

TELANGANA STATE POWER GENERATION CORPORATION LTD

5 X 800 MW YADADRI TPS

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

SPECIFICATION NO.: PE-TS-417-555-A001



BHARAT HEAVY ELECTRICALS LTD

**POWER SECTOR PROJECT ENGINEERING MANAGEMENT
NOIDA-INDIA**



5 X 800 MW YADADRI TPS

INDEX

SPECIFICATION NO. PE-TS-417-555-A001

REV 00

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5 X 800 MW YADADRI TPS

SECTION – I
(INTENT OF SPECIFICATION)



BHARAT HEAVY ELECTRICALS LTD
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NOIDA-INDIA



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SECTION I

REV – 00

DATE -

1.0 INTENT OF SPECIFICATION

- 1.1 The specification is intended to cover Supply part, Services part and Mandatory spares (if applicable) 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 (if applicable) 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 and carrying out Performance guarantee / Functional / Demonstration tests at site (As applicable), training of customer/client O&M staff (if applicable) 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 TSGENCO.

5 X 800 MW YADADRI TPS

SECTION – I

(PROJECT INFORMATION)



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

YADADRI THERMAL POWER STATION

PROJECT INFORMATION

1	Name of the Project	YADADRI Thermal Power Station
2	Station Capacity	5X800 MW (Coal based)
3	Owner	Telangana State Power Generation Corporation Limited (TSGENCO)
4	Site Location	Site is located 7 km from the NH5.
5	Latitude	16° 42'20.40 N
6	Longitude	79° 34'41.56 E
7	Nearest Town	30 Km Miryalaguda
8	Nearest Railway Station	6.5 Km Damercherla
9	Nearest Airport	130 Kms (Vijayawada)
10	Site Conditions	
	Ambient Temperature	
	Daily minimum (average)	10°C
	Daily maximum (average)	47°C
	Design Ambient Temperature	50°C
	Ambient temperature (performance)	38°C
	Relative Humidity for design / efficiency	48-84 %
	Annual rainfall, mm	600 mm
	Plant Elevation above MSL	85 m above MSL
	Wind Pressure	As per the latest revision of IS 875/1987

TELANGANA STATE POWER GENERATION CORPORATION LIMITED

From
Chief Engineer/Civil/ Thermal
TSGENCO, Vidyut Soudha,
Hyderabad – 500082

To
✓ The Dy.General Manager,
M/s.BHEL Camp Office,
Vidyut Soudha,
Khairtabad,
Hyderabad – 500082

Lr.No.CE/C/Thermal/KTPSD/E1/F.YTPS-M/s.BHEL/D.No. 247 /2015-16,Dt. 29.08.2015

Sir,

Sub:- YTPS – 5x800MW- Wind load & Seismic zone details - Reg

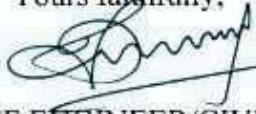
Ref: email: dated.11.08.2015 from M/s.BHEL.

...

With reference to the email cited,the details of wind load & seismic zone pertaining to proposed Yadradri Thermal Power Station (5x800MW) are herewith furnished for taking further action.

Wind load		Seismic zone	
Wind Speed	Terrain category	Seismic zone	Type of soil
44m/Sec	Category-2	Zone-III as per IS 1893:2002	Type of soil may be confirmed at your end after conducting soil investigation in the plant area.

Yours faithfully,


CHIEF ENGINEER/CIVIL/THERMAL

Copy to the:

Chief Engineer/TPC/TSGENCO/Vidyut Soudha/Hyderabad,
A.S to Director/Projects/ TSGENCO/Vidyut Soudha/Hyderabad
M/s.DESEIN Private Limited, 102, First floor, My Home Sarovar Plaza, Secretariat Road,
Hyderabad-500063.

जलवायवी सारणी

CLIMATOLOGICAL TABLE

BACK

स्टेशन : नलगोंदा
STATION : Nalgonda

अक्षांश
LAT. 17°03'

देशांतर
LONG. 79°16'

समुद्री तल माध्य से ऊंचाई
HEIGHT ABOVE M.S.L. 227 METRES

प्रक्षेपों पर आधारित
BASED ON OBSERVATIONS 1975-2000

BASED ON OBSERVATIONS 1975-2000									
HEIGHT ABOVE M.S.L. 227 METRES									
LONG. 79°16'									
LAT. 17°03'									
वायु तापमान									
चरम									
आर्द्रता									
मेघ की मात्रा									
सामरिक योग									
वर्षा के दिनों की संख्या									
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CLIMATOLOGICAL TABLE

स्टेशन : नलगाँवा
STATION : Nalgonda

मौसम परिघटना										पवन										मेघ										दृश्यता																			
के साथ दिनों की संख्या										पवन की दिशा के दिनों की संख्या का प्रतिशत										मेघ मात्रा (सभी मेघ) सहित दिनों की संख्या - अष्टमांश										निम्न स्तरी मेघ मात्रा सहित दिनों की संख्या - अष्टमांश										दृश्यता सहित दिनों की संख्या									
वर्षाण मि.मि.या अधिक	ओले	गर्जन	कुहरा	आंधी	धूल	चंद्र परी	अधिक	20- 61	1- 19	0	3	उप	पूर	दक्षि	द	प	उप	गर्जन	0	ले-2	3-5	6-7	8	0	ले-2	3-5	6-7	8	कुहरा	1	कि.मी. प्रति	1-4 कि.मी.	4-10 कि.मी.	10-20 कि.मी.	20 से अधिक														
No. OF DAYS WITH WEATHER PHENOMENA										PERCENTAGE No. OF DAYS WIND FROM										No. OF DAYS WITH CLOUD AMOUNT (ALL CLOUDS) O K T A S										No. OF DAYS WITH LOW CLOUD AMOUNT O K T A S										No. OF DAYS WITH VISIBILITY									
PFT 0.3 mm Or more	MAIL	THUN DER	FOG	DUST STORM	SQU ALL	SOU ALL	52 more	20-61	1-19	0	N	NE	E	SE	S	SW	W	NW	CALM	0	T-2	3-5	6-7	8	0	T-2	3-5	6-7	8	FOG 8	LP TO 1 Km	10-20 Kms	20 Kms	OVER Kms															
जनवरी JAN	0.5	0.0	0.0	0.0	0.0	0.0	0	0	29	2	0	30	3	39	3	4	0	11	10	25	0	2	1	3	0	25	0	2	1	3	0	0.6	6.7	21.3	2.3	0.1													
फरवरी FEB	0.6	0.0	0.0	0.0	0.0	0.0	0	0	28	0	1	26	1	55	3	5	0	7	2	18	1	3	2	4	21	1	2	1	3	0	0.1	7.8	18.0	1.7	0.5														
मार्च MAR	0.7	0.0	0.1	0.0	0.0	0.0	0	1	30	0	1	25	1	55	3	5	0	9	1	23	2	3	1	2	25	1	3	1	1	0	0.0	3.8	24.1	2.9	0.3														
अप्रैल APR	1.1	0.0	0.0	0.0	0.0	0.0	0	0	29	1	0	20	1	46	4	18	0	8	3	20	2	4	2	2	21	1	4	2	2	0	0.0	3.0	21.5	4.3	1.1														
मई MAY	1.8	0.0	0.0	0.0	0.0	0.0	0	0	31	0	1	14	0	27	3	21	3	30	1	19	2	5	2	3	21	2	4	1	3	0	0.0	3.1	22.5	3.4	1.9														
जून JUN	4.5	0.0	0.0	0.0	0.0	0.0	0	1	29	0	1	2	0	6	0	36	8	47	0	5	1	5	4	15	7	1	4	3	15	0	0.0	4.7	20.2	3.1	2.0														
जुलाई JUL	7.1	0.0	0.1	0.0	0.0	0.0	0	1	30	0	1	1	0	1	0	43	10	44	0	2	1	3	5	20	4	1	2	3	21	0	0.0	4.3	23.1	1.9	1.6														
अगस्त AUG	7.7	0.0	0.0	0.0	0.0	0.0	0	0	31	0	0	3	0	3	0	40	9	43	2	1	0	3	4	23	1	1	3	4	22	0	0.0	1.7	4.7	22.4	2.2														
सितम्बर SEP	6.6	0.0	0.0	0.0	0.0	0.0	0	0	29	1	1	6	0	11	1	29	4	42	6	4	1	6	4	15	5	1	4	3	17	0	0.0	3.2	20.9	3.6	2.3														
अक्टूबर OCT	3.9	0.0	0.0	0.0	0.0	0.0	0	0	30	1	2	37	6	26	1	7	2	12	7	18	1	5	2	5	21	0	3	2	5	0	0.1	3.7	22.4	3.8	1.1														
नवम्बर NOV	3.3	0.0	0.0	0.0	0.0	0.0	0	0	26	4	3	33	7	18	2	4	0	19	14	16	1	4	3	6	21	1	2	2	4	0	0.0	8.8	17.8	2.9	0.4														
दिसम्बर DEC	0.4	0.0	0.0	0.0	0.0	0.0	0	0	29	2	3	46	3	22	1	2	1	14	8	21	1	4	1	4	23	1	3	1	3	0	0.1	6.8	20.8	3.3	0.0														
वार्षिक योग या माध्य ANNUAL TOTAL OR MEAN	33.3	0.0	0.1	0.0	0.0	0.0	1	5	346	13	1	19	2	24	2	18	3	26	5	205	13	46	29	70	238	11	37	22	57	0	0.8	60.1	255.4	35.6	13.0														
वार्षिक सं NUMBER OF YEARS																																																	

5 X 800 MW YADADRI TPS

SECTION - IA

SPECIFIC TECHNICAL REQUIREMENT – MECHANICAL



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

	TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM 5 x 800 MW YADADRI TPS	SPECIFICATION NO. PE-TS-417-555-A001	
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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 10 Nos.(5 W+5 S) Compressors (Oil Free Screw type, common for Instrument Air and service air) each of minimum 55 NM³/Min capacity at 8.5 Kg/sqcm (g) (min) discharge pressure, suction filter with silencer, inter cooler and after cooler with moisture separators, automatic drain traps, instruments, control system and other accessories. Electric motor for compressors are excluded from bidder's scope. **Two compressor house at different locations has been envisaged for the project (refer layout drawing). 4 nos. (2W+2S) compressors are located at house #1 while 6 Nos. (3W+3S) compressors are located at compressor house #2**
 - 1.1.2 10 Nos. (5 W+5 S) Air Drying Plants Refrigerant Type of min. 61 NM³/min. capacity connected to above compressors with all instruments, control panels and other accessories as specified.
 - 1.1.3 10 Nos. Air Receivers (4 nos adjacent to compressor house#1 & 6 nos adjacent to compressor house #2) of minimum 15 (Fifteen) Cu.M capacity each with instruments, relief valve, drain connection with automatic trap stations and other accessories as specified.
 - 1.1.4 10 Nos. Electronic Dew point meters.
 - 1.1.5 Bidder to note that RTD/BTD of HT motor of air compressor shall be terminated to temperature scanner (one for each compressor to be provided by bidder) mounted on compressor itself. Signals of RTD/BTD shall be communicated to micro-processor based compressor panel through this temperature scanner (by bidder). Interlocks and protection for RTD/BTD of compressor motor has to be provided from compressor panel itself (By bidder).
 - 1.1.6 Bidder to provide necessary pad of for mounting of sensors and key phasor slot for each motor & Compressor Driven and Non Driven end in each X & Y direction. Dimension for the same shall be finalized during detail engineering.
 - 1.1.7 Pipes for compressed air line & interconnecting air line shall be of stainless steel as per ASTM- A312 GR. 304. Size shall be as per schedule 40 S ANSI B 36.19 for sizes up to 50 mm NB and as per schedule 10 S, ANSI B 36.19 for sizes equal to & greater than 65 mm NB. Fittings for air piping shall be of stainless steel as per ASTM A-182 F 304. Cooling water piping will be M.S. conforming to IS: 1239 (Part-I) (Heavy Grade) up to 150 NB and IS 3589 for sizes above 150 NB with minimum pipe thickness of 6 mm . Fittings for cooling water line ASTM A-234 Gr. WPB for sizing including 65 mm NB and above and ASTM A 105 for size up to 50 NB. 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 shall be provided by bidder .
 - 1.1.8 All airline valves shall be ball valve type. Valves material for airline shall be stainless steel and shall be as per BS-5351. Valve shall be forged body up to 50 mm NB and cast body above that. Valve size 65 NB and above with flanged end, valve size 50 NB and below with screwed. For water service, cast iron valves with GM internals as per relevant IS/equivalent and other applicable standards above 50 mm size and forged body up to 50mm NB.

