

**400 MW MARIB GTPS
PHASE II**

VOLUME - IIB & III

**TECHNICAL SPECIFICATION
FOR
COMPRESSED AIR SYSTEM**

SPECIFICATION NO.: - PE-TS-372-555-A001, REV. - 01



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



TITLE **400 MW MARIB GTPS PH II**
COMPRESSED AIR SYSTEM
INDEX

SPECIFICATION NO: PE-TS-372-555-A001

REV 01

DATE 21.01.2013

SHEET 1 OF 1


VOLUME – IIB

SECTION	TITLE	SPECIFICATION NO.	PAGE NO.
SECTION-A	SCOPE OF ENQUIRY	PE-TS-372-555-A001	2
SECTION-B	PROJECT INFORMATION		3-6
SECTION-C1	SPECIFIC TECHNICAL REQUIREMENT	PE-TS-372-555-A001	7-13
SECTION-C2	CUSTOMER TECHNICAL SPECIFICATION		14-33
SECTION-C3	TECHNICAL SPECIFICATION (ELECTRICAL PORTION)		34-101
SECTION-C4	TECHNICAL SPECIFICATION (C & I PORTION)		102-210
SECTION-C5	PAINTING SPECIFICATION		211-230
SECTION-C6	SEAWORTHY PACKING SPECIFICATION		231-292
	<u>ANNEXURES</u>		
i)	ANNEXURE-I	LIST OF MAKES	293-297
ii)	ANNEXURE-II	CODES & STANDARD	298-300
SECTION-D	STANDARD TECHNICAL SPECIFICATIONS		301-317

VOLUME-III

(DATA SHEET AND SCHEDULES)

SECTION-E	TITLE	PAGE NO.
1	Suggestive Price Format	318-319
2	Gauranteed Power consumption Figures	320
3	Format – No Deviation Certificate	321
4	Schedule of Clarification/ Deviation	322
5	Schedule of Declarations	323
6	Schedule of Drawings/ Documents	324
SECTION-F	LIST OF ENCLOSURES	
1	Schematic for Compressed Air Plant- PE-DG-372-555-A501	325

	<p align="center">COMPRESSED AIR SYSTEM SCOPE OF ENQUIRY</p>	SPECIFICATION NO: PE-TS-372-555-A001	
		VOLUME IIB	
		SECTION - A	
		Rev 01	DATE: 21.01.2013
		SHEET 1 of 1	
<p>1.</p>	<p>SCOPE</p> <p>This specification covers the design, manufacture, inspection and testing at manufacturer's works, proper packing, delivery to designated port, supervision of erection and commissioning, final painting & carrying out acceptance tests at site of Compressed Air system as mentioned in the different Section of this specification for Marib GTPS, Yemen.</p>		
<p>2.</p>	<p>GENERAL TECHNICAL INSTRUCTIONS</p>		
<p>2.1.1</p>	<p>This volume IIB covers requirements of design, engineering, manufacture, and delivery to site, supervision of erection & commissioning of the complete plant. The requirements specified under Volume-I, Volume-IIA & Volume-IIC shall be considered as a part of Volume-IIB.</p>		
<p>2.1.2</p>	<p>It is not the intent to specify herein all the details of design & construction. However, the equipment shall conform to high standards of design, engineering & workmanship in all respects and shall be capable of performing the required duties in a manner acceptable to owner who will interpret the meaning of drawings and specifications and shall be entitled to reject any work or material which in his judgment is not in full accordance herewith.</p>		
<p>2.1.3</p>	<p>In case of any Technical Deviation, the Bidder shall indicate the same clause by clause in the enclosed schedules. In the absence of duly filled schedules, it will be construed that the bid conforms strictly to the specification.</p>		
<p>2.1.4</p>	<p>The bidder may offer optionally the standard design of equipment indicating the deviations from the specification. However, feedback reports must be furnished of equipment performance. The acceptance of optional equipment shall not be binding on Purchaser.</p>		
<p>2.1.5</p>	<p>The requirements mentioned in Section-'C'/ Data Sheet-'A' of Section-D shall prevail and govern in case of conflict between the same and the corresponding requirements mentioned in the description portion in Section-D</p>		



TITLE	SPECIFICATION NO. PE-TS-372-555-A001	
	VOLUME	
	SECTION	
	REV 00	DATE 20/07/2012
	SHEET	

SECTION-B

PROJECT INFORMATION

400 MW MARIB GTPS PHASE-II, YEMEN

PROJECT INFORMATION-REV00

1.	Owner	PUBLIC ELECTRICITY CORPORATION, MINISTRY OF ELECTRICITY AND ENERGY , REPUBLIC OF YEMEN
2.	Project	400 MW MARIB GTPS PHASE-II
3.	Owner's consultant	The Kuljian corporation , Philadelphia , USA
4.	Location	Marib , Yemen
5.	Nearest Airport	El Rahaba Airport (SAH), Sana'a, Yemen
6.	Nearest Railway Station	No rail network in Yemen
7.	Access to site	a. <u>Through sea</u> : <ul style="list-style-type: none">Distance of site: From Aden Port (Gulf of Aden): 419 Km b. <u>By Air</u> : Sana'a Airport <ul style="list-style-type: none">Distance from site : 172 Km
8.	Site data	
A	Altitude	1100 m above Mean Sea Level
B	Ambient Air Temperature	45 °C

	1. Design Minimum Temp.	-----
C	RELATIVE HUMIDITY	
	Design Relative Humidity	60%
D	RAINFALL	
1.	Average Rainfall per annum	< 100 mm
E	WIND VELOCITY & PRESSURE	
1.	Max. Design Wind Velocity	120 km/h
2.	Max. Barometric Pressure Barometric Pressure at sea level	1023.6 mbar 887.7 mbar
F	SEISMIC ZONE	UBC 1997,Zone-2 A
9.0		
A	Design Ambient temperature for Gas Turbine & Mechanical equipment	45 °C
B	Design Ambient temperature of electrical equipment	50 °C
10.0	Electrical Details	Refer attached Anx-I

Electrical Power Sources and Equipment Voltage Rating

ANX-I

- i. 400,000±10% Volts, 3-phase, 50 Hz, solidly grounded system.
- ii. 33,000±10% Volts, 3-phase, 50 Hz, solidly grounded system.
- iii. 6600±10% volts, 3-phase, 50 Hz, low resistance grounded system.
- iv. 400±10% volts, 3-phase, 50 Hz, solidly grounded system
- v. 230±10% volts, 1-phase, 50 Hz, (PH/N of 400 volt) for lighting, receptacles and small power
- vi. AC 230 ± 5% volts, 50 Hz, 1-phase, for instrumentation and controls.
- vii. 220V / 125 / 24 / 48V (+) 10% to (-) 15% volts (DC), ungrounded system

Electric Equipment Voltage Rating

AC Equipment Voltage Rating

- | | | | |
|------|--------------------------------------|---|---------------------|
| i. | Motors larger than 250 kW | : | 6.6 KV, 3-ph, 50 Hz |
| ii. | Motors less than and equal to 250 kW | : | 400V, 3-ph, 50 Hz |
| iii. | Lighting with associated equipment | : | 230V, 1-ph, 50 Hz |
| iv. | MOV motors | : | 400V, 3-ph, 50 Hz |

Frequency : 50 Hz ± 5%

Fault Level

- | | | | |
|------|----------------------|---|---|
| i. | 400,000 volts system | : | 31.5KA for 3 sec. (In line with Phase - I) |
| ii. | 33,000 volts system | : | 31 kA for 3 sec. (In line with Phase - I) |
| iii. | 6600 volts system | : | 25 kA for 3 sec. (In line with Phase - I) |
| iv. | 400 volts system | : | Min. 50 kA for 1 sec. in line with Phase-I to be uprated based on calculation to be submitted for Phase - II. |
| v. | DC system | : | By Bidder for 1 sec. |




400MW MARIB GTPS PH II
COMPRESSED AIR SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION NO. PE-TS-372-555-A001	
VOLUME - IIB	
SECTION C1	
REV. 01	DATE: 21.01.2013
SHEET 1 OF 7	

SECTION – C1

SPECIFIC TECHNICAL REQUIREMENT

	400MW MARIB GTPS PH II COMPRESSED AIR SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-372-555-A001	
		VOLUME - IIB	
		SECTION C1	
		REV. 01	DATE: 21.01.2013
		SHEET 2 OF 7	

1.

