / remote operation, general warning and shut down, interlocks & protection (Logics for interlock and protection of compressor are inbuilt in their own microprocessor based control system and shall be further deliberated during detailed engineering.

5.5.7 The compressor automatic or local operation, general warning / alarm, compressor loading /unloading will be hardwired to DCS as a general philosophy. RTD and BTD temperature signals of compressor motor shall be wired to individual compressor microprocessor panel for tripping of compressor in case of high temperature. Control signals from compressor switchgear shall be wired to individual compressor microprocessor panel for interlock. The running status of air driers will also be available in the DCS.

5.5.8 Each air receiver shall be provided with automatic, no air loss type drain valve for removal of drain.

5.5.9 Necessary anti-vibration pads for free standing shall be provided in case of vertical control panels.

6.0 PAINTING SCHEDULE

6.1 This shall be as per contract painting specification. A separate document, Painting schedule shall be submitted for approval during detailed engineering.

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SECTION IA

(CUSTOMER SPECIFICATION)



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POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA

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	BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1	Section – 1
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1.0 INTRODUCTION

This specification is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacturer'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 system for Bhusawal TPS Unit-6: 1 X 660 MW Project at Bhusawal, Maharashtra.

1.1 Since the project is being implemented on turnkey concept of engineering, procurement and construction (EPC) with single point responsibility with the successful bidder, is not intended to specify completely herein, all details of design and construction of equipments. 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 upto the vendor's guarantee in a manner acceptable to the owner, the owner 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.

1.2 Compressed Air shall cover the following areas :

1.2.1 Pulveriser coal sampling.

1.2.2 APH soot blowing.

1.2.3 Turbine Generator (TG) and Auxiliaries.

1.2.4 DM Plant & Water system area.

1.2.5 TG & SG area cleaning and maintenance.

1.2.6 Fuel oil pump house area

1.2.7 LDO atomization

1.2.8 Station C & I area

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1.2.9 Any other area (if required) which is not covered above.

Besides, dedicated Compressed Air Systems (as described in respective Volumes) shall be provided for each of the following areas:

- (a) CHP area
- (b) AHP area
- (c) Mill Reject handling system

2.0 SYSTEM DESCRIPTION

2.1 The compressed air plant shall be located in the combined Air Compressor and DG Building. The air receivers shall be located outdoor. All equipments, electricals, instruments to be supplied under this specification shall be suitable for their respective location. For details of electrical equipment relevant sections of the Electrical Specification shall be referred.

2.2 **Total Six (6) air compressors, (three (3) for IA system & three (3) for SA system), sufficient to meet the unit requirement or 40.5 Nm³/min (minimum), whichever is higher at pressure 8.5 kg/cm² (g) (minimum) at the outlet of after cooler shall be used to cater the instrument air requirement and service air requirement of total plant except for Coal Handling Plant, Ash Handling Plant and Coal Mill reject system.**

2.3 **Air drying plant of capacity (1.10 times IA compressor capacity) and number equal to that of each instrument air compressor shall be installed in order to supply moisture free instrument air.**

2.4 **Instrument and Service Air Receiver of capacity and number equal to that of each instrument and service air compressor respectively shall be provided to store instrument and service air.**

2.5 All the piping works including all accessories shall be provided.

2.6 The Compressed Air System shall meet the requirement of the Instrument Air for the control of various pneumatically operated instruments and the Service Air for general plant services.

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2.7	Air drying plant of Refrigerant type non-cyclic version with continuous and fully automatic operation shall be provided to ensure dry moisture free Instrument quality air. The schematic arrangement of Compressed Air System has been shown in Drg. No. PE-189-GA-124	
3.0	<u>CODES AND STANDARDS</u>	
3.1	In addition to the requirements spelt out in Volume-II, the equipment 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 :	
3.1.1	BS-726	: Measurement of Air Flow for Compressor
3.1.2	IS-2825	: Code for unfired pressure vessels.
3.1.3	IS-4503	: Shell and Tube Type Heat Exchanger
3.1.4	IS-5456	: Code of Practice for testing of positive displacement type air compressors and exhausters.
3.1.5	IS-57271	Glossary of terms relating to compressors and exhausters.
3.1.6	IS-1239 Part-1	: Mild Steel tubes, tubulars and other wrought steel pipes.
3.1.7	IS-1239 Part-2	: Mild steel tubes, tubulars and other wrought steel fittings.
3.1.8	IS-6206	: Guide for selection, installation and maintenance of air compressors/plants with operating pressure up to 10 bars.
3.1.9	ANSI-B16.5	: Steel Pipes Flanges and Fittings.
3.1.10	IS-7938	: Air Receivers for Compressed Air Installations.

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3.1.11	IS-10431 Part-I	:	Measurement of Air Flow of Compressor and Exhausters by nozzles.
3.1.12	ASME PTC-9	:	Performance Test Codes for Displacement Compressors, Vacuum Pumps and Blowers.
3.1.13	BS-5169/1975	:	Fusion Welded Steel Air Receiver.
3.1.14	IS-11989	:	Compressed air dryer.
3.1.15	ISO-7183	:	Compressed Air Dryers - Specification and Testing
3.1.16	ISO-7183 (Part-II)	:	Compressed Air Dryers - Performance rating
3.1.17	IS-12258	:	Technical supply condition for Screw Air Compressor.
3.1.18	BS-1571	:	Simplified Acceptance Test for Air Compressor and Exhausters
3.1.19	IS-2062	:	Steel for General Structural Purpose- Specification
3.2	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.		
4.0	<u>SPECIFIC DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS</u>		
4.1	The Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis. It consists of two sub systems namely,		
4.1.1	Instrument Air (IA) for Instrumentation and Control purposes.		
4.1.2	Service Air (SA) for some boiler equipment, general house cleaning and other miscellaneous usage.		