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1.1.9

Bidder to provide dual redundancy for alarm/annunciation and triple redundancy for trip/shutdown within the compressor and dryer skid. In case, additional set of instruments is not possible to accommodate within skid due to space constrain, the same shall be supplied as loose items.

1.1.10

Factory check for loose controllers for air compressors (to be supplied with compressed air system package) shall be witnessed by BHEL/TSGENCO for logic and software.

1.1.11

Vortex type flow meter at the outlet of instrument and service air distribution header.(refer P&ID of compressed air system ,Annexure-IV of technical specification).

1.1.12

Field instruments as specified, all instruments necessary for performance testing of compressors as well as air drying plants.

1.1.13

Control and Instrumentation – Individual compressor control shall be through compressor mounted microprocessor based control panel. Each compressor shall be interfaced with DCS through gateway / convertor for start, stop, load and unload from common control room (CCR) including giving input for developing software at DCS (by BHEL EDN) and hardware link for status monitoring, start/stop, load/unload from CCR. Individual compressor control shall be through redundant microprocessor based control system. If manufacturer unable to provide redundant microprocessor control, then only microcontrollers shall be supplied as loose items.

1.1.14

Any type of special cable as per electrical scope sheet given under electrical portion of specification.

1.1.15

Maintenance tools and tackles, start up and commissioning spares, consumables, first fill of lubricants inclusive of packing – Lot

1.1.16

All HT motors which 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.

1.1.17

Any other item not included above or in specification but required for Compressed Air System.

1.1.17.1

The maximum velocity to be considered in compressed air shall be limited to 20 to 30 m/s for pipe size up to 50 NB and shall be limited to 25 to 40m/s for pipe size above 50 NB (under Average pr. & Temp. Conditions).

1.1.18

Civil works:-Minor dressings of foundation blocks, grouting of equipments, supply and fixing of supports etc. on walls, foundations; floor and trenches will be done by successful bidder.

1.1.19

Quality Plans attached in different sections of this specification are indicating minimum requirements for inspection and testing. Bidder shall note that quality plan is subject to Customer & BHEL approval during detail engineering stage. All the comments by BHEL/customer shall be complied by successful bidder without any commercial & delivery implication to BHEL.

2.0

TERMINAL POINTS :

2.1

Bidder will terminate compressed air piping at common IA header and common SA header downstream of air receiver near compressor house #1 and compressor house #2 as per enclosed tender drawing (section – IA, ANNEXURE-IV) .

2.2

250NB Cooling water supply pipeline connections for both the compressor houses will be provided by the purchaser outside the compressor house (at 5.0 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.

	TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM 5 x 800 MW YADADRI TPS	SPECIFICATION NO. PE-TS-417-555-A001	
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3.0

EXCLUSIONS:

3.1

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

3.2

Civil works including construction of compressor house, foundation of all compressor, air dryer and Air receiver, pipe / cable trenches. However Civil works such as opening in wall, grouting of equipments & structural material and insert plates for pipe support etc. are in bidder scope of supply.

3.3

Lighting and ventilation of compressor house.

3.4

HT motor for all compressors.

3.5

Monorail hoists/Cranes as necessary for handling of equipment after erection.

3.6

Vibration monitoring system. However, there shall be provision for VMS sensors on DE & NDE bearings of motors and fans/pumps/compressors. Each bearing shall have two vibration sensor, one in X direction and other in Y direction along with key phasor for online vibration monitoring and analysis.

4.0

SUB-VENDOR ITEMS

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

5.0

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-III**. Any documents other than those indicated in Volume III will not be reviewed and will not form part of contract.

6.0

DRAWINGS/ DOCUMENTS REQUIRED DURING DETAIL ENGINEERING

Tentative list of drawing / document required during detail engineering is attached in **ANNEXURE-III**. Any other drawings and documents as required by BHEL / Customer / Consultant shall be furnished by the successful bidder during detail engineering stage for which no commercial implication shall be entertained by BHEL.

7.0

DRAWINGS DISTRIBUTION SCHEDULE

Tentative drawings/docs distribution schedule is attached under **ANNEXURE-II**. Bidder to follow the same. However, exact no. of drwgs/docs desired shall be informed to successful bidder during detailed engineering stage.

8.0

DRAWINGS ENCLOSED WITH THE SPECIFICATION

Following drawings enclosed under **ANNEXURE-IV**, will form part of the specification.

1) Plot plan (PE-DG-STD-100-M001)

2) P&I Diagram for compressed air system (PE-DG-417-555-A003).

3) Compressor house layout (PE-DG-417-555-A001).

The P&I diagrams 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.

9.0

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.

10.0

OTHER REQUIREMENTS

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- 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 (refer **SECTION-IIA** also):
 - 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:
 - 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.

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- Bidder to note that during detail engineering, will 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
 - 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 under 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.

11.0

ADDITIONAL POINTS TO BE NOTED BY BIDDER

11.1

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

11.2

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

11.2.1

Design Inlet conditions for Compressor

- a) Temp : 50
- b) Relative humidity : 90
- c) Altitude : 85

11.3

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

11.4

All drawings and documents shall be computer based.

	TECHNICAL SPECIFICATION FOR COMPRESSED AIR SYSTEM 5 x 800 MW YADADRI TPS	SPECIFICATION NO. PE-TS-417-555-A001	
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11.5 All commissioning spares & consumables for trouble free operation shall be provided, with minimum to what specified elsewhere in the specification.

11.6 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.

11.7 Grouting of equipment's, like Air receiver, Air dryer & foundation bolts etc. are in the scope of the bidder.

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

11.9 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.

11.10 Compressor and air dryer shall be designed for cooling water (passivated DM water) with inlet temp of 36 deg C (max.) with terminal pressure 06 kg/sqcm (g) and rise in temp shall be limited to 10 degC and pressure drop across Compressed Air System within terminal point shall be limited to 6 to 8 MWC. However, Compressors and dryers coolers shall be designed to withstand 12 kg/cm² i.e., shutoff head of BHEL DM cooling water pumps. **Quantity of cooling water for cooling of air compressors & air dryers shall be limited to 140 m3/hr for compressor house #1 and 210 m3/hr for compressor house # 2(max.) for all working drives.** Accordingly the coolers for air compressors and driers shall designed taking the above factors into consideration.

11.11 Bidder to note that the cooling water pipe size has been decided considering cooling water requirement for Compressed air system & additional cooling water requirement of 60 M3/hr for compressor house #1 & additional cooling water requirement of 90 M3/Hr for compressor house #2 for MRS compressors. Also, bidder to provide 250 NB isolation valves (globe type) both for cooling water supply & cooling water return line for both the compressor house. Further, bidder to note that terminal point for these tapping shall be provided 5 m from compressor houses at end closer to pipe rack/pedestal.

11.12 Height of Air receivers shall be limited to 5M for all air receivers except unit air receiver. The height of unit air receiver shall be limited to 4M.

11.13 The layout of compressor house #1 & compressor house #2 building has been attached under **ANNEXURE-IV**. Compressor house is a pre-engineered building (refer layout of compressor house #1 & compressor house #2 for dimensions). All the equipment shall be accommodated inside this space only. The said layout shall be considered by successful bidder while preparing the compressor house layout during detailed engineering stage.

5 X 800 MW YADADRI TPS

SECTION - IA

PROJECT SPECIFIC REQUIREMENTS



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

SECTION-I
TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

CONTENTS

CLAUSE NO.	DESCRIPTION
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2.00.00	GENERAL INFORMATION
3.00.00	SYSTEM DESCRIPTION
4.00.00	CODES AND STANDARDS
5.00.00	SPECIFIC DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS
6.00.00	SCOPE OF SUPPLY AND WORKS
7.00.00	DESIGN AND CONSTRUCTION
8.00.00	CONTROL & INSTRUMENTATION
9.00.00	INSPECTION AND TESTING
10.00.00	PERFORMANCE GUARANTEES
11.00.00	DRAWINGS/DOCUMENTS, DATA AND INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH THE TECHNICAL OFFER
12.00.00	DRAWINGS/DOCUMENTS, DATA AND MANUALS TO BE FURNISHED AFTER AWARD OF CONTRACT

ATTACHMENTS

ANNEXURE-A	SCREW TYPE AIR COMPRESSOR AND AUXILIARIES
ANNEXURE-B	AIR DRYING PLANT AND AUXILIARIES

SECTION-I
TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM

1.00.00 INTENT OF SPECIFICATION

1.01.00 This specification is intended to cover the Design, Engineering, Manufacture, Fabrication, Assembly, Inspection, Testing at Manufacture's works, Packing, Transportation, Delivery, Receipt, Unloading, Storage and handling at site, supervision of Erection, Testing, Commissioning and Field Acceptance/ Performance Guarantee test of compressed air plant consisting of air compressors, receivers and air drier units with all associated accessories and auxiliaries as specified herein after and as required for safe trouble free operation and maintenance

1.02.00 It 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 up to the vendor's guarantee in a manner acceptable to the purchaser, who will interpret the meaning of drawings and specifications and shall be entitled to reject any work of material which in his judgment is not in full accordance therewith.

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

- i) Turbine Generator (TG) and Auxiliaries.
- ii) Steam Generator (SG) and Auxiliaries.
- iii) Water Treatment area.
- iv) Various pump house area
- v) Coal Handling Plant
- vi) Laboratory
- vii) Plant I & C area

2.00.00 GENERAL INFORMATION

2.01.01 The compressed air plant (Compressors and Air Dryers) shall be located in 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 technical requirements of electrical equipment and accessories relevant sections of the Electrical Specification, Volume-V shall be referred.

4.00.00 **CODES AND STANDARDS**

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

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

5.00.00 **SPECIFIC DESIGN CRITERIA AND PERFORMANCE REQUIREMENTS**

5.01.00 The Compressed Air System shall ensure a reliable supply of adequate quantity and quality of oil free dry air on continuous and intermittent basis

5.02.00 The normal pressure of Instrument Air supply at the outlet of Air Dryer shall be 8.0 Kg/Sq.cm (g). Corresponding to the normal pressure at the outlet of dryer, the rated discharge pressure of IA compressor shall be worked out by the Bidder, 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/sq.cm (g) at the outlet of aftercooler, 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.

5.03.00 The total Instrument Air requirements for 1 x 800 MW Unit shall be assessed by the following guideline:

$Z = (A+B+C+D+E+F) \times [1 + (mw+ml)/100]$ Where,

Z = Total Instrument Air requirement of 1 x 800 MW unit.

A = Instrument Air requirement for SG & auxiliaries.

B = Instrument Air requirement for TG & auxiliaries.

C = Instrument Air requirement for Water and effluent treatment Plant.

D = Instrument Air requirement for Ash Handling Plant.

E = Instrument Air requirement for Laboratory.

F = Plant C&I requirement.

mw = Wear & tear margin = 10%

ml = Leakage margin = 10%

The free air delivery capacity of each Instrument Air Compressor shall be equal to the one-half of the value Z as obtained or 25 NM³/Min., whichever is higher.