INTENT

1.0.1

The purpose of this document is to bring out clarity with regard to the following:

a)

System description and Basic operation & Control Philosophy

b)

Major technical requirements of various items covered under this package

c)

Scope, terminal points (if any), exclusion (if any).

1.0.2

In case of any contradiction in requirement indicated in this section and those in other tender documents, details given in this section shall prevail.

2.

GENERAL DESCRIPTION

The compressed air system is comprised of the instrument air system and the plant air system. Instrument air is required for the various pneumatically operated valves and instruments in the power plant, while plant air is required for general plant services.

3.

DESIGN CRITERIA

3.1

System Design Criteria

Compressed air system includes the following:

3.1.1

Three (3) nos. (1 W for IA, 1 W for SA & 1 common standby) air compressors for IA and SA applications, including drives, intercoolers, after coolers, step up gearbox, silencer and other accessories. Compressor shall be air cooled oil free screw or air cooled rotary tooth type.

3.1.2

Three (3) nos. (1 W for IA, 1 W for SA & 1 common standby) air-drying plants (ADP) each suitable for connecting to individual air compressor. ADP shall be air-cooled refrigerant type.

3.1.3

Intake air filters.

3.1.4

Four (04) nos. air receivers as follows:

Four (04) nos. air receivers of 6 M3 capacity, i.e., two no. for each of IA and SA applications near compressor house.

3.1.5

All interconnecting piping, valves, fittings, supports/hangers, control air tubing (complete with valves and fittings between air receiver, compressor and local panel for each compressor) for safe and satisfactory operation of air compressors.

3.1.6

Controls & interlocks and instrumentation.

3.2

Equipment Design Criteria

3.2.1

AIR COMPRESSORS

3.2.1.1

The capacity of each air compressor shall be 10 NM³/min (min). Delivery pressure will be 8.5 kg/cm² (g) at outlet of each compressor & 8.0 kg/ cm² (g) at ADP outlet. Each compressor will be designed to deliver the nominal capacity at the required delivery pressure.

3.2.1.2


Air compressors will be multi stage air cooled oil free, screw type/ air cooled rotary tooth type.

3.2.1.3

The compressors' capacity will be designed for 45⁰ C DBT and 60% RH at atmospheric pressure at site & at MSL of 1100m.

3.2.1.4

Testing of compressor will be as per ISO: 1217.

	400MW MARIB GTPS PH II COMPRESSED AIR SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-372-555-A001	
		VOLUME - IIB	
		SECTION C1	
		REV. 01	DATE: 21.01.2013
		SHEET 3 OF 7	

3.2.1.5

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

3.2.1.6

The continuous motor rating (at 50⁰ C ambient) will be at least fifteen percent (15%) above the maximum load demand of the driven equipment under the entire operating range. When the driver is not directly coupled to the compressor, due consideration will be made for losses in power transmission, in addition to the above margin.

3.2.1.7

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

3.2.1.8

Noise level near the compressors shall not exceed 85 dB at a distance of 1.0 m in free field conditions, testing as per ISO: 1217. Required acoustic enclosures may be provided to meet the above condition. The discharge blow off silencer and intake silencers shall be designed to meet the above noise limitation level.

3.2.1.9

Compressed air velocity shall be limited to 9 m/sec.

3.2.2

AIR DRYING PLANT

Air-drying plant shall be refrigerant type. The capacity of ADP shall be 10 NM3/min (min) each.

Atmospheric pressure dew point shall – 20 deg C (max).

Line pressure dew point shall be + 4 deg C (max).

3.2.3

INTER COOLER, AFTER COOLER & OIL COOLERS

3.2.3.1 Inter cooler, after cooler & oil cooler shall be air cooled.
3.2.3.2 The coolers shall be designed for the max. heat load.
3.2.3.3 Adequately sized safety valve shall be provided for both inter cooler & after cooler.
3.2.3.4 Each intercooler & after cooler shall be provided with moisture separator unit with suitable baffling. Electrically operated automatic drain trap station with bypass valve & isolation valves shall be provided for moisture separator for automatic draining of condensed moisture. Manual draining facility shall also be provided.

3.2.4

INTAKE FILTER

3.2.4.1 Heavy duty dry type suction air filters will be provided at the compressor inlet to prevent dust and dirt from entering the compressor chamber.
3.2.4.2 The filtering efficiency shall not be less than 99% for particles 3 micron & higher. Sound suppressing characteristics will be considered in the filter design.

3.2.5

AIR RECEIVER

The capacity of each air receiver shall be 6 M³.

The air receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.



400MW MARIB GTPS PH II
COMPRESSED AIR SYSTEM
SPECIFIC TECHNICAL REQUIREMENT

SPECIFICATION NO. PE-TS-372-555-A001	
VOLUME - IIB	
SECTION C1	
REV. 01	DATE: 21.01.2013
SHEET 4 OF 7	

Design Pressure for the air receiver shall be 12 kg/cm²(g) and 50 degC respectively.

The material of construction of shell, dished ends, flanges etc of the air receivers shall be of carbon steel as **SA 516 Gr. 70** or equivalent.

Air receiver shall be provided with nozzles, air release vents, safety valve, pressure gauge, temperature gauge, minimum 500 mm dia. manhole for inspection.

3.2.6

PIPING & VALVES (WITHIN COMPRESSOR HOUSE)

All interconnecting compressed air piping shall conform to A 53 Gr. B, galvanized. The fitting shall conform to A 105, galvanized. Compressed air piping from air compressor to after cooler and other lines handling hot air will be suitably insulated so as to restrict surface temperature to 60 deg C. The pipe joints will be screwed coupling type for sizes up to 50 NB and above 50 NB the same will be flanged.

All the distribution valves shall be ball valve type. Necessary auto drain shall also be provided at strategic points.

All Airlines shall be screwed connection and rubber lined pipes of flanged connection.

VALVES

a) Compressed Air Services:

- ◆ All airline valves shall be ball valve type. For compressed air application, valve material shall be galvanized cast carbon steel as mentioned below:

SIZE	BODY BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
≥ 65 NB	ASTM A 216 Gr. WCB	ASTM A 216 Gr WCB	ASTM A479 Type 410-2	ASTM A47 Gr. 32510	FLANGED RAISED FACE
≤ 50 NB	ASTM A 105	13% Cr Steel (Ball)	ASTM A479 Type 410-2	ASTM A47 Gr. 32510	SCREWED TYPE

b) Auto drain trap for each air receiver shall be provided.

c) Moisture traps at strategic locations shall be provided in the distribution network.

4. LAYOUT CONSIDERATIONS

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


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

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

5. OPERATION, CONTROL & INSTRUMENTATION

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

5.1.2 Individual compressor control shall be through microprocessor based control system as per manufacturer's standard.

	400MW MARIB GTPS PH II COMPRESSED AIR SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-372-555-A001	
		VOLUME - IIB	
		SECTION C1	
		REV. 01	DATE: 21.01.2013
		SHEET 5 OF 7	

6.

POWER SUPPLY ARRANGEMENT

6.1.1

The power supply (rated voltage, frequency, phase) of the equipments will be 3.3 KV, 415 V +/- 10%, 3ph, 50 Hz +5% to -5%. 10% combined variation of voltage and frequency.

7.