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4.2	The normal pressure of Instrument Air supply at the outlet of Air Dryer shall be 8.0 kg/cm² (g) (minimum). Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor shall be worked out, allowing for pressure drops in system piping, equipment and all other accessories. The rated discharge pressure of IA compressor shall be computed as per guidelines specified above or 8.5 kg/cm² (g) (minimum) at the outlet of after cooler, whichever is higher. Each Service Air compressor shall be designed to deliver service air at a rated discharge pressure equal to the rated discharge pressure of each Instrument Air Compressor. The maximum expected pressure in the system shall be computed by considering 20% overpressure over and above the rated discharge pressure of each air compressor as computed above.	
	4.3 The total Instrument Air requirements shall be assessed by the following guideline : $Z = (A+B+C+D) \times [1 + (mw+ml)/100]$ where, A = Instrument Air requirement for SG & auxiliaries. B = Instrument Air requirement for TG & auxiliaries. C = Instrument Air requirement for Water treatment plant and other facilities. D = Other C&I requirement. mw = Wear & tear margin (10%) ml = Leakage margin (10%) Z = Total Instrument Air requirement. The total Service Air requirement shall be assessed by considering the following guideline: $Y = (E+F) \times [1 + (mw+ml)/100]$ where,	

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Y	=	Total service air requirement	
E	=	Service Air requirement for SG, TG & auxiliaries.	
F	=	Service Air requirement for Water treatment plant and other facilities.	
mw	=	Wear & tear margin (10%)	
ml	=	Leakage margin (10%)	
Each Service Air Compressor shall have capacity identical to that of each IA compressor but in no case less than the value Y as computed above.			
4.4	Compressed air system shall comprise one (1) IA group and one (1) SA group of compressors. The capacity of each air compressor shall be determined as per clause No. 4.3.		
4.5	IA compressor group shall consist of 3 x 50% (two (2) working and one (1) standby compressors) with necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel and supplemented by an Air Drying plant for each IA compressor. There shall be one (1) Air Receiver for each IA compressor.		
4.6	SA compressor group shall consist of 3 x 50% (two (2) working and one (1) standby Compressors) with necessary intercoolers, after coolers, piping, valves, instruments and other accessories with built-in control panel. There shall be one (1) Air Receiver for each SA compressor.		
4.7	Suitable interconnections shall be kept between SA and IA headers before Air Dryers with normally closed motorized isolation valves and non - return valve connected in such a way to allow only service air inside in case of emergency.		
4.8	Equipment operating on Instrument Air and Service Air System shall be designed for a pressure range of 5.5 kg/cm ² (g) to 120% of rated discharge pressure of each air compressor.		

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4.9	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.	
4.10	Compressed air system equipment requiring ACW cooling water shall be capable of operation at design capacity with ACW cooling water inlet temperature subject to a maximum of 38°C (Indicative). The above equipment shall also be capable to withstand a pressure not less than the shut off head of each ACW pump.	
4.11	The temperature of air at outlet of after cooler shall not exceed 8°C above the cooling water inlet temperature.	
4.12	Air Compressors shall be identical and shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Data Sheet -A enclosed with this section.	
4.13	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.	
4.14	As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, and keeping noise level within permissible limits for the number of compressors working simultaneously.	
4.15	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/cm ² (g) within two (2) minutes 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:	

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$V_{AR} = \frac{TxCxP_A}{P_{MAX} - P_{MIN}} x E, \text{ where}$ V_{AR} = Volume of each Air Receiver in M³ T = Bleed down time in minutes, shall be taken as 2 minutes (minimum) P_A = Atmospheric pressure, shall be taken as 1 kg/cm² (absolute) P_{MAX} = Maximum system pressure in kg/cm² absolute, shall be taken as 110% of rated compressor delivery pressure. P_{MIN} = Minimum system pressure in kg/cm² absolute, shall be taken as 6.5 kg/cm² 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% minimum margin to account for peak requirements. The water filled volume of each Air Receiver shall be calculated in accordance with the guidelines or 10 m³, whichever is higher. 4.16 The drying capacity of each Air Drying Plant (ADP) shall be provided to match the corresponding 1.10 times capacity of each IA compressor. 4.17 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 Data Sheet - A or lower throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 85% & 45°C respectively. (Suitable to handle inlet air temperature of 60°C).		

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4.18	The drying process shall employ the Refrigerant type drying to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air shall have following quality : (a) Dew point at atmospheric pressure (-) 20⁰. (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 ISA – 57.3 (Instrument Society of America) quality standards for instrument air.	
4.19	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.	
4.20	The contractor shall assume full responsibility in the operation of the air drying plant as a whole.	
4.21	For the air drying capacity and all other relevant details pertaining to Air Drying Plant, Data Sheet -A shall be referred to.	
5.0	<u>SCOPE OF SUPPLY AND WORKS</u>	
5.1	<u>SCOPE OF SUPPLY</u>	
	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.	
5.1.1	3 x 50% IA compressors and 3 x 50% SA compressors shall be provided. There shall be one (1) Air Receiver for each IA compressor and one (1) Air receiver for each SA compressor. 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.	