The total Service Air Requirement for 1 x 800 MW Unit shall be assessed by considering the following guideline:

- Y = (G+H+J+K+L+M) x [1+ (mw+ml)/100] Where,
- Y = Total service air requirement for 1x800 MW unit.
- G = Service Air requirement for SG & auxiliaries.
- H = Service Air requirement for TG & auxiliaries.
- J = Service Air requirement for Coal Handling Plant.
- K = Service Air requirement for Ash handling Plant.
- L = Service Air requirement for Various Pump Houses.
- M = Service Air requirement for Water and Effluent treatment Plant.
- mw = Wear & tear margin = 10%
- ml = Leakage margin = 10%

Each Service Air Compressor shall have free air delivery capacity identical to that of each IA compressor but in no case less than the one-half of the value Y as computed above.

5.04.00 VOID

5.05.00 VOID

5.06.00 VOID

5.07.00 VOID

- 5.08.00 Equipment operating on Instrument Air and Service Air System shall be designed for a pressure range of 5.5 Kg/cm² (g) to 120% of rated discharge pressure of each air compressor, as computed in accordance with clause no. 5.02.00 above.
- 5.09.00 The delivered compressed air shall not contain any trace of oil, grease or any other impurities. Size of particles in the delivered air shall not exceed 1 Microns.
- 5.10.00 Compressed air system equipment requiring DMCW cooling water shall be capable of operation at design capacity with cooling water inlet temperature subject to a maximum of 36°C in DMCW system. The above equipment shall also be capable to withstand a pressure not less than the shut off head of each DMCW pump.
- 5.11.00 The temperature of air at outlet from after cooler shall not exceed 6°C above the cooling water inlet temperature.
- 5.12.00 Air Compressors shall be identical and shall be designed for continuous operation with high efficiency to satisfy the performance requirements as specified in Annexure-A enclosed with this section.
- 5.13.00 The power rating of the driver shall be selected such that a minimum margin as per the specification of electric motors, is available over the power required to deliver rated capacity against rated discharge pressure. When the driver is not directly coupled to the compressor, due account should be made for losses in power transmission, in addition to the above margin.
- 5.14.00 As more than one (1) compressor with drive is specified, satisfactory operation in parallel shall be ensured without any uneven load sharing, undue vibration, Keeping noise level within permissible limits for a number of compressors working simultaneously.
- 5.15.00 Each Air Receiver shall be so sized that even in the event of total stoppage of air inflow to the same, the pressure in the Air Receiver shall not fall below 6.5 kg/cm² absolute 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:

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

V_{AR} = Volume of each Air Receiver in M³.

T = Bleed down time in minutes, shall be taken as 2 minutes

(minimum)

- P_A = Atmospheric pressure, shall be taken as 1 Kg/Sq.cm (absolute).
- P_{MAX} = Maximum system pressure in Kg/Sq.cm absolute, shall be taken as 110 percent of rated compressor delivery pressure.
- P_{MIN} = Minimum system pressure in Kg/Sq.cm absolute, shall be taken as 6.5 Kg/Sq.cm absolute.
- C = Free air delivery capacity of each Air compressor for IA system or free air delivery capacity of each SA compressor for SA system, M^3 .
- E = 1.15, considering 15 percent minimum margin to account for peak requirements.

The water filled volume of each Air Receiver shall be calculated in accordance with the guidelines specified above.

- 5.16.00 The drying capacity of each Air Drying Plant (ADP) shall be provided to match the corresponding capacity of each IA compressor.
- 5.17.00 The air drying plants receiving compressed air saturated with moisture shall be capable of operating continuously to provide reliable moisture free compressed air. Dew point of the outlet air measured at the stated operating pressure shall be as mentioned in Annexure-B or lower throughout the operation. For calculating moisture load, relative humidity and dry bulb temperature at ADP inlet shall be taken as 95% & 34°C respectively.
- 5.18.00 The drying process shall employ Refrigerant type air drying unit to remove moisture from air. The air drying plant shall be considered to remove the moisture and dry air to following quality:
- a) Dew point at atmospheric pressure (-) 20 degree.
 - b) Oil content 0.01 ppm (maximum tolerable) or oil free.
 - c) Dust – Practically dust free but maximum particle size 1 micron.
- Air quality after air drying plant shall be in accordance with above stipulations or as per ISA – S7.3 (Instrument society of America) quality standards for instrument air, whichever is stringent.
- 5.19.00 Driers shall be suitable for part load operation while maintaining the outlet air dew point as specified above. Necessary instruments and controls shall be provided to ensure that the specified dew point is maintained irrespective of input variations.
- 5.20.00 The contractor shall assume full responsibility in the operation of the air drying plant as a whole.
- 5.21.00 For the air drying capacity and all other relevant details pertaining to Air
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	Drying Plant, Annexure-B shall be referred to.
6.00.00	SCOPE OF SUPPLY AND WORKS
6.01.00	Scope of Supply The detailed scope of supply under this section shall be as below and as indicated in relevant tender drawings. Items not specifically mentioned but deemed necessary to make the system completely reliable and efficient shall also be included.
6.01.01	
	Each Air Compressor shall be complete with Intake Air filter cum Silencer, Intercooler, after cooler, Moisture Separator, interconnecting piping, valves, drive motors, instruments and all other accessories.
6.01.02	Skid mounted redundant proprietary microprocessor based controllers will be provided with individual compressors. These individual controllers shall be hooked upto plant DDCMIS RTU. Air dryer logics shall be implemented in DDCMIS RTU.
6.01.03	All Cooling water piping, control air and interconnecting air piping, valves, supports and hangers, instruments as indicated in tender drawings and as required for smooth, reliable and efficient functioning of the system.
6.01.04	One (1) no. air drying plant for each compressor shall be provided by the Bidder. Each air drying plant shall be complete with the following accessories: a) Air inlet strainer. b) Air to air heat exchanger (pre-cooler). c) Air to refrigerant heat exchanger (evaporator). d) One (1) moisture separator with auto drain trap. e) Refrigerant condensing unit complete with one (1) hermitically sealed compressor, one (1) compressor drive motor, one (1) water cooled condenser, refrigerant circuit access connection, refrigerant distributor, high and low pressure cut-out switches, interconnecting pipes, valves, fittings as required, liquid and suction line, one (1) filter dryer, one (1) sight glass with moisture indicator, safety valves or any other pressure relief devices. f) One (1) automatic expansion valve in refrigerant line. g) All inter-connecting/integral piping, valves trap stations with by-pass valves at drains, fittings, flanges, gaskets, etc.

	h)	Instrument and controls.
	i)	Interconnecting wiring.
	j)	One (1) dew point indicator.
6.01.05		Supporting structures, base plates, support plates, foundation/ anchor bolts, nuts, sleeves, inserts, lifting lugs, eye bolts, etc. as needed for efficient installation and handling of equipment.
7.00.00		DESIGN AND CONSTRUCTION
7.01.00		The Compressors shall be designed to deliver the nominal capacity at the required delivery pressure as mentioned in Annexure-A of this section.
7.02.00		The design shall be such as to ensure trouble free operation with least vibration and noise. Suitable acoustical treatment will be provided to ensure the noise level within permissible limits as specified in Vol-IIA. Different parts of the compressor and accessories shall be arranged neatly in a compact manner. Due consideration shall be given for easy accessibility and maintenance of the compressors.
7.03.00		The compressors shall be non lubricated, oil free, horizontal, multi-stage water cooled, electric motor driven screw type, heavy duty and rugged construction. Their speed shall be so selected as to result in low maintenance and trouble-free operation under specified conditions.
7.04.00		Unless inconsistent with this section, equipment from the standard range of manufacture of the Bidder shall be preferred.
7.05.00		Compressor components shall be interchangeable as far as possible. Material of construction shall be suitable for the service.
7.06.00		Design capacity, outlet pressure and the material of construction for various parts of the compressor and accessories shall be as specified in Annexure-A enclosed with this section.
7.07.00		Compressor casing, rotor and shaft
7.07.01		Compression chamber wall thickness shall be such that to withstand maximum design pressure.
7.07.02		During maintenance of compressor suitable arrangement for cleaning of the cooling water jackets shall be provided.
7.07.03		Dynamically balanced, one-piece Rotor construction with a symmetric profile

to keep leakage loss to a minimum and ensure high efficiency.

- 7.07.04 Rotor shaft mounted, highly precise timing gears shall be designed to counter the axial forces incurred in compression.
 - 7.07.05 The rotor and shaft shall be of single piece construction, made of forged steel with suitable corrosion resistant coated material to minimize leakage and wear (AISI C1141 or equivalent). The stator (casing) shall be of Cast-Iron Construction with corrosion resistant material and with integral jacket cooling.
 - 7.07.06 The shaft sealing and retainers shall be free for radial self-adjustment on the rotor shafts.
 - 7.07.07 The seal rings and retainers shall be of stainless steel construction. The seals shall prevent air and oil leakage along the shaft. Air vented from second stage discharge end seals shall provide buffer air to the other seals to prevent migration of oil towards the compression chamber under all operating conditions.
 - 7.07.08 The gaskets shall be of asbestos free material.
 - 7.07.09 Use of Oil lubricated anti friction type bearings to be at least 8000 running hours.
 - 7.08.00 **Lubrication System**
 - 7.08.01 The compressor package shall include a lubricant management system which shall lubricate the bearings and seal. By the design, the compressor chamber (screw rotor housing) is totally separated from bearing / gear chamber.
 - 7.08.02 The lubricant pump shall be shaft driven. An auxiliary motor driven pump shall be provided if required by the manufacturer to supply pre-start and shut down system. All lube oil pumps shall be of rotary positive displacement type, having stainless steel rotors and steel casing. The pump discharge system will be protected by a relief valve.
 - 7.08.03 The heat exchanger for lube oil cooler shall be water cooled. The heat exchanger shall be located within the enclosed compressor skid.
 - 7.08.04 The fouling factor shall be considered as per the recommendation of TEMA.
 - 7.08.05 The lube oil cooler shall be designed for a heat duty corresponding to the peak power demand of the compressors.
 - 7.08.06 The cooler shall be designed in accordance with the requirement of IS-2825.
 - 7.08.07 Due consideration for the differential expansion of shell and tube shall be given in the design of the coolers.
 - 7.09.00 **Gear Box**
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- 7.09.01 Speed increasing gears between the motor and compressor stages shall consist of a common helical gear driving the pinion of each stage. Helical timing gears shall be mounted on the rotor shafts to maintain accurate relative rotor position. Gears shall have a rating of AGMA-12 or equivalent.
- 7.10.00 **Inter Cooler, After Cooler and Moisture Separator**
- 7.10.01 Inter-cooler shall be located between the low and high-pressure stages, if required, to reduce overall power consumption. Design performance shall be in accordance with Manufacturer's Standard and wall thickness of tubes and expansion joints shall ensure maximum trouble-free service for long period.
- 7.10.02 Design of intercooler and after cooler shall be such as to keep the Cooling Water pressure drop within limits and complete leak tight condition for long period of service time.
- 7.10.03 After-cooler at each compressor discharge shall be water cooled and supplied by the Bidder. It shall be located after compressor discharge to bring the outlet temperature of the compressed air within 6°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.
- 7.10.04 Inter-cooler, After-cooler and Moisture Separator shall be provided with Auto trap stations including strainer, bypass and double isolating valves for the traps. A level gauge glass with isolating cock shall be provided near the bottom of moisture separator. Automatic traps shall be of reputed make and shall be of float type suitable for intended services. Y-strainer of 20 mesh screen of stainless steel shall be placed before each trap.
- 7.10.05 The water cooled after coolers and intercoolers shall be shell and tube type. The intercooler shall have air in shell side and water in tube side to add surge volume for reducing air pulsation before the second stage.
- 7.10.06 The shell, tubes, tube sheets and expansion joints with tube sheets particularly at flange portion etc. of the heat exchangers shall be designed to withstand the maximum working pressures encountered. Necessary allowance for corrosion shall be provided.
- 7.10.07 The tubenest shall be removable type to facilitate cleaning and maintenance.
- 7.10.08 Intercoolers/After coolers shall be provided with supports, which are designed to avoid undue stress or deflection in support or body of the equipment.
- 7.10.09 Due consideration for the differential expansion of shell and tube shall be given in the design of coolers.
- 7.10.10 Necessary drain and vent nozzles shall be provided for intercooler and after cooler.
- 7.11.00 **Air Receiver**
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- 7.11.01 Air receiver(s) shall be in accordance with IS-2825 or ASME Sections-VIII Div.I and IS-7938.
- 7.11.02 The design pressure, capacity and other parameters shall be as specified in Annexure-A of this section.
- 7.11.03 The air receiver shall be vertical self-supporting cylindrical vessel with torispherical dished ends and with supporting stand for resting on the Civil foundation in accordance with Annexure-A enclosed with this section.
- 7.11.04 Receivers shall be of welded construction with minimum number of joints. Longitudinal seams in adjacent sections of shell shall not be in the same line.
- 7.11.05 All welding shall be performed in accordance with relevant codes. Filler material that will deposit weld metal with a composition and structure as near as that of the material being welded shall be used. The electrodes shall be dried in oven immediately before use to ensure freedom from porosity.
- 7.11.06 Receivers shall be provided with required number of nozzles, the orientations of which shall be subject to approval by the Purchaser. At least two gasketed inspection holes shall be provided for receivers up to 600 mm diameter. For larger diameter manhole of minimum 450 mm diameter shall be provided.
- All openings shall be placed as far as possible from welded seams and in no instance shall pierce the seam.
- 7.11.07 Receivers shall be provided with one or more safety relief valves of proper capacity so that the maximum working pressure of the system is not exceeded under any circumstance. Unless otherwise mentioned, each receiver shall be provided with at least one pressure gauge and one temperature gauge of proper range and required number of pressure switches for compressor control purposes.
- 7.11.08 Each air receiver drain connection shall be provided with automatic no air loss type drain valve for automatic removal of drain consisting of valve, strainer, double isolation and bypass valves.
- Each Air Receiver should have air release vents at the top to facilitate statutory hydraulic tests as per IS-7938.
- 7.11.09 Receiver shall be heat-treated in accordance with BS-5169.
- 7.12.00 **Intake Air Filter and Silencer**
- 7.12.01 Filters with multiple elements and quick removal type for easy cleaning to be provided at suction of each air compressor and shall also be of heavy-duty dry type. Oil bath type shall not be acceptable for non-lubricated compressors.
- 7.12.02 The filters shall be complete with integral silencers and all other accessories. The filtering elements shall be easily removable for cleaning or for
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replacement.