GENERAL

7.1.1

Compressed Air system shall be offered as turnkey basis (supply, supervision of erection & commissioning) meeting specification requirements.

7.1.2

Base plates and foundation bolts including anchor bolts, nuts, loose fittings etc. for equipment and as would be necessary for erection and complete anchoring of steel materials for the pipes, hangers and supports and Compressors, Air receivers etc. Anchor fasteners shall be in the scope of bidder.

7.1.3

Compressed Air plant supplier to follow Schematic for Compressed Air Plant, BHEL drg no. PE-DG-372-555-501 Rev 01 indicating scope of supply attached with this specification. Following shall be noted in addition to above:

a)

Air pipe sizing shall be done by considering compressed air velocity not exceeding 9 m/s.

b)

Compressed air plant supplier shall provide microprocessor based controls for compressor pack.

7.1.4

Painting Specification is enclosed. The painting procedure for the subject package will be subject to BHEL/Customer approval during detail engineering stage. However, compressor pack to be provided with powder coated epoxy paint only.

7.1.5

Codes and Standards shall be as per Annexure – I.

7.1.6

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 BHEL / Customer approval during detail engineering stage.

7.1.7

All drawings and documents shall be computer based.

7.1.8

All commissioning spares & consumables for trouble free operation shall be provided.

7.1.9

First fill of lubricants & consumables for all equipment in Compressed Air System shall be in the scope of bidder.

7.1.10

Supply of special tools and tackles including toolbox required for operation, maintenance and overhauling of the system shall be in the scope of bidder.

7.1.11

Drawings, Data and instruction manual for the system as per drawings / documents distribution schedule required by customer shall be in the scope of bidder.

7.1.12

Quality Plans attached with the specification are indicating minimum requirements for inspection and testing. Bidder to note that quality plans is subject to BHEL/Customer approval during detail engg. Stage.

7.1.13

List of make is enclosed as per Annexure-II. Makes of equipment shall be subject to BHEL/Customer approval during detailed engineering.

7.1.14

Unit rates for all the items in mandatory spares list shall be furnished separately by the bidder.

7.1.15

The tools and tackles required for regular maintenance shall be supplied by compressed air plant supplier.

7.1.16


The following (minimum) shall be demonstrated at shop:


7.1.16.1.

Capacity and discharge pressure of each compressor.

7.1.16.2.

Power consumption of each air compressor at its rated duty point with its own motor.

	400MW MARIB GTPS PH II COMPRESSED AIR SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-372-555-A001	
		VOLUME - IIB	
		SECTION C1	
		REV. 01	DATE: 21.01.2013
		SHEET 6 OF 7	
7.1.17	The following (minimum) shall be demonstrated at site:		
7.1.17.1.	Parallel Operation of air compressors.		
7.1.17.2.	Vibration and noise level of air compressors.		
7.1.18	Instrument for testing shall be calibrated by compressed air plant supplier before taking up testing.		
7.1.19	All motors shall be in accordance with the technical specification enclosed hereinafter. Deviation, if any, shall be clearly brought out in schedule of deviation.		
7.1.20	Each motor terminal box shall be provided with cable gland and lugs for the size and type of power and control cable of respective motor.		
7.1.21	Electrical items to be provided by compressed air plant shall be as indicated elsewhere in the specification		
7.1.22	Technical specification for control and instrumentation items to be provided by compressed air plant shall be as indicated elsewhere in the specification.		
7.1.23	The above clauses specify equipment for general guidance only. Any other equipment and / or material necessary to ensure safe & satisfactory erection, commissioning & operation of the plant shall be included in bidder's scope & brought out clearly. The detail design & equipment sizing shall be in the bidder's scope of supply.		
7.1.24	The bidders proposal shall be for equipment in accordance with the Tech. Specification.		
7.1.25	Bidder to clearly note that there is no deviation from the tech specification other than those indicated in their offer under "DEVIATION OF TECH. SPECIFICATION" Bidders shall also note that the deviation in any other form except above is not acceptable (i.e. in data sheet or other Annexures or elsewhere in this offer) and same shall not be considered for review/evaluation purpose/comments and it is assumed that the system/material/equipment have been offered strictly in line with specifications/requirements.		
8.	EXCLUSIONS		
	Items of works listed below are excluded from scope of the compressed air plant supplier.		
8.1.1	Civil works including construction of compressor house, foundation of all compressor, and air receiver, pipe/cable trenches.		
8.1.2	Lighting and ventilation of compressor house.		
8.1.3	Handling arrangement in the compressor house.		
8.1.4	Compressed Air Distribution Piping running compressed air header after the air receivers outside the compressor house.		
9.	DRAWINGS / DOCUMENTS TO BE FURNISHED BY BIDDER ALONG WITH TECHNICAL OFFER		
9.1.1	Scope of work along with system description, equipment being supplied including mandatory spares & commissioning spares.		
9.1.2	"Deviation of Technical Specification", if any.		
9.1.3	P&I Diagram of compressed air system.		
9.1.4	Space requirement / layout of compressor house.		
9.1.5	Handling arrangement requirement for maintenance purpose.		

	400MW MARIB GTPS PH II COMPRESSED AIR SYSTEM SPECIFIC TECHNICAL REQUIREMENT	SPECIFICATION NO. PE-TS-372-555-A001	
		VOLUME - IIB	
		SECTION C1	
		REV. 01	DATE: 21.01.2013
		SHEET 7 OF 7	

9.1.6	Completely filled Data Sheet B of compressed air system and other instruments attached with the Technical Specification.
9.1.7	Quality Plans for the compressor, motor, valves, instruments etc, duly signed by the bidder, to be furnished along with the Technical Offer.
9.2	Successful bidder in the event of award of contract shall furnish all the drawings/ documents (in soft and hard form) required to successfully design, install and commission the system. The schedule of such drawings is as per Section E – 6 (Schedule of Drawings/ Documents).



TITLE	SPECIFICATION NO. PE-TS-372-555-A001	
	VOLUME	
	SECTION	
	REV 00	DATE 20/07/2012
	SHEET	

SECTION-C2

CUSTOMER TECHNICAL SPECIFICATION

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				1

(PEC TENDER NO.: 12/2008)

VOLUME IV
SECTION 7.2
COMPRESSED AIR PLANT

FORMT9-P REV-B

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				2

(PEC TENDER NO.: 12/2008)

Table of Contents

7.2.0	COMPRESSED AIR SYSTEM	3
7.2.1	GENERAL	3
7.2.2	SCOPE OF WORK	3
7.2.3	COMMON EQUIPMENT AND SERVICES	4
7.2.4	TECHNICAL REQUIREMENTS	5
7.2.5	SPECIFIED DESIGN DATA	8
7.2.6	TECHNICAL DATA BY THE TENDERER	9
7.2.7	GUARANTEES, REJECTION	13

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				3

7.2.0 Compressed Air System

7.2.1 General

The compressed air system shall provide supply of compressed air having suitable pressure and quality of Service air for cleaning of filters, strainers and general purpose and for instrument and Instrument Air for operation of I/P converters, purge instruments, pneumatic actuation of control valves, dampers, etc. for different systems.

This specification includes, the design, manufacture, supply, testing, erection & commissioning of complete Compressed Air Plant. The enclosed drawing No. 30-7195-M-005 shall be referred.

The proposed Compressed Air Plant shall be designed as per the design criteria and material specification given in this specification.

If any provision of the specification departs from the Contractor's usual construction sufficiently to materially increase the cost of the equipment without in his opinion providing corresponding increase in quality/reliability or if he considers that his standard construction would provide better quality/reliability he shall offer the equipment/system on the basis of his standard construction. In case such offer is made, the Contractor shall state very clearly the merit of his offer and the demerits, (in his opinion) the specified equipment/system, has and the deviations taken against the specification are to be clearly stated in the "Deviation Schedule" without which it will be considered that the Contractor complies to the specification requirements. However the Contractor shall not make any changes on the offered equipment during execution.