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5.1.2	Microprocessor based control system shall be used for each compressor. There shall be one common PLC based control panel for compressor & driers. This panel shall be complete with necessary PLC Hardware and Software, push buttons, annunciations as needed to make the system completely reliable and efficient. Necessary anti-vibration pads for free standing in case of vertical control panels are to be provided. This panel shall be located in the compressor control room. One number operating cum programming station with 24" LCD TFT color monitor & A3 size color laser printer shall be provided with this common panel. All individual compressor and drier local panels shall be hardwired interface with this common PLC panel. This PLC system shall be interfaced with plant DCS through MODBUS/Ethernet OFC link OPC.	
5.1.3	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 shall be provided.	
5.1.4	One (1) air drying plant for each IA compressor shall be provided by the Bidder. Each air drying plant shall be complete with the following accessories: (a) Air Ejector as applicable. (b) Filters and coolers, as required. (c) Moisture separator with auto drain trap (no air loss type). (d) Dryer container/tower. (e) All inter-connecting/integral piping, valve trap stations with by-pass valves at drains, fittings, flanges, gaskets etc (f) Instrument and controls. (g) Interconnecting wiring. (h) Differential pressure indicator.	

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(i) One (1) dew point indicator (on line). 5.1.5 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. 5.1.6 Air receivers The number and capacity shall be as specified. 6.0 <u>DESIGN AND CONSTRUCTION</u> 6.1 The Compressors shall be designed to deliver the nominal capacity at the required delivery pressure as mentioned in Data Sheet -A of this section. 6.2 The design shall be such as to ensure trouble free operation with least vibration and noise. Suitable acoustical treatment shall be provided to ensure the noise level within permissible limits. 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. 6.3 The compressors shall be non lubricated, oil free, horizontal, multi-stage water cooled, electric motor driven screw type, heavy duty and rugged construction. Speed of compressor shall be so selected as to result in low maintenance and trouble-free operation under specified conditions. 6.4 Unless inconsistent with this section, equipment from the standard range of manufacture shall be preferred. 6.5 Compressor components shall be interchangeable as far as possible. Material of construction shall be suitable for the service. 6.6 Design capacity, outlet pressure and the material of construction for various parts of the compressor and accessories shall be as specified in Data Sheet - A enclosed with this section.		

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6.7	<u>COMPRESSOR CASING, ROTOR AND SHAFT</u>	
6.7.1	Compression chamber wall thickness shall be such that to withstand maximum design pressure.	
6.7.2	During maintenance, suitable arrangement for cleaning of the cooling water jackets shall be provided.	
6.7.3	Compressor shall have dynamically balanced, one-piece Rotor with a symmetric profile to keep leakage loss to a minimum and ensure high efficiency.	
6.7.4	Rotor shaft mounted, highly precise timing gears shall be designed to counter the axial forces incurred in compression.	
6.7.5	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.	
6.7.6	The shaft sealing and retainers shall be free for radial self-adjustment on the rotor shafts.	
6.7.7	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.	
6.7.8	The gaskets shall be of asbestos free material.	
6.7.9	Oil lubricated anti friction type bearings shall give service of at least 8000 running hours.	
6.8	<u>LUBRICATION SYSTEM</u>	
6.8.1	The compressor package shall include a lubricant management system which shall lubricate the bearings and seal. By the design, the compressor	

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chamber (screw rotor housing) is totally separated from bearing / gear chamber. 6.8.2 The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided, if required, 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 shall be protected by a relief valve. 6.8.3 The heat exchanger for lube oil cooler shall be water cooled. The heat exchanger shall be located within the enclosed compressor skid. 6.8.4 The fouling factor shall be considered as per the recommendation of TEMA. 6.8.5 The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors. 6.8.6 The cooler shall be designed in accordance with the requirement of IS-2825. 6.8.7 Due consideration for the differential expansion of shell and tube shall be given in the design of the coolers. 6.9 <u>GEAR BOX</u> 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. 6.10 <u>INTER COOLER, AFTER COOLER AND MOISTURE SEPARATOR</u> 6.10.1 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.		

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6.10.2	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.	
6.10.3	After-cooler at each compressor discharge shall be water cooled. It shall be located after compressor discharge to bring the outlet temperature of the compressed air within 8°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.	
6.10.4	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.	
6.10.5	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.	
6.10.6	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.	
6.10.7	The tube nest shall be removable type to facilitate cleaning and maintenance.	
6.10.8	Intercoolers/After coolers shall be provided with supports, which are designed to avoid undue stress or deflection in support or body of the equipment.	
6.10.9	Due consideration for the differential expansion of shell and tube shall be given in the design of coolers.	
6.10.10	Necessary drain and vent nozzles shall be provided for intercooler and after cooler.	

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6.11 <u>AIR RECEIVER</u> 6.11.1 Air receiver (s) shall be in accordance with IS-2825 or ASME Sections-VIII Div.I and IS-7938. 6.11.2 The design pressure, capacity and other parameters shall be as specified in Data Sheet -A of this section. 6.11.3 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 Data Sheet - A enclosed with this section and typical drawing enclosed with the specification. 6.11.4 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. Long seam and circular seam shall be provided in shell as per size of plate available. 6.11.5 Nozzle openings shall not pierce any weld seam. 6.11.6 All welding shall be performed in accordance with relevant codes. Filler material 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. 6.11.7 Receivers shall be provided with required number of nozzles, the orientations of which shall be subject to approval by the Owner. 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. All openings shall be placed as far as possible from welded seams and in no instance shall pierce the seam. 6.11.8 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.		