- 7.12.03 The filters shall be designed for an efficiency of not less than 95% for particles 1 microns and larger.
 - 7.12.04 The silencer shall be of very high efficiency type to adequately dampen the operating noise as per the requirements in Volume-IIA.
 - 7.12.05 Pulsation dampener of approved design shall be provided on the compressor suction and discharge manifold.
 - 7.12.06 If filter after receiver is specified in Attachments/Annexures, the same shall be provided to remove the bulk of moisture and other contaminants entrained in the air stream.
 - 7.13.00 **Drive Unit**
 - 7.13.01 The compressors shall be driven by constant speed squirrel cage induction motor unless otherwise specified in Annexure-A of this section. For determining the output rating of driver, general guidelines as indicated in Cl. no. 5.13.00 of this section and Volume V of this specification shall be followed.
 - 7.13.02 The driver shall be connected to the compressor either directly or through gear box as per Annexure-A of this section.
 - 7.13.03 For other types of connection between drive unit and compressor, suitable flexible coupling shall be provided.
 - 7.13.04 Necessary guard shall cover all exposed moving parts.
 - 7.13.05 Motor speed torque curve shall match with that of the compressor for trouble free start up.
 - 7.13.06 Motor shall be capable for three (3) equally spreaded starts per hour. Two start in quick succession from cold condition and one restart from hot condition.
 - 7.14.00 **Moisture Separator**
 - Moisture separator shall be of high efficiency design & no air loss type and provided with vent nozzle and auto drain trap system.
 - 7.15.00 **Air Dryer, Precooler, Evaporator and Refrigerant condenser**
 - 7.15.01 Air-drying plant shall be of Refrigerant type.
 - 7.15.02 Air dryer shall be located Indoor.
 - 7.15.03 Complete ADP equipments shall be preferably mounted on a skid.
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- 7.15.04 Precooler, Evaporator and Refrigerant condenser shall be of shell and tube type construction.
- 7.15.05 Precooler shall use dry air and wet air as shell and tube side fluids respectively.
- 7.15.06 Evaporator shall use refrigerant as shell side fluid and air as tube side fluid media.
- 7.15.07 Refrigerant condenser shall be water cooled with refrigerant as shell side and cooling water as tube side fluid.
- 7.15.08 Design shall conform to TEMA (USA) – Class-C.
- 7.15.09 Heat Exchanger elements like shell, tube and tube sheet shall be adequately designed to withstand the design pressure.
- 7.15.10 Drain and vent nozzles and safety valves, as necessary, shall be provided for the precooler, evaporator and refrigerant condenser.
- 7.16.00 **Refrigerant Compressor**
- 7.16.01 The compressor for the refrigerated type air dryer shall be hermetically sealed, reciprocating, medium speed, single acting type designed with ecofriendly refrigerant R-134A or equivalent.
- 7.16.02 The reciprocating compressor shall be complete with cylinder liner, pistons, crank shaft, connecting rod, bearings, suction and discharge valves, crank case heater, proper lubrication system etc. (as applicable).
- 7.16.03 The compressor shall be complete with all parts and accessories commended by the manufacturer to run it efficiently and satisfactorily.
- 7.16.04 The safety devices against high pressure of refrigerant, low pressure of refrigerant shall be provided.
- 7.16.05 The horse power for the compressor motor shall be sized with margin as per specification of electric motors over maximum rated power required for the unit including the drive loss.
- 7.16.06 The compressor assembly shall be adequately designed for minimum vibration and noise disturbances.
- 7.16.00 Expansion valve shall be of thermostatic type.
- 7.16.00 All the components of the Air Drying plant including the strainers, filter, interconnecting piping, valves, fittings, control panels, etc. shall be mounted on a common fabricated steel base frame to form a self contained unit.
- 7.17.00 **Pressure Vessels**
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7.17.01	All pressure vessels shall be designed as per IS : 2825 or approved equal.
7.17.02	The vessels shall be of self supporting construction. All welding materials and procedures shall be as per IS: 2825 or approved equal.
7.17.03	Each vessel shall be provided with suitable air-tight manhole and other connections as required.
7.17.04	Relief valves of adequate capacity shall be provided for each vessel. Relief valves shall be provided with hand lever. The valves shall be of stainless steel construction.
7.17.05	Internal surfaces of all the vessels shall be suitably protected against corrosion and rusting. Corrosion allowance of 2.5 mm shall also be provided on shell and dished end thickness.
7.17.06	Draining trap station complete with Auto drain trap, isolation and by-pass valves and Y-strainer shall be provided for the moisture separator.
7.18.00	Solenoid Valves and Multiway Valves
7.18.01	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.
7.18.02	The solenoid valves shall be of bronze body with stainless steel trim. The coil shall be of continuous duty and of epoxy moulded type, Class-F. The enclosure shall conform to NEMA-4X standard.
7.19.00	Drives and Mounting
7.19.01	All relevant details pertaining to drives shall generally comply with the stipulations laid in Volume V.
7.19.02	All the components of the Air Drying plant including the strainers, filter, interconnecting piping, valves, fittings, control panels, etc. shall be mounted on a common fabricated steel base frame to form a self contained unit.
7.20.00	Interconnecting Piping, Valves and Fittings
7.20.01	Pipelines shall be selected as per IS-6206/equivalent standard. Piping in airlines 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 Annexure-A enclosed with this section.
7.20.02	The air discharge piping shall be full size of compressor outlet or larger, short and direct with minimum number of fittings. Only long radius elbows shall be

used where bends are unavoidable. The velocity of compressed air in pipe shall be limited as per pipe size 50 NB below 20 to 30 m/sec. & 50 NB above 25 to 40 m/sec.

Any pocket in compressed air and interconnecting air piping shall be provided with drain connection complete with automatic trap station.

Long runs of vertical piping at compressor discharge shall not be acceptable.

The layout shall be such as to prevent resonance. Provision of thermal expansion of hot pipes shall be made.

All pipe connections with equipment shall be flanged type. All pressure gauges/switches shall be complete with root valves and all temperature elements shall be mounted in a proper thermowell.

All instruments, safety valves etc. as shown in tender drawings shall be furnished on the piping.

- 7.20.03 For water cooled compressors, cooling water shall normally be piped through the intercooler and after cooler in parallel. From the intercooler, the water shall be taken to cylinder jackets. A solenoid valve shall be provided on the water inlet line for interlocked starting of compressors. Where provision for automatic water flow regulation by thermostatic valve has been made, a suitable bypass arrangement to the valve shall be made so that flow to the cylinder is ensured under all circumstances.

The velocity in water pipes shall be limited to 2.0 Metres/Sec.

Sight flow indicators shall be provided on water discharge from each cylinder, intercooler and after cooler.

- 7.20.04 Valves to be supplied for compressed air service and DMCCW service shall be as per Annexure-A.

- 7.20.05 All traps shall be float operated. All traps shall be of auto drain type to drain out moisture at regular intervals. The body and cover shall be of cast iron/solid steel construction and internals shall be of SS. Isolating valves shall be of stainless steel.

- 7.20.06 All strainers shall be Y-type with suitable blow-off plugs. The body material shall be cast iron. The screen shall be of stainless steel with 40 mesh openings.

- 7.20.07 Complete piping system shall be provided with adequate supporting arrangement to avoid undue forces and moments at the equipment terminals and vibration.

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

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

- a) Range : (-) 30 °C to (+) 20 °C
- b) Accuracy : ± 0.1 °C

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

7.22.00 **Automatic Drain Valve**

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

8.00.00 **INSTRUMENTATION & CONTROL**

Refer to VOLUME VI.

9.00.00 **INSPECTION AND TESTING**

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

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

9.03.00 Hydrostatic testing of compressor, intercoolers, aftercoolers, moisture separators, air receivers, strainers, filters, all interconnecting air and water

pipng with valves and all other applicable pressure parts that could not be spelt out in this clause. Hydrostatic testing shall be carried out at 150% of the design pressure for at least one (1) hour, unless contradicted by the relevant test code.

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

10.00.00 **PERFORMANCE GUARANTEES**

10.01.00 **Performance Guarantee**

- 10.01.01 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.
- 10.01.02 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.
- 10.01.03 Drying plant capacity shall be guaranteed for the dew point of minus (-) 20 Deg. C at atm pressure at the dryer outlet as specified in data specification sheet.
- 10.02.00 **Deficient Performance**
- 10.02.01 Performance test and guarantee test shall be carried out in line with the stipulations laid down in data sheets for compressed air system and all defects shall be satisfactorily rectified without affecting overall time schedule of the project. No extra cost shall be charged to the owner for such rectification. After rectification, retesting shall be done by the contractor without any extra cost to the owner till satisfactory performance is achieved.
- 11.00.00 **DRAWINGS/DOCUMENTS, DATA & INFORMATION TO BE FURNISHED BY THE BIDDER ALONG WITH THE TECHNICAL OFFER**
- 11.01.00 The Bidder shall furnish along with his proposal following specific drawings/ documents/data as asked for in this section.
- 11.01.01 P&I Diagram.
- 11.01.02 Preliminary Layout drawing.
- 11.01.03 Calculations establishing the rated pressure, FAD capacity of compressors and characteristic curves showing efficiency against capacity, capacity of Air Receivers and ADPs.
- 12.00.00 **DRAWINGS/DOCUMENT, DATA, AND MANUALS TO BE FURNISHED AFTER AWARD OF CONTRACT**
- 12.01.00 Final version of all drawings/data/informations asked for in clause 10.00.00 above.
- 12.02.00 Certified dimensioned general arrangement drawing; detailed cross-sectional drawing with parts list and details of material; piping layout drawings for Compressed Air System.
- 12.03.00 Foundation drawings with dead load, operating load and other design data.
- 12.04.00 Functional logic diagram showing operational philosophy, inter lock and

protection for the compressed air system.