7.2.2 Scope of Work

This section sets out the scope of the installations covered by this specification as well as required supplies and services but without excluding other necessary components and services not mentioned.

- Two (2) Nos. of compressor (2 x 100%) each for Instrument Air (IA) and 2x100% for Service Air (SA) system of non lubricated, oil free reciprocating, two stage complete with suction filter, silencer, intercooler, aftercooler, lubricating system, baseplate, etc.
- 2 x 100% Air drying plant complete with prefilter, after filter (fine filter), etc.
- Service air receiver and Instrument air receiver, one each
- Interconnecting piping between the equipment supplied for both instrument & Service air with necessary valves, fittings, etc.

Pipe work

Complete piping networks required for distribution of instrument air and service air including compensators, impulse tubing, automatic operating devices, supports, fasteners, necessary automatic condensate traps, isolating valves, bypass control valves, fittings, etc, including the following particular items:

- discharge line check valves
- discharge line overpressure relief valves

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				4

Control and monitoring equipment

- completely wired, equipped and factory tested local control board for the compressed air plant including:
 - i) independent compressor control devices (connected to the main air receivers)
 - ii) automatic start and stop control combined with loading and unloading devices as required and described in this specification.
- All signalling annunciators, pressure gauges, thermometers, flow meters, safety valves, etc. for in-line mounting of networks
- Pressure-reducing valves and control valves where necessary
- All necessary local measuring, control, instrumentation and monitoring equipment, including cabling, sensors, etc. as well as additional instrumentation necessary to suit any special design features of the plant and its accessories.

7.2.3 Common equipment and services

- All general services as required such as transport, erection, commissioning, trial operation, testing, training on site, supervision of operation and maintenance during guarantee period, etc. as stipulated in Vol.II
- All necessary base frames, base plates, anchor bolts, supports, covers, etc.
- Spare parts as stipulated in Section 10.0 of Vol.II.
- All necessary venting, draining & emptying equipment,
- All necessary insulation as required in section 7.7 of Vol. IV
- All necessary painting, corrosion protection & preservation measures as required in section 7.6 of Vol. IV
- Complete detailed labelling of all installations as required in section 13.0 of Vol. II
- Documentation according to section 12.0 of Vol. II
- Complete electrical system including drive motors suitable for area specified, control panel, local push button stations, transformers rectifier set, power & control cables, cabling complete with supports, cable trays, glands, lugs, for the successful operation of the plant. The electrical system shall confirm to the requirements specified Section 8.0 of Vol. V
- All consumables as per section 3.0 of Vol. II
- One set of special tools, tackles and equipment as stipulated in Section 11.0 of Vol.II.
- All standard equipment and accessories normally included in the supply schedule but not separately listed.

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				5

7.2.4 TECHNICAL REQUIREMENTS

The requirements specified in section 17.0 of Vol. II are to be applied as well as further regulations from the other sections of this specification.

The installation and dismantling of the various parts of the equipment must not present any great difficulty and appropriate design features must be incorporated for this purpose.

7.2.4.1 Compressors, drives and transmissions

The air compressors are to be of the dry running (non lubricated, oil free) reciprocating type with two stages.

Compressors shall have intercoolers and after-coolers. Compressors offered shall be well balanced, requiring light foundations, preferably soleplate-mounted factory-tested units. Preference will be given to reciprocating compressors working at relatively low speed.

The suction and discharge valves of the reciprocating compressors are to be of sufficient size and so designed that wire-drawing and air-baffling are reduced to a minimum. They are to operate without shock.

Compressors are to be complete with all necessary drain valves, drain pipes, relief valves, inlet and outlet air valves, sight feed lubricators, pressure gauges, thermometer pockets and other necessary fittings. Appropriate instrumentation shall be provided to monitor the lubricating oil system of the compressors. The compressor design shall comply with recognized International Standards.

The compressors are to be driven by electric motors. The drives are to be sized with an appropriate load factor and service factor to overcome the maximum torque at the minimum air temperature in the intake. The motor rating shall have a margin of 15% over BKW at duty point.

Directly coupled motors with flexible coupling or multiple V-belt transmission shall be employed. V-belts are to be furnished in matched sets and shall be of heavy duty of premium quality rating, oil resistant & have static conducting characteristics. Flat belt transmission, Planetary gear or chain transmission are not permitted.

Particular emphasis shall be placed on satisfactory machinery, sound and vibration isolation. Care must be taken, by introducing appropriate amplitude dampers, that resonance does not take place as a result of an insufficient margin between the natural frequency of the installation, or multiples thereof, and the existing frequency in normal operation. Moreover, the critical speed of the compressor and drive, taken together, shall have a sufficient margin from the normal operating speed. No vibration of the building or building floor stemming from the normal operation of the compressors units will be acceptable. If necessary, the foundations of the compressors units are to be installed as separate foundation slabs with spring elements supported on the building floor.

7.2.4.2 Aftercoolers and Intercoolers

Intercoolers and after coolers shall be of air cooled type. The design of the coolers must permit the tube nest to be withdrawn in one piece from the shell to facilitate cleaning. Electrically actuated automatic arrangements must be provided for draining the moisture condensed during cooling from the cooler air space. The coolers shall be designed to the requirements of ASME Code Section – VIII for unfired pressure vessels. The coolers shall be pressure tested at 1.5 times of the working pressure.

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				6

7.2.4.3 Air dryers

2 x 100% Refrigerant type air dryer unit shall be provided to make moisture free air. The dryer shall be designed to make dry air at an atmospheric dew point of -40°C. Where the inlet air temperature to the air dryer exceeds 50°C the dryer shall incorporate a pre-cooler in order to optimize the dryer package sizing. The pre-cooler shall be packed in a common base plate of the dryer.

7.2.4.4 Air filters

The inlet filters are to be designed for the maximum throughput of the respective compressor. All other filters are to be designed for the maximum throughput equal to the output of all duty compressors together if more than one duty compressor will be provided. Automatic and maintenance-free working conditions are mandatory during normal operation.

The inlet filters are to be suitable for operation in a dust-laden atmosphere. The minimum lifetime of these filters has to be 16000 working hours.

The prefilter and fine filters shall allow for service time intervals no shorter than 1000 working hours. They shall be equipped with electrically actuated condense traps.

7.2.4.5 Air receivers

The air receivers shall be sized, designed and constructed according to ASME SEC VIII for unfired pressure vessel, division - I. They shall be of the vertical type with dished ends, welded construction suitably coated against corrosion, complete with all connection, instruments, relief valves, lifting brackets, electrically operated moisture traps, manholes (500 mm diameter), etc. The air receivers shall be constructed of carbon steel plates conforming to ASTM A-283 Gr.C.

7.2.4.6 Piping

The general requirements for piping shall comply with the stipulations laid down in section 7.5 of Vol. IV. The piping shall be designed, fabricated and tested in accordance with the relevant standards as agreed by the purchaser, incorporating any other features required by this specification.

No pipework shall be buried unless expressly approved by the purchaser. Where a pipe passes under a road special precautions are to be taken to ensure that no damage is done to the pipe by traffic and that no subsidence of the road will occur. All buried piping shall have fusion-welded joints tested for air-tightness before they are covered.

Integral pipework layout and compressor connections shall avoid straight pipes of such lengths that the column of air inside the pipe would vibrate at the same frequency as the pulsation from the reciprocating air compressors.

A connection from the service air network to the instrument air network shall be provided in such a way that in case of emergency service air compressors can supply air to instrument air system and not vice versa.

Gaskets shall be supplied pre-cut. Gaskets for flat faced flanges shall be full faced.

Service air tapping points in the service air system shall be supplied in sufficient number within the entire plant. An isolating valve complete with a quick release hose connection shall be provided on all tapping points, with in easy access of the operating personnel.