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6.11.9 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 shall have air release vents at the top to facilitate statutory hydraulic tests as per IS-7938. 6.11.10 Receiver shall be heat-treated in accordance with BS-5169. 6.12 <u>INTAKE AIR FILTER AND SILENCER</u> 6.12.1 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. 6.12.2 The filters shall be complete with integral silencers and all other accessories. The filtering elements shall be easily removable for cleaning or for replacement. 6.12.3 The filters shall be designed for an efficiency of not less than 95% for particles 1 microns and larger. 6.12.4 The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirements in Volume –II. 6.12.5 Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold. 6.12.6 If filter after receiver is specified in Attachments/Annexure, the same shall be provided to remove the bulk of moisture and other contaminants entrained in the air stream. 6.13 <u>DRIVE UNIT</u> 6.13.1 The compressors shall be driven by constant speed squirrel cage induction motor. For determining the output rating of driver, general guidelines as indicated in cl. no. 4.13 of this section and Volume-IV of this specification shall be followed.		

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6.13.2 The driver shall be connected to the compressor either directly or through gear box as per Data Sheet -A of this section. 6.13.3 For other types of connection between drive unit and compressor, suitable flexible coupling shall be provided. 6.13.4 Necessary guard shall cover all exposed moving parts. 6.13.5 Motor speed torque curve shall match with that of the compressor for trouble free start up. 6.13.6 Motor shall be suitable for eight (8) equally spreaded starts per hour. 6.14 <u>MOISTURE SEPARATOR</u> Moisture separator shall be of high efficiency design & no air loss type and provided with vent nozzle and auto drain trap system. 6.15 <u>AIR DRYING PLANT (ADP)</u> 6.15.1 Air-drying plant shall be of Refrigerant type 6.15.2 Air dryer shall be Indoor located. 6.15.3 All pressure vessels shall be designed as per IS: 2825 or equivalent code. 6.15.4 All vessels shall be included with required manholes/hand holes. 6.15.5 All hot vessels & pipelines to be insulated to restrict the outside temperature within 60^o C with mineral wool (or equivalent). 6.15.6 Complete ADP equipments shall be preferably mounted on a skid. 6.15.7 Required sample connections in piping shall be provided for sampling of air at desired locations.		

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6.16	<u>PRESSURE VESSELS</u>	
6.16.1	All pressure vessels shall be designed as per IS: 2825 or approved equivalent code.	
6.16.2	The vessels shall be of self supporting construction. All welding materials and procedures shall be as per IS: 2825 or approved equal.	
6.16.3	Each vessel shall be provided with suitable air-tight manhole and/or handhold and other connections as required.	
6.16.4	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.	
6.16.5	Internal surfaces of all the vessels shall be suitably protected against corrosion and rusting. Corrosion allowance of 1.5 mm shall also be provided on shell and dished end thickness.	
6.16.6	Draining trap station complete with Auto drain trap, isolation and by-pass valves and Y-strainer shall be provided for the moisture separator.	
6.17	<u>SOLENOID VALVES AND MULTIWAY VALVES</u>	
6.17.1	The solenoid valve shall be of approved make. The solenoid valves shall have heavy duty, double impregnated tropicalised coils (Single or double solenoid as required) and shall be suitable for the operating temperature and for operation continuously energised, in a tropical climate.	
6.17.2	The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy molded type, Class-F. The enclosure shall be watertight, dust tight, weather proof and shall conform to NEMA-4X standard. The valves shall be suitable for mounting in any position. Solenoid coils shall be Class-H high temperature construction and shall be suitable for continuous operation. Type of operation and electrical ratings shall be subject to the owner's approval.	

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6.18 <u>DRIVES AND MOUNTING</u> 6.18.1 All relevant details pertaining to drives shall generally comply with the stipulations laid in Volume-IV. 6.18.2 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. 6.19 <u>INTERCONNECTING PIPING, VALVES AND FITTINGS</u> 6.19.1 Pipelines shall be selected as per IS-6206/equivalent standard. Piping in air lines and cooling water lines up to 40 NB shall be socket welded and 50 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 Data Sheet - A enclosed with this section. 6.19.2 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 as under. (a) For pipe size 50 NB & below: 20 m/s) (b) For pipe size above 50 NB: 20 m/s) 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.		

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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. 6.19.3 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 m/s. Sight flow indicators shall be provided on water discharge from each cylinder, intercooler and after cooler. 6.19.4 Valves to be supplied for compressed air service and auxiliary cooling water service shall be as indicated in the Volume III-F, Section II. 6.19.5 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. 6.19.6 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. 6.19.7 Complete piping system shall be provided with adequate supporting arrangement to avoid undue forces and moments at the equipment terminals and vibration. 6.19.8 All pipes and equipment conveying hot air shall be properly insulated to limit outside surface temperature to 60°C. The insulating material shall be		

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glass or mineral wool as per IS-3690/IS-3677/equivalent with chicken wirenet and 22 gauge aluminium cladding. 6.20 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. 6.21 <u>MASS FLOW METER</u> (with sensor probe) 6.21.1 One number Mass Flow meter with insertion sensor shall be installed in the compressed air line for air mass flow measurement and evaluation system. The locations for measurement of the air flow shall be (a) After the after-cooler for each air compressors so that performance of each air compressors can be ascertained. (b) At the inlet of each of the air dryers to ascertain the air flow through the air dryers. 6.21.2 The Mass Flow meter should be complete in the scope of supply to ensure easy operation and monitoring. The major processes and scope of the Flow Meter should be (a) The evaluation unit should be one only and should be portable with the retractable probe unit. (b) The ball valve retractor assembly in stainless steel shall be installed at all the locations where the measurements are to be taken. (c) The probe should be available with the facility to be inserted or removed under pressurized condition.		