- 12.05.00 Complete design calculations for heat exchangers, moisture separator, air receiver, etc.
- 12.06.00 Local panel layout and complete electrical schematic drawings for instrumentation and control.
- 12.07.00 Detailed list of Instruments showing make, size, range, tag nos. etc.
- 12.08.00 Bill of material indicating tag nos., type, sizes, working pressure, material of construction, quantity etc. of the following :
 - a) Pipe
 - b) Valves and
 - c) Fittings
- 12.09.00 Detailed test reports, certified performance curves as required for all the applicable equipment in Compressed Air System.
- 12.10.00 Quality assurance plan, datasheet, flow diagram and final layout drawing.

ANNEXURE-A

SCREW TYPE AIR COMPRESSOR AND AUXILIARIES

A. Performance Data

Free Air Delivery	: Bidder to compute and indicate as per guidelines specified in this section.
Discharge Pressure	: As per clause no. 5.02.00
Noise level near compressors	: 85 dBA (Maximum)
Vibration limit	: As per API 619, Table-1
Guaranteed Power consumption at motor input terminals at rated condition	: Bidder to indicate

B. Construction Features

Location	: Indoor
No. of compressors	: AS PER SCOPE OF SUPPLY
Type	: Oil-free, dry screw type, water cooled, horizontal, two (2) stage, rotary screw compressors or centrifugal type.
Service	: Instrument Air and Service Air
Duty	: Continuous
Type of Drive	: Electric Motor
Design ambient for drive	: 50°C
Number of starts per hour	: 3 (equally spreaded)
Type of transmission	: Gear
Antivibration arrangement required	: Yes
Maximum temperature for any step during the cycle	: Bidder to indicate.
Type of control	: Dual i.e., both load-unload and auto start/stop
Type of Annunciation	: Audio-visual

Flange standard : ANSI B-16.5/equivalent

C. Materials of Construction

Compressor chamber : Cast iron coated with corrosion resistant material

Rotors : Forged carbon steel coated with corrosion resistant material

Bearing : As per manufacturing standard. (Antifriction Bearing)

Timing Gear : Low alloy steel

Base Plate : MS

Inlet throttle valve & housing : Aluminium

Shaft seals : High Alloy Steel

Safety valves : Brass

Water separator : Cast Iron

Blow off valve : Stainless Steel

Unloading Cylinder header : Aluminium

Tube of oil cooler : SS-304

Outer casing of coolers : Carbon Steel

Gear Box : Cast Iron GGG 40 (DIN 1693)

Gears : Alloy Steel

D. Supply of Accessories and Service

Intake air filters with silencers : Yes

Intercoolers : Yes

Aftercoolers with moisture separators : Yes

All instruments as specified, as shown in tender drawing and as required for safe and trouble- free operation of the system : Yes

Coupling guards : Yes

Air receivers	: Yes
Base plates	: Yes
Foundation bolts, nuts, sleeves, inserts etc.	: Yes
All interconnecting air and cooling water piping, complete with valves, fittings as shown in relevant tender drawings and as required for reliable and smooth operation of the system	: Yes
Eye bolts, lifting tackle, tools, etc.	: Yes
Control panels complete with all accessories	: Yes
Instrument gauge panels complete with all accessories	: Yes
E. DM Cooling Water Data	
Quality	: Passivated DM Water
Design inlet temperature	: 36°C (max)
Maximum Allowable temp. rise	: 6°C
Design pressure	: Bidder to indicate. Shall not be less than the shut off head of DMCCW pump.
Normal inlet pressure	: Bidder to indicate. Shall be equal to the rated TDH of DMCCW pump
Maximum pressure drop allowable between inlet and outlet points	: 6.0 to 8.0 MWC
F. Testing And Inspection	
Material Testing and identification	: Required
Dye Penetration test	: Yes
Type of performance test to be conducted	: Routine test/Type test as per Clause No. 9.04.02 of this section.
Bend Test as per BS 5169	: Yes
Field performance test	: Yes
MPI and UT tests	: Yes

Spot Radiography for all circumferential and longitudinal butt joints : Yes

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

G. Drive Motor

Drive motor for compressor shall comply with the requirements of Clause No. 7.13.00 of this section and Volume V of this Specification.

H. Compressor Accessories

a) Intake Air Filter

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

Location : Indoor/At the suction of each air compressor

Type : Dry type

Silencer : Yes

Air flow rate : To suit compressor rating

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

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

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

b) Air Receiver

Numbers required : AS PER SCOPE OF SUPPLY

Installation : Outdoor

Type : Vertical cylindrical with torispherical dished ends.

Design pressure	: 10 Kg/Sq.cm(g)
Hydraulic test Pressure	: 15 Kg/Sq cm(g)
Design code	: IS-2825/IS-7938/ Approved equal
Capacity of each air receiver	: Bidder to compute in accordance with clause no. 5.15.00 of this section. However the water filled volume shall not be less than 10 M ³ under any circumstances.
Material of construction of shell	: IS-2002
Material of construction of dished ends	: IS-2002
Material of construction of flanges	: IS-2002
Supply of Accessories & Services	:
Flanges with nuts, bolts and gaskets	: Yes
Pressure gauge with snubber	: Yes
Pressure switch	: Yes
Temperature indicator	: Yes
Relief valve	: Yes, set pressure shall be atleast 10% above working pressure.
Trap station	: Yes
Level gauge	: Yes
Vent valve/plug	: Yes
Supporting stand with necessary foundation bolts, nuts, sleeves, etc	: Yes
Eye bolts, lifting tackle etc.	: Yes
Painting	
i) External	: Two coats of red-oxide primer and two finish coats of synthetic enamel paints.
ii) Internal	: Shop painted as per manufacturer's

standard.

Inspection and Testing

Material testing and identification : Yes

Bend test as per BS-5169 : Yes

Spot radiography of circumferential and longitudinal butt welds : Yes

Field performance test : Yes

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

Hydraulic Test : Yes

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

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

i) Aftercooler :

Installation : Indoor

Type : Shell and Tube

Relief Valve : Yes

Moisture Separator : Yes

Trap Station : Yes

Temperature Indicator : Yes

Temperature Switch : Yes

Level Gauge : Yes

ii) Intercooler :

Installation : Indoor

Type : Shell and Tube

Relief Valve : Yes

Trap Station	: Yes
Pressure Gauge	: Yes
Temperature Indicator	: Yes
Temperature Switch	: Yes
Moisture Separator	: Yes
iii) Supply of Accessories and Services	
Supporting stands with bolts, nuts and gaskets	: Yes
Eye bolts, lifting tackle etc with tools and tackle	: Yes
Flanged connections for supply and return of cooling water	: Yes
iv) Material of Construction :	
Tube	: Stainless steel with in star profile
Shell	: Mild Steel
Tube Sheet	: IS 2002 Gr 2A
Baffles	: IS 2062
Flanges	: IS 2062
v) Cooling Water Data	: Same as mentioned earlier
vi) Piping, Valves and Fittings for Compressed Air System :	
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.
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 mm NB and as per schedule 10S. ANSI – B36.19 for sizes equal to & greater than 65 mm NB.
Fittings	

Fittings for cooling water line	: ASTM A-234 Gr. WPB for sizing including 65 mm NB and above. ASTM A105 for sizes upto 50 mm NB.
Fittings for compressed air piping & interconnecting air piping	: Stainless steel as per ASTM A-182 F304
Valves for air line	: Stainless Steel
Valves for cooling water line	: Carbon Steel
vii) Testing and inspection	: As per clause No. 9.00.00 of this section.

ANNEXURE-B

AIR DRYING PLANT AND AUXILIARIES

A. General Information

Numbers of Air drying Plant	:	AS PER SCOPE OF SUPPLY
Duty	:	Continuous
Operation	:	Fully Automatic
Service	:	Instrument Air
Version	:	Non-Cyclic
Installation	:	Indoor
Type of Drying	:	Refrigerated or desiccant air dryer
Type of Refrigerant	:	R-134 A
Outlet dew point	:	Atleast (-) 20 Deg.C at 1 atm pressure.
Annunciation	:	Local and remote
Location	:	Indoor skid mounted

B. Performance Specification

Air drying capacity	:	To suit the compressor capacity (110% of the compressor capacity)
Pressure dew point (constant) at prevailing pressure	:	By Bidder
Inlet air pressure	:	To suit compressor rating
Air flow (Free Air delivery)	:	To suit compressor rating
Inlet air temperature	:	Suitable to handle air inlet temperature of 60 Deg.C
Maximum allowable air pressure drop	:	0.5 kg/sq.cm
Design Requirement	:	Atleast (-) 20 Deg.C dew point at outlet (at atm. Pressure). Dust laden not more than 1 ppm, oil free

C. Technical Particulars

a) Pre-cooler

- i) Type : Shell and tube type (Fixed tube bundle type).
 - ii) Shell side fluid media : Dry Air
 - iii) Tube side fluid media : Wet Air
 - iv) Design pressure : Bidder to indicate
 - v) Code of construction : TEMA-Class-C
- b) Evaporator
- i) Type : Shell and tube type (Fixed tube bundle type).
 - ii) Shell side fluid media : Refrigerant
 - iii) Tube side fluid media : Air
 - iv) Design pressure : Bidder to indicate
 - v) Code of construction : TEMA-Class-C
- c) Refrigerant condenser
- i) Type : Shell and tube type (Fixed tube bundle type).
 - ii) Shell side fluid media : Refrigerant
 - iii) Tube side fluid media : Passivated DM Cooling water
 - iv) Design pressure : Bidder to indicate
 - v) Code of construction : TEMA-Class-C
- d) Refrigerant Compressor
- i) Type : Hermetically sealed, Reciprocating
 - ii) RPM : 1500
 - iii) No. of cylinders : Bidder to indicate
 - iv) Type of coupling : By Bidder
 - v) Refrigerant : R-134 A
 - vi) Design standard : API-618

vii) Testing standard : IS-5111

D. Materials Of Construction

Precooler, evaporator, refrigerant condenser

- a) Tube : Stainless steel
- b) Shell : Seamless pipe or fabricated from steel plate (ASTM A-285 Gr.C)
- c) End plates : IS-2002 Gr.2A or equivalent.
- d) Tube sheet : IS-2002 Gr.2A or equivalent.

E. Supply Of Accessories And Services For Each ADP

- Strainer : 2 x 100%
- Dew point indicator : Yes
- Instruments as per specification and as required for safe and trouble free operation : Yes
- Control panel with accessories : Yes
- Tools and tackle : Yes
- All interconnecting piping complete with fittings, valves etc : Yes
- Insulation : Yes
- Baseframe, foundation bolts, nuts, sleeves etc. : Yes
- Vessel internal point : Anti-corrosive
- Shop painting : Yes

F. Testing And Inspection

- Non destructive material test : Yes
 - Performance tests at shop and site : Yes
-

Spot Radiography of welds parts : All pressure parts and vessels
to be tested

Dye Penetration test : Yes

Hydrostatic Test : Yes

Other Specific Tests : As per clause No. 9.00.00 of this section.

G. Miscellaneous

Air flow variations : 0 to 100%

Auto drain trap : No air loss type

VOLUME : IIIE

SECTION-V

LOW PRESSURE PIPING, VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

This section covers all the low-pressure piping up to 400mm NB size, associated valves and specialties that include but is not limited to the following systems.