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				7

Pressure gauges shall be provided at extreme ends of the instrument air headers. For both systems suitable connection with blind flanges for future connection shall be provided.

All piping other than threaded shall be fabricated with fusion-welded joints except where flange connections are specified or are required to facilitate erection or maintenance. Connections to machinery or equipment such as receivers, etc. are to be flanged.

Instrument and service air system of Phase II shall be interconnected with Phase I instrument and service air system with isolation valves.

7.2.4.7 Control and Instrumentation

All necessary operational controls, regulating controls, automation, measuring and monitoring required to cope with the equipment duty are to be so designed and arranged such that operation of the plant can be fully automatic or, if required, fully manual. All necessary interlocking and alarm circuits shall be arranged so as to eliminate any possible damage to the plant due to mal functioning of instruments or any probable operational mistakes. Technical features of the controls and instruments shall basically comply with the applicable general requirements of Section 9 of Vol. V & Section 17 of Vol. II.

It must be possible to start the compressed air plant from a common floor-mounted local board. Only those common alarms which are required to indicate malfunctions or failure of the compressed air plant shall be transmitted to the central control room.

An auto/manual selection shall be arranged in such a way that any of the compressors may be selected, the operation of the stand-by compressor shall be controlled by pressure switches located at the main receivers.

Changeover from manual to automatic or vice versa shall occur without interruption.

When the pressure in instrument air receiver falls below the preset value then the supply of air to plant service shall be cut off through a solenoid valve.

Adaption of the specified scope and design of the control and Instruments shall be done where needed for matching the special versions and requirements of apparatus and plant equipment.

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				8

7.2.5 SPECIFIED DESIGN DATA

DESCRIPTION	MINIMUM REQUIREMENTS	
	Unit	Data
Max. ambient temperature	°C	45
Max. humidity	%	60
Attitude above MSL	m	1100
Site ambient pressure	bar	0.8877
Capacity of each compressor referred to the total max. compressed air requirement of the entire unit.	%	120
Number of compressors	No	4 (2 x 100% each for IA and SA)
Pressure at instrument air receiver outlet	bar (g)	≥ 7
Max. air temperature at aftercooler outlet	°C	50
Max. atmospheric dew-point	°C	-40
Number of drier	No	2 x 100%
Capacity of air dryer referred to total max. instrument air requirement of the entire unit	%	125
Storage capacity of Service air receiver	minutes	5
Storage capacity of Instrument air receiver	minutes	5

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				9

7.2.6 TECHNICAL DATA BY THE TENDERER

DESCRIPTION	UNIT	DATA
General		
Nominal steady-state compressed air requirement including pipe losses and instrument losses of the entire unit to be considered, if all plants are in operation and produce 100% output continuously.	Nm ³ /hr	
Max. total compressed air requirement for the whole plant (at 1.013 bar & 0°C)	Nm ³ /hr	
Max. instrument air requirement for entire plant (at 1.013 bar & 0°C)	Nm ³ /hr	
Instrument Air system Pressure	bar (g)	
Switch-on pressure in main receivers for :		
- duty compressor	bar (g)	
- stand-by compressor	bar (g)	
Compressor		
Number of compressors	-	
Make, Model No.	-	
Design code	-	
Capacity of the each compressor (at 1.013 bar & 0°C)	Nm ³ /hr	
Air pressure at aftercooler outlet	bar (g)	
Testing code	-	
Number of stages	-	
Speed of compressors	rpm	
Number of cylinders	-	*
Type of bearings	-	*
Type of bearing lubrication	-	*
Method of no-load control	-	

FORMT9-P REV-B

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				10

DESCRIPTION	UNIT	DATA
Type of transmission	-	*
Shaft power	KW	
Motor rating	KW	
Materials : Crankshaft Connecting rod Piston Piston rod	-	
Driving motor:		
Make	-	*
Speed	rpm	
Rating	kW	
Oil pump		
Rate of delivery	m ³ /h	*
Rating (in case of separate motor)	KW	*
Intercooler		
Design Code	-	
Max. air outlet temperature	°C	
Material of tubes	-	
Aftercooler		
Design Code	-	
Max. air outlet temperature	°C	
Material of tubes	-	
Air dryer		
Number of air dryers	-	
Make, Model No.	-	*
Type	-	

FORMT9-P REV-B

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				11

DESCRIPTION	UNIT	DATA
Capacity of the air drier	Nm ³ /hr	
Air inlet temperature	°C	*
Air outlet temperature	°C	
Atmospheric Dewpoint	°C	
Pressure loss in dryer	bar	*
Rated power demand (if applicable) Heater	KW	*
Motor (for Blower)	KW	*
Prefilter		
Number of filters	-	
Max. throughput of one filter (at 1.013 bar & 0°C)	Nm ³ /hr	*
Mesh size	µm	*
After-filter (fine filter)		
Number of filters	-	
Max. throughput of one filter (at 1.013 bar & 0°C)	Nm ³ /hr	*
Mesh size	µm	*
Service Air receiver		
Number of air receivers	-	
Make	-	
Design Code		
Capacity	m ³	
Pressure at receiver outlet	bar (g)	
Design pressure	bar (g)	
Total height	mm	*
Diameter of receiver	mm	*
Material	-	

FORMT9-P REV-B

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				12

DESCRIPTION	UNIT	DATA
Protection against corrosion:		
Internal	-	*
External	-	*
Instrument Air receiver		
Number of air receivers	-	
Make	-	
Design code	-	
Capacity	m ³	
Pressure at receiver outlet	bar (g)	
Design pressure	bar (g)	
Total height	mm	*
Diameter of receiver	mm	*
Material	-	
Protection against corrosion:		
Internal	-	
External	-	
Pipework		
Materials and relevant standard of pipework to be stated in detail	-	
Note		
* In the data sheet indicate the data may be furnished after award of contract. All other data to be filled in by the Tenderer during Bid stage itself.		

FORMT9-P REV-B

Project	Subject	Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.2
				Sheet No.
				13

7.2.7 GUARANTEES, REJECTION

DESCRIPTION	UNIT	DATA
GUARANTEES		
Max. air temperature at aftercooler outlet	°C	50
Atmospheric Dew point of instrument air	°C	-40
Air intake temperature (dry bulb)	°C	
Relative humidity	%	
Atmospheric pressure	bar	
Compressor		
Capacity of one compressor (at 1.013 bar & 0°C)	Nm ³ /hr	
Air dryer		
Capacity of one dryer (at 1.013 bar & 0°C)	Nm ³ /hr	
Pressure loss at max. throughput	bar	
Instrument air receiver outlet pressure	bar (g)	
Power demand		
Power demand at full load operation of		
- One instrument air compressor	kW	
- One service air compressor	kW	
- One air dryer	kW	
Noise Pressure Level	db	
(at a distance of 1.0 m away from the equipment)		
REJECTION		
Should the deterioration of the guarantee values be greater than following values then the purchaser shall have the right to reject the equipment concerned.		
Compressor capacity	%	4
Atmospheric dew point of instrument air	C	-1
Power demand	%	5

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				1

(PEC TENDER NO.: 12/2008)

VOLUME IV
SECTION 7.5
PIPING, VALVES AND FITTINGS

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				11

PIPE CLASS : PC7

- | | | |
|--------------------|---|--|
| 1. Service | : | Instrument Air, Service Air, Potable & Service water |
| 2. Material | : | A 53 Gr. B. galvanised |
| 3. Dimensions | : | B 36.10 |
| 4. End finish | : | Threaded to NPT. To be supplied with coupling at one end.

