

**400 MW MARIB GTPS PHASE-II**  
**PUBLIC ELECTRICITY CORPORATION**  
**MINISTRY OF ELECTRICITY AND ENERGY**  
**REPUBLIC OF YEMEN**

**VOLUME - IIB & III**

**TECHNICAL SPECIFICATION**  
**FOR**  
**AIR CONDITIONING SYSTEM**

**SPECIFICATION NO: PE-TS-372-553-A001, REV. - 01,**  
**MAY 2013.**



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

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

SPECIFICATION NO: PE-TS-372-553-A001

VOLUME

SECTION

REV 00

DATE MAY 2013

SHEET 1 OF 2

**VOLUME – IIB**

SECTION	TITLE	SPECIFICATION NO.	No. of Sheets.
SECTION-A	SCOPE OF ENQUIRY	PE-TS-372-553-A001	2
SECTION-B	PROJECT INFORMATION		2
SECTION-C1	SPECIFIC TECHNICAL REQUIREMENT	PE-TS-372-553-A001	10
SECTION-C2	CUSTOMER TECHNICAL SPECIFICATION		21
SECTION-C3	TECHNICAL SPECIFICATION (ELECTRICAL PORTION)		67
SECTION-C4	TECHNICAL SPECIFICATION (C & I PORTION)		108
SECTION-C5	PAINTING SPECIFICATION		19
SECTION-C6	SEAWORTHY PACKING SPECIFICATION		60
	<b><u>ANNEXURES</u></b>		
i)	ANNEXURE-I	LIST OF MAKES	2
SECTION-D	STANDARD TECHNICAL SPECIFICATIONS		64
SECTION-E	QUALITY ASSURANCE		3

**VOLUME-III**

(DATA SHEET AND SCHEDULES)

SECTION	TITLE	No. of Sheets.
1	Data Sheet B	11
2	Deviation Sheet Part B	1
3	Deviation Sheet Part C	1
4	Suggestive Price Format	4
5	Guaranteed Power consumption Figures	1
6	Format – No Deviation Certificate	1
SECTION-F	<b>LIST OF ENCLOSURE</b>	
1	Control Room Layout - PE-DG-372-145-I401	1



TITLE	<b>400 MW MARIB GTPS PH II</b>		SPECIFICATION NO: PE-TS-372-553-A001	
	<b>INDEX</b>		VOLUME	
	<b>AIR CONDITIONING SYSTEM</b>		SECTION	
	REV	00	DATE MAY 2013	
	SHEET	2	OF 2	

SECTION	TITLE	No. of Sheets.
2	Switchgear room layout – PE-DG-372-100-E002	1
3	Master drawing/ Document list	2



**AIR CONDITIONING SYSTEM  
SCOPE OF ENQUIRY**

**Specification No: PE-TS-372-553-A001**

**VOLUME IIB**

**SECTION - A**

**Rev 00**

**DATE: MAY 2013**

**SHEET 1 of 2**

**SCOPE OF ENQUIRY**



## AIR CONDITIONING SYSTEM SCOPE OF ENQUIRY

Specification No: PE-TS-372-553-A001

VOLUME IIB

SECTION - A

Rev 00

DATE: MAY 2013

SHEET 2 of 2

### SCOPE

This specification covers the design, manufacture, inspection and testing at manufacturer's works or at sub vendor's work, proper packing, delivery to site, supervision of erection and commissioning, final painting & carrying out acceptance tests at site of Air Conditioning System as mentioned in the different Section of this specification for 400 MW MARIB GTPS PH II.

### GENERAL TECHNICAL INSTRUCTIONS

1. 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.
2. 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.
3. 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.
4. 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.
5. In case of conflict between the Customer Specification & BHEL Specification, stringent of the two conditions shall prevail.