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(d) The evaluation unit enclosure housing should be IP 65. (e) The pipeline shall be minimum 10 D upstream and 5D downstream area. (f) It should be suitable for adequate pipeline size. (g) A portable aluminum case with necessary tools for the measurement system shall be provided. 6.22 Automatic Drain Valve (a) Type : No air loss, electronically controlled version. (b) Operation : Continuous (c) Air flow : Minimum 60 m³/minute (free air delivery) (d) Air pressure : 8.5 bar (g) (e) Ambient temperature : 50^o C (maximum) (f) Maximum pressure : 16 bar (g) (g) Drain connection : 1 inch from back side (h) Power supply : 230 V/single phase/50 Hz 7.0 <u>INSTRUMENTATION & CONTROL</u> 7.1 <u>INSTRUMENTATION</u> Please refer to VOLUME-V.		

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7.2 7.2.1	<u>CONTROL CONCEPT OF COMPRESSORS</u> 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: (a) Continuous run load - unload control. (b) 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-V. <u>7.3 INTERFACING WITH PLANT DCS</u> There shall be one common PLC based control panel for compressors and driers. The common panel shall be located in the compressor room. One (1) operating cum programming station with 24" TFT monitor and printer shall be provided with this common panel. All individual compressors and drier local panels shall be hardwired interfaced with this common PLC panel. Required Hardware/soft link interface between common PLC panel and DCS is foreseen for remote operation, monitoring and alarm. Air conditioner (split type) of suitable capacity with standby arrangement shall be provided to PLC based control panel room. <u>7.4 ANNUNCIATION SYSTEM</u> Annunciation shall be provided for following conditions for the compressed air system : (a) Compressor motor tripped	

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(b) Lub oil pressure - low (c) Air temperature at inlet of after cooler-high (d) Air temperature at outlet of after cooler-high (e) Air temperature at outlet of inter cooler-high (f) Air Pressure in receiver-high and low (g) Cooling water flow to compressor – low (h) Cooling water pressure - low (i) Bearing and winding temperature of compressor motor - high and very high (j) Air pressure after cooler - high (k) Compressor discharge pressure - high and low (l) Air pressure low (common for a group of compressors) (m) Cylinder jacket cooling water outlet temperature - high (n) Lub Oil temperature - high (o) Any other annunciation as may be necessary for safe and trouble free operation of the system. 7.5 <u>INTERLOCK</u> 7.5.1 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		

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(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) Stand by compressor shall start on auto mode when running compressor trips or on low preset air header pressure. The compressor (standby) shall stop automatically if it runs for half an hour in unloaded condition. (g) Any other interlock as required for safe and reliable operation of the system. (h) Compressor shall have auto/manual mode of selection. (i) The compressor shall trip by operating local lock-out switch or when any motor protection device is operated. (j) The compressor shall be started in unloaded condition as the loading /unloading solenoid valve is kept in de-energized condition through a timer. As soon as the compressor motor reaches its full speed, the timer shall switch on the loading/unloading control circuit. Depending upon the requirement of header pressure, the pressure switch shall energize/de-energize the compressor loading/unloading solenoid valves & in-turn the compressor shall load the receiver or run in unloaded condition. 7.5.2 All pressure and temperature conditions used for tripping the compressor shall be provided with pre-trip annunciation in the local control panel 7.6 <u>PERFORMANCE GUARANTEE</u> 7.6.1 The Bidder shall guarantee that the equipment offered shall meet the ratings and performance requirements stipulated for various equipment covered in this specification. All compressor units and accessories shall be guaranteed to operate without pulsation, noise or vibration while operating in isolation as well as in parallel with other compressor.		

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7.6.2 All compressor unit and accessories shall be guaranteed for capacity, pressure and power consumption for specified capacity and pressure either in isolation or during parallel operation. 7.6.3 Drying plant capacity shall be guaranteed for the dew point of minus (-) 20 °C at atmospheric pressure at the dryer outlet as specified in data specification sheet. 8.0 <u>DRAWINGS, DATA, INFORMATION & MANUALS</u> 8.1 For Drawing, Data and Information required along with BID, please refer Volume VIII.		

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<u>DATA SHEET-A</u> <u>SCREW TYPE AIR COMPRESSOR AND AUXILIARIES</u>			
<u>SR. NO.</u>	<u>ITEM</u>		
1.0	<u>PERFORMANCE DATA</u>		
1.1	Free Air Delivery	:	Bidder to compute and indicate as per guidelines specified in this section.
1.2	Discharge Pressure	:	As per relevant clause
1.3	Noise level near compressors	:	As per Volume -II
1.4	Vibration limit (measured at top and bottom of main bearing)	:	40 microns
1.5	Guaranteed Power consumption at motor input terminals at rated condition	:	Bidder to indicate
2.0	<u>CONSTRUCTION FEATURES</u>		
2.1	Location	:	Indoor
2.2	Number of compressors	:	Three (3) IA compressors + Three (3) SA compressors connected on a common discharge manifold.
2.3	Type	:	Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw compressors
2.4	Service	:	Instrument Air and Service Air
2.5	Duty	:	Continuous