For sizes \leq 40 NB, bevelled for sizes \geq 50 NB |
| 5. Test | : | Hydro test required and others as per code. |
| 6. Galvanising | : | Zinc coated inside and outside by hot dip process, |
| 7. Certificates | : | Material and hydro test certificates required. |
| 8. Product Marking | : | Manufacturer's name, Specifications, OD and Thickness. |

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				15

FITTING CLASS : FC7

Service : **Instrument Air (IA), Service Air (SA), Potable Water (PW) & Service Water (DW).**

I. Bends, Elbows & Tees

1. Material : A 105, Galvanised
2. Design/dimensions : ASME B 16.11
3. Ends : Threaded to NPT
4. Certificates : Chemical and mechanical properties, hydro test certificates

II. Flanges

1. Material : ASTM A105 GALVANISED
2. Type/End : Threaded to NPT
3. Design/Dimension : ANSI B 16.5

III. Gaskets

1. Material : CAF
2. Design : ANSI B 16.21

IV. Bolts and Nuts

1. Material : A 193 Gr B7, A 194 Gr 2H
2. Test : Tensile test
3. Certificates : Chemical and tensile test certificates

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				22

VALVE CLASS : VC7**1.0.0 GATE/GLOBE VALVES****1.1.0 Design/Construction**

- 1.1.1 Service : Instrument air, Service air, Service water & Potable water
- 1.1.2 Ends : Screwed for \leq 100 NB, flanged for $>$ 100 NB
- 1.1.3 Design/Dimensions : ANSI B16.34/B 16.10/BS : 5352/BS : 1873
- 1.1.4 Type : ----
- 1.1.5 Bonnet connection : Screwed/Flanged

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				23

1.1.6	Actuator	:	-
1.1.7	Seat	:	Hardened
1.1.8	Back seat	:	-
1.1.9	Hand wheel	:	Required
1.1.10	Sealing equipment	:	
1.2.0	Material		
1.2.1	Body	:	ASTM A181/ASTM A105
1.2.2	Bonnet	:	ASTM A181/ASTM A105
1.2.3	Seat	:	CS hardened
1.2.4	Wedge/Plug	:	ASTM A181
1.2.5	Stem	:	CS
1.2.6	Gasket (Bonnet)	:	-
1.2.7	Gland	:	Brass
1.2.8	Packing	:	Expanded PTFE stem packing
1.2.9	Yoke sleeve	:	Brass
1.2.10	Hand wheel	:	CS
1.2.11	Studs	:	ASTM A193 Gr. B7
1.2.12	Nuts	:	ASTM A194 Gr. 2H
2.0.0	CHECK VALVES		
2.1.0	Design/Construction		
2.1.1	Service	:	Instrument air, Service air, Service water & Potable water
2.1.2	Ends	:	Screwed for \leq 100 NB, flanged for $>$ 100 NB
2.1.3	Design/Dimensions	:	ANSI B16.34 / ANSI B16.10 / BS : 5352 / BS : 1868
2.1.4	Type	:	Swing check
2.2.0	Material		
2.2.1	Body	:	ASTM A181/ASTM A105
2.2.2	Disc	:	ASTM A181/ASTM A105

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	7.5
				Sheet No.
				24

2.2.3	Lever arm	:	CS
2.2.4	Arm nut	:	CS
2.2.5	Arm pin	:	CS
2.2.6	Seat ring	:	CS Hardened
2.2.7	Stud & Nut	:	ASTM A193 Gr. B7/ASTM A194 Gr. 2H
2.2.8	Cover plate	:	MS



TITLE	SPECIFICATION NO. PE-TS-372-555-A001	
	VOLUME	
	SECTION	
	REV 00	DATE 20/07/2012
	SHEET	

SECTION-C3

TECHNICAL SPECIFICATION (ELECTIRCAL PORTION)



**TECHNICAL SPECIFICATION FOR
COMPRESSED AIR SYSTEM
(ELECTRICAL PORTION)**

SPECIFICATION NO. PE-TS-
VOLUME II B
SECTION-C
REV 00 DATE 28.05.12
PAGE 1 OF 1

ELECTRICAL EQUIPMENT SPECIFICATION FOR COMPRESSED AIR SYSTEM

1.0 EQUIPMENT & SERVICES TO BE PROVIDED BY BIDDER/ PURCHASER

- 1.1 Scope for supply, and erection & commissioning of various equipment forming part of electrical system for this package shall be as per Annexure-I to Section – C [Scope of Work (Electrical)].
- 1.2 Make of various equipment/ items in the scope of bidder shall be to approval of owner during detailed engineering stage without any commercial implications.
- 1.3 Bidder shall furnish all AC loads required for the system at different voltage levels (eg. 400V AC etc.) of all types, such as motor feeders, supply feeders in PEM format along with the offer.
- 1.4 All electrical equipment shall be suitable for the power supplies, fault levels and climatic conditions indicated in project information enclosed with the specification.
- 1.5 All drawings, data sheets, Quality Plan, calculations, test reports, test certificates, etc. shall be submitted during detailed engineering stage. The same shall be subject to approval without any commercial implications.
- 1.6 Technical requirements shall be as per specifications listed in Clause 4.1, 4.2, 4.3 & 4.4 below.

3.0 DOCUMENTS TO BE SUBMITTED ALONG WITH BID

- 3.1 Bidder shall confirm total compliance to the electrical specification without any deviation from the technical/ quality assurance requirements stipulated. In line with this, the bidder as technical offer shall furnish two signed and stamped copies of the following:
 - a) A copy of this sheet "Electrical Equipment Specification for Compressed Air System and sheet "Electrical Scope between BHEL and Vendor" with bidder's signature and company stamp.
 - b) List of Erection and Commissioning spares.
 - c) List of Erection & Maintenance tools & tackles.
 - d) Electrical load requirement in the load data format.
- 3.2 No technical submittal such as copies of data sheets, drawings, write-up, quality plans, type test certificates, technical literature, etc, is required during tender stage. Any such submission even if made, shall not be considered as part of offer.

4.0 LIST OF ENCLOSURES

- 4.1 Electrical Scope Matrix between BHEL & vendor (Annexure-I).
- 4.2 Technical specification and Data Sheets for 400V Electric Motors.
- 4.3 Technical Specification for Power, Control, Instrumentation Control Cable & Miscellaneous electrical item
- 4.4 Quality Plan for motors.
- 4.5 Load data format (Annexure-II).

ANNEXURE-I
ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR

PROJECT: MARIB 400MW GTPS PROJECT, PHASE-II **PACKAGE: COMPRESSED AIR SYSTEM**

<u>S.N</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	400V MCC	BHEL	BHEL	BHEL will provide 400V, 3-phase 4-wire supply. Any other voltage level (AC/DC) required will be derived by the vendor. Any other local panels if required shall be in vendor scope.
2	Local push button station (for motors)	BHEL	BHEL	Located near the motor
3	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor.	Vendor	BHEL	
4.	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor & BHEL.	BHEL	BHEL	
5	Any special type of cable like compensating. Co-axial, prefab, MICC and fibre optical	Vendor	Vendor	
6 III	termination	BHEL	BHEL	
7	Cabling material (cable trays, accessories and cable tray-supporting system etc.)	BHEL	BHEL	
8	Marshalling Boxes/Junction Boxes for Power, control, instrumentation and special cable	Vendor	BHEL	
9	Conduits and conduit accessories for cabling between equipments by vendor	Vendor	BHEL	
10	Equipment earthing.	BHEL	BHEL	Arrangement at equipment end for earthing connection to be ensured by vendor.
10	Motors with Base frame and fixing hardware for motors.	Vendor	BHEL	
11 a	a) Input cable schedules b) Cable interconnection details. c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for control cables for vendor-supplied equipment (soft copies in the BHEL cable schedule format) shall be furnished during detail engineering by vendor.
12	Equipment layout drawings.	Vendor	-	Layout details between vendor supplied equipment and installation drawings by vendor
13	Cable glands and lugs for equipment supplied by vendor	Vendor	BHEL	1. Double compression Nickel-Cr plated brass cable glands (suitable for selected cable size). 2. Solder less crimping type heavy duty tinned copper lugs (suitable for selected cable size).