## **400 MW MARIB GTPS PHASE-II, YEMEN**

### **SECTION - B** **PROJECT INFORMATION**

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"><li>Distance of site: From Aden Port (Gulf of Aden): 419 Km</li></ul> b. <u>By Air</u> : Sana'a Airport <ul style="list-style-type: none"><li>Distance from site : 172 Km</li></ul>
8.	Site data	
A	Altitude	1100 m above Mean Sea Level
B	Ambient Air Temperature	45 °C
	1. Design Minimum Temp.	-----

## **400 MW MARIB GTPS PHASE-II, YEMEN**

### **SECTION - B** **PROJECT INFORMATION**

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



**400 MW MARIB GTPS PHASE-II  
SPECIFIC TECHNICAL  
REQUIREMENT  
AIR CONDITIONING SYSTEM**

**SPECIFICATION No: PE-TS-372-553-A001**

**VOLUME II B**

**SECTION C**

**REV: 01**

**DATE : May 2013**


**SHEET 1 OF 10**

**PUBLIC ELECTRICITY CORPORATION  
MINISTRY OF ELECTRICITY AND ENERGY  
REPUBLIC OF YEMEN**

**SECTION C**

**AIR CONDITIONING SYSTEM**



	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 2 OF 10</b>	

1.

**FUNCTION**

The purpose of the system is to provide Air Conditioning for different areas of 400 MW MARIB GTPS PHASE-II under the scope of BHEL.

2.

**SYSTEM DESCRIPTION**

2.1

**COMMON CONTROL ROOM**

2.1.1

A Centralised DX type air conditioning plant shall be provided to cater to the air conditioning requirements of the following areas.

2.1.1.1.

Control Room.

2.1.1.2.

Equipment Room.

2.1.1.3.

UPS Room.

2.1.1.4.

Computer Room.

2.1.1.5.

Shift Incharge Room.

2.1.1.6.

Office & Conference Room

2.1.1.7.

400 KV control room

2.1.2

The air conditioning plant shall comprise of 2 x 100 TR (Actual capacity) (1W + 1SB) DX type condensing units. The refrigerant compressor shall be Reciprocating / Scroll, Open / Semi-hermetic type suitable for Refrigerant R-134a / R-407c / R-410a environment friendly HFC refrigerants with drive package (for open type compressor only), Suction and discharge valves, capacity control system, crank case heater etc. A control panel shall be provided to house all gauges and controls. The panel shall contain all necessary terminal strips to facilitate external wiring.

2 x 100% working Air handling units shall be provided. Each DX unit shall have a dedicated AHU. The AHU shall be double skin type with 0.63 mm inner and outer sheet having 25 mm sand-witched insulation in between. The conditioned air obtained from the AHUs shall be distributed through GSS ductwork having zinc costing of 120g/sqm (including both sides) to the areas to be air conditioned. The return air shall be collected in the void above the false ceiling and led back to the AHU room, which serves as a mixing plenum for fresh and return air. The AC system shall be controlled through Relay based control panel.

2.2

**SWITCHGEAR BUILDING**

The air conditioning plant shall comprise of 2 x 50 TR (Actual capacity) (1W + 1SB) DX type condensing units along with 2 x 100% working Air handling units as described under clause 2.1.2 above.

2.3

**SPLIT TYPE AIR CONDITIONERS**

2.3.1

Split type air conditioners (air cooled) shall be provided to cater to the air conditioning requirements of Local control rooms with PLC/Microprocessor based control for auxiliary buildings / areas as under:

2.3.1.1.

Local Control Room.

2.3.1.2.

Battery Charger room.

2.3.1.3.

Office area.

2.3.1.4.

These air-conditioners shall be operated with Push Button Station. No humidification and heating controls are provided for this type of system.



**400 MW MARIB GTPS PHASE-II  
SPECIFIC TECHNICAL  
REQUIREMENT  
AIR CONDITIONING SYSTEM**

**SPECIFICATION No: PE-TS-372-553-A001**

**VOLUME II B**

**SECTION C**

**REV: 01**

**DATE : May 2013**

**SHEET 3 OF 10**

- 2.3.1.5. The areas mentioned for air-conditioning with split AC unit as above are indicative only. Depending upon the finalisation of layout drawing, and capacity calculations, these area may be provided with air cooled, Package units.