- 1.01.00 Service Air System - shall consist of distributions service air to different buildings.
- 1.02.00 Instrument Air System - shall comprise of distribution of instrument quality air to pneumatically operated instruments/ valves/dampers.
- 1.03.00 Demineralised Water Supply system including hot well make-up water piping from condensate storage tank.
- 1.04.00 Demineralised Water closed cycle cooling system.
- 1.05.00 Service water system.
- 1.06.00 Potable water system.
- 1.07.00 Any other low pressure piping as found necessary during detail engineering shall also be included.

2.00.00 CODES AND STANDARDS

- 2.01.00 In addition to the requirements spelt out in Volume IIA, the design, manufacture, inspection and testing of the piping, fittings, valves and specialties covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below:
 - 2.01.01 IS-1239 : Mild steel tubes, tubular and other wrought steel fittings.
[Part-I & II]
 - 2.01.02 IS-3589 : Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
 - 2.01.03 IS-554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
 - 2.01.04 IS-1363 : Hexagonal head bolts, screws and nuts (size range M5 M36)
[Part-I & II]

2.01.05	IS-1364	:	Precision and Semi-precision hexagon bolts, screws, nuts and lock nuts (diameter range 6 to 39 mm)
2.01.06	IS-3138	:	Hexagon bolts & nuts (M42 to M150)
2.01.07	IS-5312	:	Swing check type reflux (non-return) valves.
2.01.08	IS-2379	:	Colour code for the identification of pipelines.
2.01.09	IS-2016	:	Plain washers
2.01.10	IS-2712	:	Compressed asbestos fibre jointing
2.01.11	ANSI B-16.5	:	Steel pipe flanges and flanged fittings
2.01.12	ANSI B-16.9	:	Wrought steel Butt welding flanged
2.01.13	ANSI B-16.11 : ANSI B-36.10 :		Forged steel fittings, Socket-welding and Threaded. Steel pipes thickness
2.01.14	API-600	:	Steel gate valves
2.01.15	BS-2633	:	Class I Arc welding of ferrite steel pipe work for carrying fluids.
2.01.16	BS-534	:	Specification for steel pipes and specials for water and sewage.
2.01.17	BS-5351	:	Specification for Ball valves.
2.01.18	AWWA-C-504	:	Specification for Butterfly valves.
2.01.19	AWWA-C-208	:	Dimension for fabricated steel water pipe fittings.
2.02.00	Other international codes and standards may also be offered by bidder. However, same may be subject to acceptance by the Purchaser.		
3.00.00	SCOPE OF WORK		
3.01.00	The equipment and materials to be supplied shall include but not be limited to the following:		
	a)	Supply of all low pressure piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this section.	
	b)	Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc.	
	c)	Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work.	

- d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.
- e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.
- f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.
- g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.
- h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.
- i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

- a) Instrument Connections including instruments, root valves, sensing lines etc.
- b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 **GENERAL DESIGN AND CONSTRUCTION**

4.01.00 **General Considerations**

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

- 4.01.03 All design and fabrication shall be in accordance with codes/standards specified.
- 4.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.
- 4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.
- 4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.
- 4.01.09 **Drain Pipe Work**
- a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.
 - b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.
 - c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.
- 4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.
- 4.02.00 **Material Specification**
- 4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.
- 4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = $1.5 \times$ pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

- a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.
- b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

- a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.
- b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.
- c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.
- d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.
- i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.
- j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.
- m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
- n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:
 - i) Hand wheel with embossed open and shut directions.
 - ii) Local position indicator.
 - iii) Motorised operation as specified by Engineer.
- o) Gate valves, in addition shall be provided with following extra features
 - i) Bypass valve for larger valves
 - ii) Draining arrangement
 - iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.
 - iv) Motorised operation as specified by Engineer.
- p) All gate and globe valves shall be rising stem type.

- q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.
- r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.
- s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.
- w) Plastic or bakelite valve hand wheels will not be accepted.
- x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.
- z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.
- aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

cc) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves refer Annexure-II & III.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hosepipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

- a) The water hose shall be as per IS-444 (Type-3).
- b) Length of each hose shall be 15 metres.
- c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

- a) The compressed air hose shall be as per IS-911 (Type 2).

- b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.

5.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

5.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.

5.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.

5.01.02 A complete list of all valves with their type, quantities & ratings.

5.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.

5.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.

5.02.00 **After Award of Contract**

Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.

5.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

5.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

5.02.03 Wiring diagram for all limit switches of motor operated valves.

5.02.04 The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

6.00.00 **BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING**

6.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

6.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered

part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

- 6.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.
- 6.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.
- 6.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.
- 6.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.
- 6.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.
- 6.08.00 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.
- 6.9.00
 - a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.
 - b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.
 - c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

- d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.
- e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I SPECIFICATION OF PIPES FOR DIFFERENT SERVICES				
	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.	Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736	Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construct ion	ERW / Seamless	ERW / Seamless	ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.	Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.	Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > 65 mm NB Pipe Sizes < 50 mm NB	Pipe Sizes > = 65 mm NB Pipe Sizes < 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS- 4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construct ion	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA- C-208	ANSI-B- 16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size >=65mm NB Butt welded as per ANSI-B- 16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B- 16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B- 16.11 All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i)	Service Water	For sizes 65mm NB and above.
		ii)	Clarified Water	
		iii)	Drinking/ Potable Water	
		iv)	Inhibited Demineralised Water	
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i)	For Demineralised water	For all sizes
		ii)	Potable/ Drinking Water	For sizes less than and equal to 50 mm NB
		iii)	Service and Instrument Air	For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i)	Clarified Water	For sizes less than and equal to 50 mm NB
		ii)	Inhibited Demineralised Water for DMCW system	
D.	Cast Iron body butterfly valve	i)	For Demineralised Water	For butterfly valve specification refer Annexure II, Sec.IV of Vol. IIIE. For DM water line rubber lining/ EPDM/equivalent protection to be provided
		ii)	Raw water	
		iii)	Clarified Water	
		iv)	Filtered Water	
		v)	Inhibited Demineralised Water for DMCW system	

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code			
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A- 182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A- 182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB ii) IS-2906 for sizes equal to and above 350 mm NB Hydrostatic Test as per MSS-SP-85 IS-5312/MSS-SP-71	As per ANSI B-16.34	API-598 BS-1873 BS--1868
	b) Globe			
	c) Check			

5 x 800 MW YADADRI TPS

SECTION IA
(GENERAL TECHNICAL REQUIREMENT)



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

GENERAL TECHNICAL REQUIREMENTS

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GENERAL TECHNICAL REQUIREMENTS (AS APPLICABLE)

1.00.00 CODES AND STANDARDS

- 1.01.00 Except where otherwise specified, the Plant shall comply with the appropriate Indian Standard or an agreed internationally accepted Standard Specification as listed in the annexure to this Section and mentioned in detailed specifications, each incorporating the latest revisions at the time of tendering. Where no internationally accepted standard is applicable, the Bidder shall give all particulars and details as necessary; to enable the Owner to identify all of the Plant in the same detail as would be possible had there been a Standard Specification.
- 1.02.00 Where the Bidder proposes alternative codes or standards he shall include in his tender one copy (in English) of each Standard Specification to which materials offered shall comply. In such case, the adopted alternative standard shall be equivalent or superior to the standards mentioned in the specification.
- 1.03.00 The plant will be designed in compliance with applicable National and International Codes and Standards such as ASME, ASTM, DIN, BS, IEC, IEEE, IS, etc. Wherever specified or required the Plant shall conform to various statutory regulations such as Indian Boiler Regulations, Indian Explosives Act, Indian Factories Act, Indian Electricity Act, Environmental Regulations, etc. Wherever required, approval for the plant supplied under the specification from statutory authorities shall be the responsibility of the Contractor.
- 1.04.00 In the event of any conflict between the codes and standards referred above, and the requirements of this specification, the requirements, which are more stringent, shall govern.
- 1.05.00 In case of any change of code, standards and regulations between the date of purchase order and the date the 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.
- 1.06.00 Successful Bidder to furnish two (2) sets of latest of national/inter-national codes and standards to owner.

2.00.00 RESPONSIBILITY FOR DESIGN

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

- 2.02.00 Notwithstanding the Owner's wish to receive the benefits of new, advanced and improved technologies, a prime requirement is that all the systems and components proposed shall have been already adequately developed and shall have demonstrated good reliability under similar, or more arduous conditions elsewhere, at least for continuous 2 years in two different power station.
- 2.03.00 The successful bidder shall have to carry out surge analysis, BFP transient analysis and other transient condition studies as may be necessary and as required by the Owner as per proven engineering practice.
- 2.04.00 The Bid shall include a detailed discussion on the development status of, and the reasons for any changes made in proposed systems or components for the Plant, as compared with similar items previously supplied in other installations cited by the bidder as reference plants.
- 2.05.00 The Bidder may also make alternate offers, provided such offers are superior in his opinion in which case adequate technical information, operating 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.
- 3.00.00 **NAME PLATES (RATING PLATES)**
- 3.01.00 Instruction plates, name plates or labels shall be permanently attached to each main and auxiliary item of plant in a conspicuous position. These plates shall be engraved with the identifying name, type and manufacturers serial number, together with the loading conditions under which the item of plant has been designed to operate.
- 3.02.00 Items such as valves, etc. which are subject to hand operation, shall be provided with nameplates so constructed as to remain clearly legible throughout the life of the plant giving due consideration to the difficult climatic conditions to be encountered. Nameplates shall be securely mounted where they will not be obscured in service by insulation, cladding, actuators or other equipment. Direction of flow is also to be engraved.
- 3.03.00 All trade nameplates and labels shall be in English language. All measurements shall be in M.K.S. Units.
- 3.04.00 The size and location of nameplates shall be subject to Approval of the Engineer.
- 4.00.00 **SAFETY AND SECURITY**
- 4.01.00 The design shall incorporate every reasonable precaution and provision for the safety of all personnel and for the safety and security of all persons and

property. The design shall comply with all appropriate statutory regulations relating to safety. All structures and equipment shall be designed and constructed to withstand every foreseeable static and dynamic loading condition, including loading under earthquake conditions, with an adequate margin of safety.

4.02.00 Ready and safe access with clear head room shall be provided to all parts of the plant for operation, inspection, cleaning and maintenance.

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

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

5.00.00 **GUARDS**

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

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

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

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

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

LOCATION AND LAYOUT REQUIREMENTS

The majority of plant and equipment (excluding steam generator and some other auxiliaries) shall all be of indoor installation. A broad list of buildings housing such equipment is given elsewhere in this specification. 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 given under the various equipment and system specifications as well as those stipulated in Annexure-II attached to this section.

Enclosed General Layout and other tender layout drawings 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 power house 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 finds the proposal more attractive in terms of techno-economic consideration.

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

- a) The minimum width of clear access corridors around equipment shall be 1.2 meter.
- b) Each building shall have an identified vacant space for equipment unloading and maintenance and preferably a separate bay altogether in buildings housing heavy equipment. Provision for handling equipment by monorail hoist and/or overhead crane shall be made as specified.
- c) The minimum clear height available between two consecutive floor slabs shall not be less than five (5) meters. A clear head room of 2.5m 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.
- d) There shall be at least two (2) nos. main access doors, one on either side of each building, of which one shall be minimum 3 meters wide with rolling shutters for equipment entry. For multistoried buildings, at least two (2) nos. regular staircases diagonally opposite to each other shall be provided connecting all the floors and roof. These minimum requirements shall be augmented as required depending on the floor area, statutory requirements and TAC recommendations.
- e) All buildings shall have provision for toilet and associated effluent discharge system together with facility for drinking water. The criteria for ventilation, fire protection and illumination of building spaces specified

elsewhere in this specification shall be complied with.