Note:-

1. Make of all electrical equipments/ items supplied shall be of reputed make & shall be subject to approval of BHEL/ Customer after award of contract.
2. All QPs shall be subject to approval of BHEL/ Customer after award of contract.
3. Soft Copy of Cable Schedule in the Cable Schedule Format Shall Be Furnished By Vendor After Award of Contract.

400 MW MARIB GTPS PHASE-II, YEMEN

PROJECT INFORMATION-REV00

1.	Owner	PUBLIC ELECTRICITY CORPORATION, MINISTRY OF ELECTRICITY AND ENERGY , REPUBLIC OF YEMEN
2.	Project	400 MW MARIB GTPS PHASE-II
3.	Owner's consultant	The Kuljian corporation , Philadelphia , USA
4.	Location	Marib , Yemen
5.	Nearest Airport	El Rahaba Airport (SAH), Sana'a, Yemen
6.	Nearest Railway Station	No rail network in Yemen
7.	Access to site	<p>a. <u>Through sea</u>:</p> <ul style="list-style-type: none"> Distance of site: From Aden Port (Gulf of Aden): 419 Km <p>b. <u>By Air</u> : Sana'a Airport</p> <ul style="list-style-type: none"> Distance from site : 172 Km
8.	Site data	
A	Altitude	1100 m above Mean Sea Level
B	Ambient Air Temperature	45 °C

	1. Design Minimum Temp.	-----
C	RELATIVE HUMIDITY	
	Design Relative Humidity	60%
D	RAINFALL	
1.	Average Rainfall per annum	< 100 mm
E	WIND VELOCITY & PRESSURE	
1.	Max. Design Wind Velocity	120 km/h
2.	Max. Barometric Pressure Barometric Pressure at sea level	1023.6 mbar 887.7 mbar
F	SEISMIC ZONE	UBC 1997,Zone-2 A
9.0		
A	Design Ambient temperature for Gas Turbine & Mechanical equipment	45 °C
B	Design Ambient temperature of electrical equipment	50 °C
10.0	Electrical Details	Refer attached Anx-I

Electrical Power Sources and Equipment Voltage Rating

ANX-I

- i. 400,000±10% Volts, 3-phase, 50 Hz, solidly grounded system.
- ii. 33,000±10% Volts, 3-phase, 50 Hz, solidly grounded system.
- iii. 6600±10% volts, 3-phase, 50 Hz, low resistance grounded system.
- iv. 400±10% volts, 3-phase, 50 Hz, solidly grounded system
- v. 230±10% volts, 1-phase, 50 Hz, (PH/N of 400 volt) for lighting, receptacles and small power
- vi. AC 230 ± 5% volts, 50 Hz, 1-phase, for instrumentation and controls.
- vii. 220V / 125 / 24 / 48V (+) 10% to (-) 15% volts (DC), ungrounded system

Electric Equipment Voltage Rating

AC Equipment Voltage Rating

- | | | | |
|------|--------------------------------------|---|---------------------|
| i. | Motors larger than 250 kW | : | 6.6 KV, 3-ph, 50 Hz |
| ii. | Motors less than and equal to 250 kW | : | 400V, 3-ph, 50 Hz |
| iii. | Lighting with associated equipment | : | 230V, 1-ph, 50 Hz |
| iv. | MOV motors | : | 400V, 3-ph, 50 Hz |

Frequency : 50 Hz ± 5%

Fault Level

- | | | | |
|------|----------------------|---|---|
| i. | 400,000 volts system | : | 31.5KA for 3 sec. (In line with Phase - I) |
| ii. | 33,000 volts system | : | 31 kA for 3 sec. (In line with Phase - I) |
| iii. | 6600 volts system | : | 25 kA for 3 sec. (In line with Phase - I) |
| iv. | 400 volts system | : | Min. 50 kA for 1 sec. in line with Phase-I to be uprated based on calculation to be submitted for Phase - II. |
| v. | DC system | : | By Bidder for 1 sec. |

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME .400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				1

8.8	ELECTRIC MOTORS AND ACTUATORS
8.8.1	General <p>This specification covers the design, manufacture, supply, erection, testing and commissioning of Motors for various driven equipment and Actuators.</p> <p>It is not the intent to specify completely herein all details of the equipment, nevertheless, the equipment shall be complete and operative in all respects and shall conform to the highest standard of engineering, design and workmanship.</p> <p>Should the bidder wish to deviate from this specification in any way, he shall draw specific attention to such deviation by listing the deviations in the deviation schedule without which his offer will be considered in conformity with the specification in all respects.</p>
8.8.2	Scope of work <p>The scope of work shall include but not limited to the following:</p> <ul style="list-style-type: none">- AC & DC Motors required for various application- Actuators required for various applications.- List of recommended spare parts as per Section-10.0, Vol.-II.- Commissioning spares.
8.8.3	Technical Requirements <p>Motors shall confirm to IEC and other applicable international standards amended upto date. Equivalent ANSI standards are also acceptable.</p>
8.8.3.1	Motors <p>Design Features</p> <p>All AC motors shall be squirrel cage three phase/ single phase induction motors. Lifts/Crane motors may be of slip ring type. DC motor shall generally be of shunt wound type rated for 220 V DC. DC motors shall be sized for operation with fixed resistance starter for maximum reliability. DC motors under GTG package may be rated for 220V DC. All motors shall be rated for continuous duty. Crane motors shall be rated for intermittent duty.</p> <p>Inching type motors as per the requirement shall be provided.</p> <p>The motor rating shall be at least 15% (service factor) over the maximum input power requirement of the driven equipment at rated point.</p> <p>Continuously operating motors shall be of high efficiency type.</p> <p>Power supply for AC motors shall be as follows:</p> <ul style="list-style-type: none">- Motors less than and equal to : 400 V, 3 Phase, 50 Hz solidly grounded system 250 kW- Motors larger than 250 kW : 6.6kV, 3 Phase, 50 Hz. resistance grounded system

FORMT9-P REV-0

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				2

Motors shall be capable of delivering the rated output with supply voltage variation of $\pm 10\%$ and frequency variation of $\pm 5\%$ and absolute sum of 10% .

The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, breakdown and full load torques are available for the intended service.

Squirrel cage induction motors shall be designed for direct on line starting Starting current shall not exceed 600% of full load current with 20% tolerance for ratings upto and including 1000 kW . For motors rated above 1000 kW , starting current shall be limited to 600% of full load current without any tolerance.

The starting current of 220V motors shall be restricted to 200% of full load current whereas for 125V motors, the same shall be restricted to 160% .

The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage. Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals. Motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals. Permissible number of starts per hour for continuous duty motors shall be as follows.

Starts	No. of Starts
No. of hourly startups uniformly distributed, starting from final steady working temperature (Hot)	3
No. of consecutive startups with initial temperature of motor at final steady working temperature (Hot)	2

Motors subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energised shaft rotating at 125% of rated speed in reverse direction.

The locked rotor withstand time under hot condition at 110% rated voltage shall be more than motor starting time by at least 2.5 seconds for motors with 20 seconds starting time and by 5 seconds for motor with more than 20 seconds starting time. Starting time shall be at the minimum permissible voltage of 80% rated voltage. If the above conditions cannot be met in unavoidable cases, special provisions such as motor shaft speed switch, etc. shall be provided. Hot thermal withstand curve shall have 3 margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.

The motor may be subjected to sudden application of 150% rated voltage during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.

The motor shall be designed to withstand any torsional and / or high current stresses which may result during bus transfer, without experiencing any deterioration in the normal life & performance characteristics.

FORMS-P REV.B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				3

8.8.3.2 Constructional details

Enclosure

Motors located indoor shall have IP 44 degree of protection and those located outdoor shall have IPW 55 degree of protection for the enclosure. For hazardous areas, approved type of flameproof and increased safety enclosure shall be provided.