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2.6	Type of Drive	:	Electric Motor
2.7	Design ambient temperature for drive	:	50°C
2.8	Number of starts per hour	:	8 (equally spreaded)
2.9	Type of transmission	:	Gear
2.10	Antivibration arrangement required	:	Yes
2.11	Maximum temperature for any step during the cycle	:	Bidder to indicate
2.12	Type of control	:	Dual i.e. both load-unload and auto start/ stop
2.13	Type of Annunciation	:	Audio-visual
2.14	Flange standard	:	ANSI B-16.5/equivalent
3.0	<u>MATERIALS OF CONSTRUCTION</u>		
3.1	Compressor chamber	:	Cast iron coated with corrosion resistant material
3.2	Rotors	:	Forged carbon steel coated with corrosion resistant material
3.3	Bearing	:	As per manufacturing standard (Antifriction Bearing)
3.4	Timing Gear	:	Low alloy steel
3.5	Base Plate	:	MS

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3.6	Inlet throttle valve & housing	:	Aluminium
3.7	Shaft seals	:	High Alloy Steel
3.8	Safety valves	:	Brass
3.9	Water separator	:	Cast Iron
3.10	Blow off valve	:	Stainless Steel
3.11	Unloading Cylinder header	:	Aluminium
3.12	Tube of oil cooler	:	SS-304
3.13	Outer casing of coolers	:	Carbon Steel
3.14	Gear Box	:	Cast Iron GGG 40 (DIN 1693)
3.15	Gears	:	Alloy Steel
4.0	<u>SUPPLY OF ACCESSORIES & SERVICES</u>		
4.1	Intake air filters with silencers	:	Yes
4.2	Intercoolers	:	Yes
4.3	After coolers with moisture separators	:	Yes
4.4	All instruments as specified, as shown in tender drawing and as required for safe and trouble- free operation of the system	:	Yes
4.5	Coupling guards	:	Yes
4.6	Air receivers	:	Yes
4.7	Foundation bolts, nuts, sleeves, inserts etc.	:	Yes

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4.8	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
4.9	Eye bolts, lifting tackle, tools, etc.	:	Yes
4.10	Control panels complete with all accessories	:	Yes
4.11	Instrument gauge panels complete with all accessories	:	Yes
5.0	<u>AUXILIARY COOLING WATER DATA</u>		
5.1	Quality	:	Auxiliary cooling water (Filtered Water)
5.2	Design inlet temperature	:	38°C (maximum) & 8°C (minimum)
5.3	Design pressure	:	Bidder to indicate. Shall not be less than the shut off head of ACW pump.
5.4	Normal inlet pressure	:	Bidder to indicate. Shall be equal to the rated TDH of ACW pump
5.5	pH value	:	8.5 to 9.5
5.6	Maximum pressure drop allowable between inlet and outlet points	:	6.0 to 8.0 MWC
6.0	<u>TESTING AND INSPECTION</u>		
6.1	Material Testing and identification	:	Required

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6.2	Dye Penetration test	:	Yes
6.3	Type of performance test to be conducted	:	Routine test/Type test as per relevant clause
6.4	Bend Test as per BS 5169	:	Yes
6.5	Field performance test	:	Yes
6.6	MPI and UT tests	:	Yes
6.7	Spot Radiography for all circumferential and longitudinal butt joints	:	Yes
6.8	All other specific tests as specified in relevant Clause of this section		Yes
7.0	<u>DRIVE MOTOR</u>		
7.1	Drive motor for compressor shall comply with the requirements of relevant Clause of this section and Volume IV of this Specification.	:	
8.0	<u>COMPRESSOR ACCESSORIES</u>		
8.1	<u>INTAKE AIR FILTER</u>	:	
8.1.1	Numbers required	:	One (1) with each compressor
8.1.2	Location	:	Indoor, at the suction of each air compressor
8.1.3	Type	:	Dry type
8.1.4	Silencer	:	Yes
8.1.5	Air flow rate	:	To suit compressor rating

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8.1.6	Particle removing efficiency	:	99.9% up to particle size of 3 Micron
8.1.7	Maximum allowable pressure drop at stated air flow rate in new condition of filter (viscosity of air at normal ambient temperature)	:	150 mm WG
8.1.8	Test requirement	:	No separate test. Compressor performance testing shall include the filters in test set up. Capacity, pressure drop and efficiency shall be measured.
8.2	AIR RECEIVER		
8.2.1	Numbers required	:	One (1) for each IA compressor + (1) for each SA compressor at the Compressor Outlet. Further, dedicated receivers at specified locations as per Flow diagram shall also be provided.
8.2.2	Installation	:	Outdoor
8.2.3	Type	:	Vertical cylindrical with torispherical dished ends.
8.2.4	Design pressure / Temperature	:	10.5 kg/cm ² (g) / 80° C (minimum)
8.2.5	Hydraulic test Pressure	:	150 % design pressure.
8.2.6	Design code	:	IS-2825/IS-7938/ Approved equal
8.2.7	Capacity of each air receiver	:	Bidder to compute in accordance with relevant clause of this section. However, the water filled volume shall not be less than 10 m ³ under any circumstances for receivers at