- f) All rail/road crossings for pipe/cable racks shall be done with minimum 8 meters headroom from top of rail/road to bottom of rack. Similarly top cover over underground pipes/cables shall be minimum one (1) meter. For other detail refer to Annexure-II.
- g) Cubicle for operating personnel shall be located at safe place near the equipment.
- h) Interplant cable routing will be on overhead cable trays on pipe cum cable trestle or on cable trestle except where approved by purchaser/consultant. In exceptional case, small stretch of outdoor run of interplant cable routing may be taken through cable trench only with the Employer's prior approval.
- i) Concept of various mechanical and electrical equipment location and building dimensions (including column-row spacing) as shown in Plot Plan/Floor Plan drawing are to be adhered to. Any departure from this suggestive layout is primarily not recommended.

7.00.00 **OPERATION, MAINTENANCE & AVAILABILITY CONSIDERATIONS**

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

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

7.03.0 Motorised lifting devices, i.e. hoists, chain pulleys, jacks, etc. shall be provided for handling and carrying out maintenance of any equipment and/or part having weight in excess of 3000 Kg. Suitable beams, hooks etc. for this purpose shall be provided in the buildings.

No lifting arrangement is necessary for part having weight less than 500 Kg. Hoist shall be well protected by environment. Suitable painting and coating covering hoist at outdoor shall be provided.

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

7.04.00 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same material and workmanship as the corresponding parts of the equipment. Where feasible common

components shall be employed in different pieces of equipment in order to optimize the spares inventory and utilization.

8.00.00 MATERIALS

8.01.00 In selecting materials of construction of equipment, the Contractor shall pay particular attention to the atmospheric conditions existing at the Site and the nature of material/fluid handled. Wherever deviations are taken in respect of materials specified, the reasons shall be spelt out clearly in the proposal.

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

8.02.00 In as far as is possible; materials shall be in accordance with Indian or international standard specifications and shall be used in accordance with Indian or international codes of practice. Where such standards or codes of practice are not available sufficient information shall be provided to allow the Owner to assess the suitability of the material for the particular application.

All materials used shall have performed lengthy satisfactory service in similar or more arduous conditions to those proposed by the Contractor.

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

9.00.00 LUBRICATION

9.01.00 Provision shall be made for suitable efficient lubrication where necessary to ensure smooth operation free from undue wear.

9.02.00 Non ferrous capillary tubing shall be used throughout.

9.03.00 Gear boxes and oil baths shall be provided with filling and drain plugs, both of adequate size. An approved means of oil indication including level switches and temperature indication shall be provided.

9.04.00 All high speed gears shall be oil bath lubricated. Low speed gears shall be lubricated by means of soft grease. Removable and accessible drip pans shall be provided to collect lubricant which may drop from operating parts.

9.05.00 All lubrication points shall be conveniently situated for maintenance purposes. It must be possible to carry out lubrication from a gangway or landing and without the removal of guarding or having to insert the hand into it. Where accessibility to a bearing for oiling purposes would be difficult a method of remote lubrication shall be fitted.

9.06.00 The Contractor shall supply grease gun equipment suitable to service each type of nipple fitted.

10.00.00 **LUBRICANTS AND CONTROL FLUIDS**

- 10.01.00 The Contractor shall provide a detailed and comprehensive specification for all lubricating oils, greases and control fluids required for the entire plant. A sufficient supply of these shall be provided by the Contractor for initial commissioning, first fill and till COD of the unit.
- 10.02.00 The Contractor shall supply a detailed schedule giving the lubricant testing, cleaning and replacement procedures. All equipment and facilities necessary for the testing, cleaning and changing of lubricants and control fluids shall be provided. The Contractor shall endeavor to reduce the varieties and grades of required lubricants and control fluids to a minimum, matching them where possible to those already in use in the generating station in order to simplify procurement and minimise storage requirements. All lubricants and control fluids shall be of internationally recognised standards and shall be easily obtainable from a large number of Indian suppliers. Bidder shall also indicate the equivalent Indian Standard for the above for easy procurement in future.
- 10.03.00 No lubricant or control fluid shall have toxic or other harmful effects on personnel or on the environment.

11.00.00 **OPERATION AND MAINTENANCE**

- 11.01.00 The plant shall be designed and constructed so that operation and maintenance manpower requirements are minimised.
- The design and layout shall facilitate inspection, cleaning, maintenance and repair. The importance of continuity of operation is second only to that of safety.
- 11.02.00 Spare parts for equipment shall be interchangeable with the original components and, so far as possible, be of common design and manufacture.
- 11.03.00 All similar standard components/parts of similar standard equipment provided shall be interchangeable with one another. Further identical equipments shall be provided for similar duties so that the same are interchangeable with one another in totality and component wise.
- 11.04.00 All heavy parts (500 Kg and above) must be provided with a convenient arrangement for slinging and handling during erection and overhaul. Any item of plant normally stripped or lifted during periods of maintenance and weighing one tonne or above, shall be clearly marked with its weight.
- 11.05.00 On completion of commissioning, a complete set of tools for the maintenance of the entire plant shall be provided by the Contractor. This shall include all necessary spanners, special wrenches, extraction equipment and any special tools reasonably required by the Engineer. Tools used during erection and commissioning shall not be accepted except with the specific approval of the Engineer.
- 11.06.00 All equipment and major valves should be provided with adequate maintenance approach and facility.

12.00.00 PLANT LIFE AND MODE OF OPERATION

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

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

The allowable stresses shall be reduced so that life expectancy to minimum 2,00,000 hours of operation can be achieved. The Bidder shall discuss this aspect in his technical proposal.

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

The expected start-ups should be considered as minimum
(Based on HPT metal temperature)

Cold start-up (>72 hrs. shutdown)	:	6 per year
Warm start-up (between 10 to 72 hrs. of shutdown)	:	40 per year
Hot start-up (less than 10 hrs. shutdown)	:	160 per year

13.00.00 PACKAGING & MARKING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. While packing all the materials, the limitations from the point of view of availability of railway wagon sizes in India should be taken account of. The details of various wagons normally available with Indian Railways for transportation of heavy equipment shall be considered by the Bidder. The Contractor shall be responsible for all loss or damage during transportation, handling and storage due to improper packing.

As per the information available, the dimensions of OD consignment for transportation of the equipment by rail (if any equipment to be handled through rail transportation) are as below :

- | | | | |
|----|---|---|-------------|
| a) | Width of the Package
(from centre-line of rails
- 1.6 metres on both sides) | : | 3.2 Meters |
| b) | Height of the package from rail top | : | 4.47 Meters |

The above indicates the dimensions which can be normally transported on the

wagons without infringement of the "moving gauge". This is however not indicative of the consignment which can be carried out with infringement of "moving gauge" duly authorised and approved by the Indian Railways. There may be difference between the "moving gauge" and the "fixed structure gauge" and consignments infringing the "moving gauge" can be moved after investigation regarding possible infringement with the fixed structures. As the critical fixed structures in each route are different, consignments infringing moving dimensions have to be individually investigated to select a route and also determine the restrictions under which such movement is to be carried out. Such routes selected or other mode of transport envisaged is to be clearly brought out in the proposal wherever transport of over dimensional equipment is involved.

Bidder to consider unloading of material delivered through rail transportation, at near by railway station/ site unloading siding. The subsequent transportation up to project work place shall be considered by road only. All unloading and handling equipment both at railway station siding and at project site shall be arranged by the Bidder. Necessary arrangement to be organized with the railway authority for such purpose shall also be under the scope of services of the Bidder. Bidder may consider entire material delivered up to site through rail transportation only.

The identification marking indicating the name and address of the consignee shall be clearly marked in indelible ink on two opposite sides and top of each of the packages. In addition the Contractor shall include in the marking gross and net weight, outer dimension and cubic measurement. Each package shall be accompanied by a packing note (in weather proof paper) quoting specifically the name of the Contractor, the number and date of contract and names of the office placing the contract, nomenclature of contents and Bill of Material.

For imported equipment and material, suitable port facilities may be used in which case material may be transported from the port by tractor-trailer. Bidder may consider this aspect.

14.00.00 **PROTECTION**

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

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

All piping, tubing and conduit connections on equipment and other equipment openings shall be closed with rough usage covers or plugs. Female threaded openings shall be closed with rough usage covers or forged steel plugs. The closures shall be taped to seal the interior of the equipment. Open ends of

pipings, tubing and conduit shall be sealed and taped.

Returnable containers and special shipping devices shall be returned by the manufacturer's field representative at the Contractor's expense.

15.00.00 **ENVIRONMENT PROTECTION AND NOISE LEVEL REQUIREMENT**

15.01.00 **Environment Protection**

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

In case the Ministry of Environment & Forest stipulate any other conditions not specified hereunder while clearing the project shall be complied with the plant by the contractor.

15.01.01 For Liquid Effluent

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

15.01.02 For Air Emission

- a) Suspended Particulate Matter i.e. dust burden at chimney outlet - Maximum 50 mg/Nm³ (with worst coal and one field out at TMCR).
- b) NO_x - 365 ppm Max. or 750 mg/Nm³ (Equivalent NO₂).
- c) SO₂ - Concentration based standard 2000 mg/Nm³. Load based standard 0.2 metric tonne /MWe/day (for first 500 MW and 0.1 metric tonne/MWe/day for rest of the capacity above 500 MW)

In absence of Indian Standard for emission from power plants as on date, for certain gaseous effluents, the internationally accepted World Bank Standard is to be followed. Indian Standard for emission of power plants are under formulation. Should this standard is published before finalisation of the contract, the bidder has to comply the more stringent of the above norm or the new Indian Standard.

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

15.02.00 **Noise Level Requirement**

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

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

An exception will be made for the plant at startup operations and other big pressure reducing devices operating during emergency periods and for the safety valves.

16.00.00 **INSPECTION AND TESTING**

16.01.00 **Inspection and Tests during Manufacture**

- 16.01.01 The method and techniques to be used by the Contractor for the control of quality during manufacture of all plant and equipment shall be agreed with the Owner prior to the Award of Contract.
- 16.01.02 The Owner's general requirements with respect to quality control and the required shop tests are set out elsewhere in this specification.
- 16.01.03 Before any item of plant or equipment leaves its place of manufacture the Owner shall be given the option of witnessing inspections and tests for compliance with the specification and related standards.
- 16.01.04 Advance notice shall be given to the Owner as agreed in the Contract, prior to the stage of manufacture being reached, and the piece of plant must be held at this stage until the Owner has inspected the piece, or has advised in writing that inspection is waived. If having consulted the Owner and given reasonable notice in writing of the date on which the piece of plant will be available for inspection, the Owner does not attend the Contractor may proceed with manufacture having forwarded to the Owner duly certified copies of his own inspection and test results.

The Contractor shall forthwith forward to the engineer duly certified copies of the Test Certificates in six copies (one to the Purchaser and five to the Consulting Engineer) for approval. Distribution of six (6) copies of Test Certificates for approval will be two(2) copies to owner and four(4) copies to consultant. These four(4) copies will be further distributed by consultant after approval to owner, site and bidder. One copy will be retained with the

consultant for record purpose.

Further, nine (9) copies of Shop Test Certificates shall be bound with Instruction Manuals referred to elsewhere. Distribution of nine (9) copies of Shop Test Certificates for approval will be Two (2) copies to owner, Three (3) copies to site, Two (2) copies to consultant, Two (2) copies to owner's library / record.

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

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

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

16.01.07 All materials used for the manufacture of equipment covered under this specification shall be of tested quality. Relevant test certificates shall be made available to the Purchaser. The certificates shall include tests for mechanical properties and chemical analysis of representative material or any other test as required by approved QAP/ Material specification.

16.01.08 All pressure parts connected to pumping main shall be subjected to hydraulic testing at a pressure of 150% of shut-off head for a period not less than one hour. Other parts shall be tested for one and half times the maximum operating pressure or as required by design code of that part, for a period not less than one hour.