The motors shall generally be of self ventilated type totally enclosed fan cooled (TEFC). Alternatively for large motors, closed air Circuit Air Cooled (CACA) System shall be adopted.

Winding and Insulation

The winding for all the motors shall be of super enameled copper wire of suitable gauge or copper strip conductor depending on its rating. All motors shall be class F insulated limiting temperature rise to class B limit.

The windings, fittings and hardware shall be corrosion resistant. The windings shall be tropicalised and shall be impregnated to make them non-hygroscopic and oil resistant.

Main insulation and inter turn insulation of Motors shall be capable of withstanding switching surges as per IEC 34, Part 15.

Motors of rating 37 kW and above shall be provided with space heaters, suitably located for easy removal or replacement. The space heater shall be rated for 230 V, single phase, 50 Hz, and sized to maintain the motor internal temperature above dew point when the motor is idle.

All HT motors shall be provided with six (6) duplex type winding temperature detectors, two (2) per phase and the motor bearing shall be provided with 2 Nos. duplex type temperature detectors on driving end and non driving end. These temperature detectors shall be resistance type, 3 wire, platinum wound, 100 ohms at 0°C. The temperature detectors shall be connected to the DCS system.

Bearings

Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type are preferred.

Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

Provide one pt-100 RTD or chromed – constant type E thermocouple, temperature measurement thermocouples, on bearing or oil reservoir associated with an anti-friction on thrust bearing.

Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types.

Bearings shall be insulated as required to prevent shaft current and resultant bearing damage for a motor rating of above 1000 kW.

FORMT9-P REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				4

In case forced lubrication is adopted, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.

Indicator/Switch

Dial type local indicator with alarm contacts shall be provided for the following:

- HT motor bearing temperature
- Hot and cold air temperatures of the closed air circuit for CACA motors.

Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V D.C. and 5A at 230 V A.C.

Motor Terminal Box

Motor terminal boxes shall be provided with a detachable extension box (cable core splitter box). Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections and shall have the same degree of protection as motor. The terminal box shall have sufficient space inside for termination/connection of cables.

Terminals shall be of stud type, substantially constructed and thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor. The terminal box shall be capable of withstanding maximum system fault current for 0.2 sec for all breaker operated motors and shall be provided with explosion vent. However for contactor operated motors, the terminal box shall be capable of withstanding the fault current for let through time of the fuse preceding it.

For 6600 V motor (if required), the terminal box shall be phase segregated type and neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection. For motors for 1000 kW and above, PS class current transformers shall be provided in the neutral side terminal box on all three connections for differential relay.

All accessory equipment such as space heater temperature detector, etc., shall be wired and terminated in a enclosure, separate from motor (power) terminal box. The degree of protection for accessory terminal box shall be same as that of motor. Terminal box shall be complete with double compression brass glands and stud type terminals and shall be suitably mounted on the side of the motor. If possible, the accessory terminal boxes shall be located on the same side of the motor as the main (power) terminal box.

Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

FORMTS-P REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				5

The cable terminal box shall have a separate grounding terminal.

Noise & Vibration

The noise level and vibration limits shall not exceed the limits specified in relevant ANSI / IEEE / IEC standards.

Rating Plate

The motors shall be provided with a rating plate of stainless steel.

In addition to the minimum information required by IEC, the following information shall be shown on motor rating plate:

- Temperature rise in °C under rated condition & method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

Lifting

All electric motors shall be provided with lifting lugs.

8.8.4 DRAWINGS, DATA & MANUALS

To be submitted with the Bid.

List of electric motor actuators

Type test certificates on similar equipment

To be furnished for Approval and Distribution. (After award of contract)

Actuator data sheet

Internal wiring diagram

Torque switch and limit switch contact development.

Manufacturer's catalogue.

Any other relevant drawings, documents, or data necessary for satisfactory installation, operation and manufacturing.

Instruction Manuals for Actuators

The manuals shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning of the equipment.

The Bidder may note that the drawings, data and manuals listed are herein minimum requirements only. The Bidder shall ensure that all other necessary write-ups, curves, calculations and information required to fully describe the equipment are submitted with his bid.

FORMTSP REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				7

8.8.5 Specified Design Data

SECTION : ELECTRIC MOTORS & ACTUATORS		
8.8.5.1 AC Motors		
Rated Voltage		
Less than and equal to 250 kW	V	400
Larger than 250 kW	V	6600 V
Rated Frequency	Hz	50
Voltage variation		±10%
Frequency Variation		±5%
Absolute sum of variation		10%
Rated Voltage for DC Motors	V	220 V ±10% to -15% (125 +10% to -15% if GTG supplier's standard)
Class of Insulation for all Motors		Class 'F' with temperature Limited to Class 'B'
Starting Current		6 times FLC.
Degree of protection		IP 44/IP W 55
Method of cooling		TEFC/CACA
Fault withstand capability of terminal box		Fault current for 0.2 sec. for breaker controlled motors
No. of consecutive hot starts with initial temperature of motor at final steady working temperature		Two
No.of hourly starts uniformly distributed from final temperature		Three (3)

FORMT9-P REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				8

8.8.6 Technical Data by the Tenderer

SECTION : ELECTRIC MOTORS & ACTUATORS

8.8.6.1 MOTORS (Bidder to fill data for each type and rating of motor)

General

* Application	-	
* Quantity	Nos	
* Make & Country	-	
Frame size	-	
Applicable standard	-	
Type of motor	-	
* Service	-	
* Rating	kW	
Duty cycle/ designation	-	
Rated continuous output at max. ambient	kW	
Rated speed	rpm	
* Rated voltage and Voltage variation range	V %	
* Rated frequency and Frequency variation range	Hz %	
Full load current	A	
No load current	A	
Rated power factor	-	
Efficiency at rated voltage and frequency		
Full load	%	
Three quarter		
50% load	%	

FORMT9-P REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				9

Method of starting	-	
Starting current at rated voltage (as % of full load current)	%	
Starting current at 80% of rated voltage (as % of full load current)	%	
Starting torque (as % of full load torque)	%	
Time to attain full speed		
- with load	s	
- without load	s	
Locked rotor withstand time		
- from cold	s	
- from hot	s	
* Degree of protection of enclosure		
Method of cooling	-	
* Insulation class	-	
* Temperature rise over max. ambient	°C	
No. of hot starts		
Winding connection	-	
Bearing	-	
Make	-	
Type	-	
Recommended lubricant	-	
Motor Terminal Box		
Type	-	
Fault with-stand current and time	kA, s	
Number of grounding pads provided		
- On motor body	-	
- On terminal box	-	
Type of mounting	-	

FORM19-P REV-B

Project	Subject	Tender Doc. No.	Rev	Section
REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	8.8
				Sheet No.
				10

Overall dimensions		
Length	mm	
Breadth	mm	
Height	mm	
Weight		
Stator	kg	
Rotor	kg	
Total	kg	
Moment of inertia		
Stator	kg.sq.m	
Rotor	kg.sq.m	
Total	kg.sq.m	
Dynamic load and foundation	-	
Drawings furnished	Yes/No	
General arrangements	Yes/No	
Terminal box details	Yes/No	
Torque vs speed (at 100% rated voltage, at 80% rated voltage at 110% rated voltage) with the driven equipment torque speed curve super imposed.	Yes/No	
Thermal withstand curves (hot & cold)	Yes/No	
Locked rotor curves (hot & cold)	Yes/No	
Starting characteristics (at 80% rated voltage and at 100% rated voltage.	Yes/No	
Performance curves (output vs efficiency, output vs current output vs slip	Yes/No	
10% margin considered for motor rating above the rated shaft power requirement.	Yes/No	
15% margin considered for BFP and GBC motor	Yes/No	

FORMT9-P REV-B