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			Compressor Outlet
8.2.8	Material of construction of shell	:	IS-2002
8.2.9	Material of construction of dished ends	:	IS-2002
8.2.10	Material of construction of flanges	:	IS-2002
8.2.11	Corrosion allowance		1.5 mm (minimum)
8.2.12	Supply of Accessories & Services	:	
8.2.13	Flanges with nuts, bolts and gaskets	:	Yes
8.2.14	Pressure gauge with snubber	:	Yes
8.2.15	Pressure switch	:	Yes
8.2.16	Temperature gauge	:	Yes
8.2.17	Relief valve	:	Yes, set pressure shall be at least 10% above working pressure
8.2.18	Trap station	:	Yes
8.2.19	Level gauge	:	Yes
8.2.20	Vent valve/plug	:	Yes
8.2.21	Supporting stand with necessary foundation bolts, nuts, sleeves etc	:	Yes
8.2.22	Eye bolts, lifting tackle etc.	:	Yes
8.2.23	Painting	:	
(a)	External	:	Two coats of red-oxide primer and two finish coats of synthetic enamel paints.

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(b)	Internal	:	Cleaned and one coat of black bituminous paint applied.
8.2.24	Inspection and Testing		
(a)	Material testing and identification	:	Yes
(b)	Bend test as per BS-5169	:	Yes
(c)	Spot radiography of circumferential and longitudinal butt welds	:	Yes
(d)	Field performance test	:	Yes
(e)	D.P. test where radiography cannot be done	:	Yes
(f)	Hydraulic Test	:	Yes
(g)	Other specific tests as specified in relevant Clause of this specification	:	Yes
8.3	<u>INTERCOOLER, AFTERCOOLER, MOISTURE SEPARATOR, PIPING, VALVES ETC:</u>		
8.3.1	After cooler :		
(a)	Installation	:	Indoor
(b)	Type	:	Shell and Tube
(c)	Relief Valve	:	Yes
(d)	Moisture Separator	:	Yes
(e)	Trap Station	:	Yes

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(f)	Temperature Indicator	:	Yes
(g)	Temperature Switch	:	Yes
(h)	Level Gauge	:	Yes
8.3.2	Intercooler :		
(a)	Installation	:	Indoor
(b)	Type	:	Shell and Tube
(c)	Relief Valve	:	Yes
(d)	Trap Station	:	Yes
(e)	Pressure Gauge	:	Yes
(f)	Temperature Indicator	:	Yes
(g)	Temperature Switch	:	Yes
(h)	Moisture Separator	:	Yes
8.3.3	Supply of Accessories and Services	:	Yes
(a)	Supporting stands with bolts, nuts and gaskets	:	Yes
(b)	Eye bolts, lifting tackle etc with tools and tackle	:	Yes
(c)	Flanged connections for supply and return of cooling water	:	Yes
8.3.4	Material of Construction :		
(a)	Tube	:	Stainless steel within star profile
(b)	Shell	:	Mild Steel

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(c)	Tube Sheet	:	IS 2002 Gr 2
(d)	Baffles	:	IS 2062
(e)	Flanges	:	IS 2062
8.3.5	Cooling Water Data	:	Same as mentioned earlier
8.3.6	Piping, Valves and Fittings for Compressed Air System :		
(a)	Pipes for cooling water line	:	IS-1239 (Heavy grade) upto 150 NB. IS-3589 for sizes above 150 NB with minimum pipe thickness of 6 mm.
(b)	Pipes for compressed air line & interconnecting air line	:	Stainless steel as per ASTM-A312 GR.304. Size – as per schedule 40S. ANSI-B36.19 up to 50 NB and as per schedule 10S. ANSI – B36.19 for sizes equal to & greater than 65 NB.
8.3.7	Fittings		
(a)	Fittings for cooling water line	:	ASTM A-234 Gr. WPB for sizing including 65 NB and above.
		:	ASTM A105 for sizes upto 50 NB.
(b)	Fittings for compressed air piping & interconnecting air piping	:	Stainless steel as per ASTM A-182 F304
(c)	Valves for air line	:	Stainless Steel
(d)	Testing and inspection	:	As per relevant clause of this section.
(e)	Valves for cooling water line	:	As per Volume III–F, Section II

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<u>DATA SHEET-A</u> <u>AIR DRYING PLANT AND AUXILIARIES</u>			
<u>SR. NO.</u>	<u>ITEM</u>		
1.0	<u>GENERAL INFORMATION</u>		
1.1	Numbers of Air drying Plant	:	Three (3) - one (1) for each IA compressor
1.2	Duty	:	Continuous
1.3	Operation	:	Fully Automatic
1.4	Service	:	Instrument Air
1.5	Version	:	Non-cyclic
1.6	Installation	:	Indoor
1.7	Type of Drying	:	Refrigerated
1.8	Refrigerant	:	R 134 a or Equivalent
1.9	Outlet dew point	:	At least (-) 20 °C at atmospheric pressure
1.10	Annunciation	:	Local and remote
1.11	Location	:	Indoor skid mounted
2.0	<u>PERFORMANCE SPECIFICATION</u>		
2.1	Air drying capacity	:	1.10 times the instrument air compressor capacity (Minimum 45 Nm ³ / min)
2.2	Pressure dew point (constant)	:	3 °C