**3. DESIGN CRITERIA**

**3.1 System design criteria**

- 3.1.1 The outside design conditions considered are as follows:-

	Summer	Winter
DBT (°C)	45	0
WBT (°C)	35	

- 3.1.2 The Central Control room and all other areas except switch gear building shall be maintained at  $22^{\circ}\text{C} \pm 2^{\circ}\text{C}$  DB and  $50\% \pm 5\%$  RH.

- 3.1.3 Switch gear building shall be maintained  $35^{\circ}\text{C} \pm 2^{\circ}\text{C}$  DB inside temperature and  $50\% \pm 5\%$  RH.

- 3.1.4 Underdeck thermal insulation of 40 mm thick phenolic foam or equivalent on the Roof over AC space exposed to sun and AHU Room.

- 3.1.5 A design margin of 12.5% on room sensible heat and 10% on room latent heat is considered while determining the AC Plant capacity.

- 3.1.6 Lighting load shall be minimum 20 Watts / Sqm or actual whichever is higher.

- 3.1.7 Fresh air shall be considered as 1.5 ACH (Air change per hour) or 17 cfm per person whichever is higher.

- 3.1.8 Coil face area of Air handling units shall be designed considering a face velocity of 2.5 m/sec.

- 3.1.9 The air distribution system shall be sized to have a constant frictional drop along it's length and velocity through ducts shall not exceed 7.62 m/sec.

**4. LAYOUT CONSIDERATIONS:**

**4.1 ACP-1 for control room AT 5.2m**


- 4.1.1 The outdoor unit for central DX plant shall be placed outside on terrace / ground floor.

- 4.1.2 AHUs for supplying conditioned air to control room areas at El 5.2 m and 400 KV control room area shall be installed in AHU room at El 11.0 m.

**4.2 ACP-2 for Switch Gear room at 0m**

- 4.2.1 The outdoor unit for central DX plant shall be placed outside on terrace / ground floor.

- 4.2.2 AHUs for supplying conditioned air to switch gear room areas at El 0.4 m shall be installed in AHU room at El 5.2 m.

	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 4 OF 10</b>	

5.

**EQUIPMENTS TO BE PROVIDED FOR ACP-1**

5.1

Two (2) Nos 100 TR (actual capacity) DX condensing Unit (1 W + 1 SB) complete with all accessories as described hereinafter.

5.2

One (1) no. Relay based control panel for Air conditioning plant.

5.3

Two (2) Nos 45000 CFM capacity double skin Air Handling Units (1 W + 1 S) shall be provided for control room areas and 400 KV control room.

5.4

Each AHU shall be complete with all accessories as described hereinafter.

5.4.1

Lot - GSS Ductwork complete with vanes, damper, hangers, supports, grills, diffusers, fire dampers, volume control dampers and insulation etc.

5.4.2

Lot – duct mounted strip heaters.

5.4.3

Face and bypass damper.

5.4.4

Pre filters (95% down to 10 micron) & fine filters (95% down to 5 micron)  
Differential pressure gauge across the filters.

6.

**EQUIPMENTS TO BE PROVIDED FOR ACP-2**

6.1

Two (2) Nos 50 TR (actual capacity) DX condensing Unit (1 W + 1 SB) complete with all accessories as described hereinafter.

6.2

One (1) no. Relay based control panel for air conditioning plant.

6.3

Two (2) Nos, 18000 CFM Capacity Double Skin Air Handling Units (1 W + 1 S) shall be provided for Switch Gear.

6.4

Each AHU shall be complete with all accessories as described hereinafter.

6.4.1

Lot - GSS Ductwork complete with vanes, damper, hangers, supports, grills, diffusers, fire dampers, volume control dampers and insulation etc.

6.4.2

Lot – duct mounted strip heaters.

6.4.3

Face and bypass damper.

6.4.4

Pre filters (95% down to 10 micron) & fine filters (95% down to 5 micron)

6.4.5

Differential pressure gauge across the filters.