16.01.09 All necessary non-destructive examinations shall be performed to meet the applicable code requirements.

16.01.10 All welding procedures adopted for performing welding work shall be qualified in accordance with the requirements of Section-IX of ASME code or IBR as applicable. All welded joints for pressure parts shall be tested by liquid penetrant examination according to the method outlined in ASME Boiler and Pressure Vessel code. Radiography, magnetic particle examination magnafux and ultrasonic testing shall be employed wherever necessary/recommended by the applicable code. At least 10% of all major butt welding joints shall be radiographed.

16.01.11 Statutory payments in respect of IBR approvals including inspection for design and manufacturer of equipment shall be made by the Bidder. All payment for erection and testing at site (i.e. under IBR jurisdiction) shall also be made by the Bidder. In such case Contractor's scope shall also be extended to preparation of all necessary documents, co-ordination and follow-up with IBR authorities for above approval.

16.02.00 **Performance Tests at Site**

- 16.02.01 The full requirements for testing the system shall be agreed between the Owner and the Bidder prior to Award of Contract. The completely erected System shall be tested by the Contractor on site under normal operating conditions. The Contractor shall also ensure the correct performance of the System under abnormal conditions, i.e. the correct working of the various emergency and safety devices, interlocks, etc.
- 16.02.02 The Bidder shall provide complete details of his normal procedures for testing, for the quality of erection and for the performance of the erected plant. These tests shall include site pressure test on all erected pipe work to demonstrate the quality of the piping and the adequacy of joints made at site.
- 16.02.03 The Contractor shall furnish the quality procedures to be adopted for assuring quality from the receipt of material at site, during storage, erection, pre-commissioning to tests on completion and commissioning of the complete system/equipment.
- 16.03.00 For details of specific tests required on individual equipment refer to respective section of this specification.

17.00.00 TRAINING OF OWNER'S PERSONNEL

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

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

17.01.00 Training at Contractor's Premises

The Contractor shall conduct training of sixty (60) engineers of the Owner on engineering, operation and maintenance of the Plant at the Contractor's or Associates or Sub-contractor's premises where adequate training facilities are available during the design and manufacturing stage of the Contractor.

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

Discipline	No. of Engineers	No. of Man-month
Operation	20 heads	20
Maintenance Boiler, Turbine, Mechanical	20 heads	20
Electrical Maintenance	8 heads	4
Control & Instrumentation	8 heads	4
Maintenance Planning	4 heads	2
	-----	-----

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

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

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

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

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

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

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

1. Coal fired thermal plant principles in management and practice for operators, technicians and maintenance personnel.
2. Plant operation and systems training for operators including simulator training as applicable.
3. Maintenance training programme covering electrical, mechanical and instrumentation and control.

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

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

The Contractor shall provide qualified English speaking instructors and training

coordinator(s) during the tenure of the training programme.

17.02.00 Operation and Maintenance Training at Site

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

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

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

17.03.00 On-the-Job Training

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

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

17.04.00 For detail C&I training refer to Volume-VI, Section-9.

18.00.00 DEVIATIONS

The Bidder is required to submit with his proposal in the relevant schedules a detail list of any and all deviations taken by him clearly without any ambiguity. In the absence of such a list it will be understood and agreed that the Bidder's proposal is based on strict conformance to this specification and no post-contract negotiations would be allowed in this regard.

Unless otherwise specifically indicated in the deviation list, it will be construed and agreed that details indicated in documents & drawings furnished by the Bidder along with the offer is in-line with the specification requirement.

ANNEXURE-I

LIST OF STANDARDS FOR REFERENCE

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

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- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS).
- z) Bureau of Indian Standards Institution (BIS).
- aa) Indian Electricity Rules.
- bb) Indian Boiler Regulations (IBR).
- cc) Indian Explosives Act.
- dd) Indian Factories Act.
- ee) Tariff Advisory Committee (TAC) rules.
- ff) Emission regulation of Central Pollution Control Board (CPCB).
- gg) Pollution Control regulations of Dept. of Environment, Govt. of India
- hh) Central Board of Irrigation and Power (CBIP) Publications.
- ii) The Air Prevention and Control of Pollution Act.
- jj) The Environmental Protection Act
- kk) The Public Liability Insurance Act.
- ll) The Forest Conservation Act
- mm) The Wildlife protection Act.
- nn) The EIA Notification, 1994.
- oo) IS: 14665-Specification for Electric Traction Lift
- pp) Any other statutory Codes/Standards/Regulations

CRITERIA FOR LAYOUT

PLOT PLAN LAYOUT REQUIREMENTS

ITEM	SPECIFICATION REQUIREMENT
A. Site conditions to be considered	
1. Prevalent wind direction	See wind-rose in plot plan. Also refer Metrological Data.
B. Layout Requirements	
1. Maximum permissible slope in	
a) Rail track	1 in 400
b) Road	1 in 30
c) Sides of unpaved embankment	1 in 2
2. Required road width	
a) Main roads	Refer VII-A, B, C.
b) Auxiliary interconnections	Refer VII-A, B, C.
c) Road to the power house unloading bay :	
• Only for entry to the unloading bay	Yes
• To pass through the unloading bay	No
3. Required minimum horizontal distance between the nearest points of	
a) Plant boundary and the boundary of residential area	(Local municipality/factory rule)
b) Electrical transformer and any other building/facility	As per the Tariff Advisory Committee/ LPA Rules
c) Fire water supply installation and any building/facility subject to fire risk.	As per the Tariff Advisory Committee/ LPA Rules
d) Inflammable liquid (fuel oil, etc.) storage & handling installation and their fencing and other buildings/facilities.	Rules of the Indian Explosive (Indian Explosives Act) and Indian Petroleum Code

4.	Required minimum vertical clearance	
a)	Under pipes/cable racks at road crossings	8.0 Metres
b)	Soil coverage over underground pipes	1.0 Metre (minimum)
5.	Railway Wagon clearance	Rules of the Indian Railways
6.	Minimum Clearance between any road edge and building/structure/ any fixed installation.	3 Metres
7.	Required level, above the local developed grade level, of	
a)	top of all roads	150 mm above FGL
b)	all outdoor paved areas	100 mm above FGL
c)	Temporary storage areas, workshops, offices, residence etc. required at the time of erection work.	Yes
d)	Green belt around power plant area	As per environmental guidelines of MOEF, Govt. of India.

BUILDING/ EQUIPMENT LAYOUT REQUIREMENTS

A.	Minimum clear space required at all working and walking areas for operating & maintenance personnel	
1.	Horizontal, in all directions	
a)	Adjacent to any electrical equipment, electrical cables, running (rotating/reciprocating) equipment, safety valve or vent/drain pipe outlet, pipe/ equipment of surface temperature exceeding 60°C.	1200 mm
b)	Adjacent to any other plant facilities (including walls/structures)	1000 mm
2.	Vertical (head-room clearance)	
a)	Under any pipe/equipment surface of temperature exceeding 60°C and any electrical cables or other electrical items.	2.5 Metre
b)	Under any other plant facilities (including structures, pipes etc.)	2.5 Metre

ITEM	SPECIFICATION REQUIREMENT
3. For all areas where any equipment (including trucks, trolleys and other material handling equipment) will move or maneuver.	Minimum 500 mm clear in all direction from the outer edges of the equipment
4. Minimum clear hand space required for	
a) The application of thermal insulation	100 mm
b) Welding work	150 mm
c) Bolt tightening	150 mm
B. Floors, platforms, staircase, ladders, walls, doors & windows	
1. Statutory Requirement	As per the regulations of Tariff Advisory Committee, Indian National Building Code, Indian Factories Act, Local Municipal Rules, etc.
2. Operation & Maintenance Requirement	
a) Adequate floor space shall be kept to permit dismantling, temporary storing and in-situ maintenance of plant & equipment parts, satisfying the clear space requirements stated above. A separate unloading bay for such purpose is required.	Yes
b) Floors or fixed/portable platforms with stairs/ ladders shall be provided for easy approach to any plant item, including valves, instruments, etc. to be operated, observed and/or to be frequently (more than once a month) maintained.	Yes
3. Plinth level of all buildings, above the finished grade level	500 mm
4. Minimum access opening required (with rolling shutter) for transportation, wherever entry of truck for material handling is envisaged	3.5M wide x 4M high or, more depending upon the equipment size to be handled

ITEM	SPECIFICATION REQUIREMENT
C. Other Maintenance Requirement	
1. Generator stator handling In case the Generator stator cannot be handled by the turbine house crane, all provisions for its overhauling, including the arrangement to slide the stator on the turbine house floor, the foundation work for stator jacking /lowering assembly, dismantling of building end walls/structures etc. shall be kept.	Yes
2. Maintenance of the internals/impellers of all important equipment, like boiler feed pumps, feed water heaters, Surface Condenser, fans of the boiler draft plant, Intake and circulating water pumps, cooling water pumps, coal mills, compressors, blowers, heat exchangers, fuel oil pumps, filters etc.	Shall be possible without disconnecting or dismantling any piping/ducting.
3. Overhauling and handling of the casings for the above items	Shall be possible without disturbing/dismantling any piping/ducting not directly connected to them.
4. Crane Approach Wherever required the unobstructed approach of the crane hook/other hoisting equipment hook to various plant & equipment shall be possible.	Yes
D. Central Control Room	
All electronic equipment other than those directly associated with control, operation or presentation of displays shall be mounted external to the control room in air conditioned control equipment room.	Yes
The bidder shall describe in his bid the proposed layout philosophy of the Central Control Room and Control Equipment Room and the arrangement of equipment best suited for the system offered by him and as per good ergonomically consideration.	
However, as a guide line, following features are given :	
a) False ceiling and false flooring shall be provided.	
b) Uniform height, colouring schemes for cabinets etc. shall be available.	

ITEM	SPECIFICATION REQUIREMENT
c) The total area of floor space covered by Control Consoles/Panels in the Control Room shall not exceed 15% of floor area.	
d) No opening shall be provided from Boiler side.	
e) Two double leaf doors, suitably located for entering the Control room shall be provided with opening towards the turbine floor.	
f) Cable entry for the panels/consoles shall be from bottom and suitable openings shall be provided.	
g) The Control Room lighting shall be designed to provide a glare free uniform illumination. The level of illumination shall be minimum 400 LUX.	
h) Necessary Air Conditioning shall be provided for Central Control room, Control Equipment Room and SWAS room etc.	
i) Basic amenities like toilet, Tiffin rooms, wash basins, rest rooms etc. shall be provided near the Control Room.	
E. Toilet and drinking water facility	Required in all buildings and on all floors wherever operating personnel are to be deployed.

PROJECT MANAGEMENT AND SITE SERVICES

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

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

- a) Planning and Monitoring
- b) Engineering Management
- c) Contracts Management
- d) Project Safety Management
- e) Quality Assurance, Inspection & Expediting
- f) Construction Management
- g) Spares Management
- h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

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

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

1.02.02 Central Co-ordination Cell

The central coordination cell shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or

references made by Owner and his Consultants without having the need to refer to his headquarters each time.

1.02.03 **Site Organisation**

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

1.02.04 **Organisation Chart**

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

1.03.00 **Implementation Schedule**

The schedule for the completion of the Project would be as follows :

Period in Months from Zero date (Taken as advance payment date of EPC Package)

- | | | |
|----|----------------------|-----------|
| a) | Boiler Hydro-test | By Bidder |
| b) | Boiler light up | By Bidder |
| e) | Commercial operation | 50 |

To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:

1.03.01 **Engineering Schedules**

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

1.03.02 **Manufacturing Schedule**

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

1.03.03 Erection Schedules

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

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

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

1.04.00 Detailed Responsibilities

1.04.01 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network.

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

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

b) Monitoring & Progress Reporting

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

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

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

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

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

1.04.02 Engineering Management

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

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