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2.3	Inlet air pressure	:	To suit compressor rating
2.4	Air flow (Free Air delivery)	:	To suit compressor rating
2.5	Inlet air temperature	:	Suitable to handle air inlet temperature of 60 °C.
2.6	Maximum allowable air pressure drop	:	0.5 kg/cm ²
2.7	Design Requirement	:	(-) 20 °C dew point at outlet (at atmospheric pressure). Dust laden, not more than 0.1 ppm, oil free
3.0	<u>MATERIAL</u>		
3.1	Absorber vessels and its internal	:	SS-304
3.2	Regeneration air cooler shell & tube sheet	:	SA-285 Gr. C or equivalent
3.3	Relief valves	:	Brass or SS
3.4	Tube of Heat exchanger	:	SS
3.5	Refrigerant piping	:	Copper
3.6	Heat Exchanger Air Circuit	:	Aluminium
3.7	Refrigerant	:	R 134 a or Equivalent
4.0	<u>SUPPLY OF ACCEESSORIES AND SERVICES FOR EACH ADP:</u>		
4.1	Pre-filters and After Filters	:	2 x 100% with automatic drain trap filter arrangement & with ceramic candle type

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4.2	Dew point indicator on line	:	Yes
4.3	Instruments as per specification, Tender drawing and as required for safe and trouble free operation	:	Yes
4.4	Control panel with accessories	:	Yes
4.5	Tools and tackle	:	Yes
4.6	Spare parts	:	Yes
4.7	All interconnecting piping complete with fittings, valves etc.	:	Yes
4.8	Insulation	:	Yes
4.9	Base frame, foundation bolts, nuts, sleeves etc.	:	Yes
4.10	Vessel internal point	:	Anti-corrosive
4.11	<u>SHOP PAINTING</u>		
4.11.1	Internal	:	Anti-corrosive heat resistant paint
4.11.2	External	:	2 coats of red-oxide primer
5.0	<u>INSPECTION AND TESTING</u>		
5.1	Non destructive material test	:	Yes
5.2	Hydrostatic test	:	Yes
5.3	Performance tests at shop	:	Yes
5.4	Performance tests at site	:	Yes
5.5	Spot Radiography of welds parts to be tested	:	All pressure parts and vessels

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5.6	Dye Penetration test	:	Yes
6.0	<u>POWER SUPPLY</u>	:	415 V/3 phase (3 wire)/50 Hz $\pm$ 5%
6.1	Variation in supply voltage	:	$\pm$ 10%
6.2	Air flow variations	:	0 to 100%
6.3	Condensate removal	:	Automatic without air loss
6.4	Maximum operating air pressure	:	16 bar (g)
6.5	Auto drain trap	:	No air loss type

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1X660 MW BHUSAWAL TPP UNIT 6

COMPRESSED AIR SYSTEM

SECTION IA

(GENERAL TECHNICAL REQUIREMENT INCLUDING LP PIPING)



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

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1.0 <u>CODES AND STANDARDS</u> 1.1 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. 1.2 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. 1.3 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 Bidder. 1.4 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. 1.5 In case of any change of code, standards and regulations between the date of purchase order and the date the Contractor proceeds with manufacturing, the Owner shall have the option to incorporate the changed requirements. It shall be the responsibility of the Contractor to advise Owner of the resulting effect. 1.6 Successful Bidder shall furnish two (2) sets of latest of national/international codes and standards to owner.		

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2.0 <u>RESPONSIBILITY FOR DESIGN</u> 2.1 The Bidder shall assume full responsibility for the design of the whole and every part of the Plant, whether or not the design work was undertaken specifically in relation to the Contract and whether or not the Contractor was directly involved in the design work. 2.2 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 two (2) years in two different power stations. 2.3 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. 2.4 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. 2.5 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating feed back 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. 3.0 <u>NAME PLATES (RATING PLATES)</u> 3.1 Instruction plates, nameplates or labels shall be permanently attached to each main and auxiliary item of Plant in a conspicuous position. These plates shall		

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	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.	
3.2	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.	
3.3	All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.	
3.4	The size and location of nameplates shall be subject to Approval of the Engineer.	
4.0	<u>SAFETY AND SECURITY</u>	
4.1	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.	
4.2	Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.	
4.3	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.	
4.4	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	

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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.		
5.0	<u>GUARDS</u>	
5.1	Effective guards and fences must be provided to prevent injury to operators through accident or malpractice.	
5.2	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.	
5.3	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.	
5.4	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.	
5.5	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 hand hold must be provided on each side of the opening or doorway.	
6.0	<u>LOCATION AND LAYOUT REQUIREMENTS</u>	
The majority of plant and equipment shall all be of indoor installation. Layout should 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		

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given under the various equipment and system specifications as well as those stipulated in Annexure-B attached to this section. Enclosed General Layout and other tender layout drawings show the location of major installations and auxiliary buildings. The Bidder shall try to retain these locations as far as practicable. The layout of equipment within the powerhouse as shown in the tender drawings is indicative. The Bidder may, subject to Owner's approval alter the same to suit the space requirement of the equipment offered. Bidder may give as an alternative his own preferred layout clearly indicating the advantages and other implications, if any. Such alternative will not be considered for evaluating the bid, but may be considered with the successful Bidder if Owner / Engineer find the proposal more attractive in terms of techno-economic consideration. 6.1 While developing the layout of buildings the following criteria shall be given effect: 6.1.1 The minimum width of clear access corridors around equipment shall be one (1) meter. 6.1.2 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 specified. 6.1.3 The plinth level with respect to the existing grade level shall be as indicated elsewhere in this specification. Finished Grade Level (FGL) above Mean Sea Level (MSL) for the plant area, CHP area and for PWS area inside plant to be developed. Mean sea level for the plant is 210 m. 6.1.4 The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of two (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.		

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