7.

**AC EQUIPMENT DETAILS**

7.1

**DX type Air cooled condensing Unit:**

7.1.1


The refrigerant compressor shall be Reciprocating / Scroll, Open / Semi-hermetic type suitable for Refrigerant R-134a / R-407c / R-410a environment friendly HFC refrigerants with drive package (for open type compressor only), Suction and discharge valves, capacity control system, crank case heater etc.

7.1.2

Each compressor shall incorporate electric/hydraulic actuation of cylinder unloading mechanism to provide a minimum, where possible, of four steps of capacity control. Refrigerant.

7.1.3

The condenser shall be designed to provide atleast 2 degrees subcooling under rated condition. The condenser shall sized to contain the entire refrigerant charge in accordance with ANSI - ASHRAE 15 standard. The condenser fan shall be axial flow type.

	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	SPECIFICATION No: PE-TS-372-553-A001	
		VOLUME II B	
		SECTION C	
		REV: 01	DATE : May 2013
		SHEET 5 OF 10	
	7.1.4	All major Items of plant shall be dried at the factory and filled with a holding charge of refrigerant or inert gas and openings shall be sealed.	
	7.1.5	A control panel shall be provided to house all gauges and controls. The panel shall contain all necessary terminal strips to facilitate external wiring.	
	7.1.6	All refrigerant circuits shall be assembled, tested and charged with refrigerant at the manufacturer's works.	
	7.1.7	Pipework in refrigerant suction gas and low pressure liquid line shall be thermally insulated with 50 mm thick expanded polystyrene or equivalent with vapour and weather barriers, and shall be fixed as per insulation, manufacturer standard.	
	7.1.8	Valves required for compressor, liquid receiver etc. shall be of diaphragm or bellows type or shall be packed valves complete with seating and a seal cap.	
	7.1.9	Unit shall be equipped with a control panel including the gauges to indicate set oil pressure, condenser pressures. Switches to permit manual or automatic operation and for sequencing. Anti-short cycle relay timer for compressor motor. High motor temperature, high discharge pressure, low suction pressure, low oil pressure cut-outs, all factory-wired to independently stop compressor motor. Each of these cut-outs shall have individual pilot lights and manual reset. Units shall be designed to start, run and stop automatically without special attention at all ambient where required by conditions	
	7.2	<b>AIR HANDLING UNIT (DOUBLE SKIN TYPE)</b> Each air handling unit shall comprise of the following:-	
	7.2.1	Double skin panels shall be fabricated using minimum 0.6 mm plain galvanized inner sheet and 0.6mm pre-coated / pre-painted outer sheet. with 25 mm thick polyurethane insulation of minimum 40 kg/m3 density in between, GSS channels shall be used as reinforcing to give structural strength.	
	7.2.2	The draw through horizontal AHUs shall comprise of Mixing box, Dampers, Filters, DX- cooling coil, Electric heating coil, Electric steam humidifier and Fan section.	
	7.2.3	Fan section complete with forward / backward curved multi-bladed centrifugal fan mounted on a shaft with adjustable motor base. The DIDW centrifugal type fan shall have discharge velocity not exceeding 10 m/s and shall be suitable for 2 years continuous operation without servicing	
	7.2.4	One No. adequately sized TEFC sq. cage induction motor with drive package comprising of fan pulley, motor pulley, V-belt and belt guard.	
	7.2.5	Cooling coil section with suitably sized DX cooling coil made of copper tubes and aluminium fins.	
	7.2.6	Pre filter section complete with 50 mm thick washable type filter having an efficiency of 95% down to 10 micron particle size. The differential pressure gauge shall be fitted across the filters. The washable filters for the AHU shall have a minimum life of at least 12 months	
	7.2.7	Fine filter section wherever required shall comprise 150/300 mm thick (5ply) synthetic non-woven washable filter panels, suitably arranged in holding frames. The filters shall have a minimum efficiency of 95 % down to 5 micron size	
	7.2.8	Drain piping from the AHUs up to nearest drain point.	
	7.3	<b>STRIP HEATER PACKAGE</b>	
	7.3.1	To meet the heating / reheating requirement of the air-conditioned areas covered by common AC Plant only, strip heaters are provided. Heaters shall be provided in the	



**400 MW MARIB GTPS PHASE-II  
SPECIFIC TECHNICAL  
REQUIREMENT  
AIR CONDITIONING SYSTEM**

**SPECIFICATION No: PE-TS-372-553-A001**

**VOLUME II B**

**SECTION C**

**REV: 01**

**DATE : May 2013**

**SHEET 6 OF 10**

AHU chamber. Heater package shall be connected with temperature/RH sensor for operation. Strip heater shall be of flame proof / spark proof construction.

**7.4 DUCTWORK**

7.4.1 Ducting & grills shall be used for air distribution system. Ducts shall be made of Galvanized steel sheets (Having zinc coating of 120 Grams / Sqm including both side). The air velocity in the ducts shall not exceed 12.0 m/sec. All ducting shall be designed on equal friction method.

7.4.2 Splitters and dampers shall be in minimum 16 gauge GS sheet of quadrant type with suitable locking device, mounted outside of duct in accessible position.

7.4.3 Diffusers, Grills & Dampers

i. Supply air diffusers / grills shall be provided with volume control dampers whereas return air grills/diffusers shall be provided without volume control dampers.

ii. The diffusers / grills shall be extruded Aluminum powder coated.

iii. Supply air grills shall be of double deflection type.

iv. All volume control (VC) damper shall be operated by a key from the front of the grills / diffusers.

v. The thickness of frames of Diffusers, grills & VC dampers shall be of minimum 20 gauge and thickness of louvers shall be of minimum 26 gauge.

7.4.4 All plenum chambers shall be constructed in 18 gauge GS sheet and supported on MS angle frames.


7.4.5 The air duct shall be provided with motor operated fire damper. Fire dampers shall be of 90 minutes fire rating As per UL-555. for Fire dampers control, fire detection signals shall be taken from Fire Detection & Alarm System.

**7.5 INSULATION**

7.5.1 Insulation shall be provided as under:

S.No	Surface	Insulation Material	Insulation Form	Thickness (mm)
i)	AC Duct	Resin bonded Fiberglass	Roll / Slab (24 Kg/m <sup>3</sup> ) Density	25 for AC area & 50 for outdoor and non AC area
ii)	Acoustic insulation of first 6M of ducting after AHUs	Rigid fibre glass board covered with 1 mm thick fibre glass cloth or craft paper	Roll / Slab (48 Kg/m <sup>3</sup> ) Density	12
iii)	Refrigerant Piping	Expanded polystyrene with vapour weather barrier	Pipe Section	50

The fibre glass insulation roll shall have 0.5 mm thick aluminium facing. and shall be laid with staggered joints, sealed with aluminium tapes. Insulation roll shall be

	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 7 OF 10</b>	

attached to ducts with Bitumen (85/25 or 85/40) or CPRX sticking compound and insulation.

**7.6 SPLIT AIR CONDITIONERS**

7.6.1 Outdoor unit consisting of rotary / scroll compressor, on anti-vibration mounts, axial flow fan air cooled condenser of seamless copper with aluminium fins, design & construction. Casing of galvanised sheet metal weather proofed or stored enameled against corrosion.

7.6.2 Indoor unit consisting of direct expansion cooling and dehumidifying coil 3 speed forward curved DIDW centrifugal motor unit, insulated drain pan, coarse filter panel, casing of aesthetically designed ABS moulded plastic construction for direct mounting unit or galvanised sheet steel casing weather proofed or stoved enameled against corrosion in case of ductable type.

Refrigeration circuit with R-22 refrigerant filling, refrigerant drier, thermostatic expansion valves unit control panel barrier all control interlocks, power supply contactor etc.

**8. CONTROL PHILOSOPHY**

8.1.1 The operation of the AC Plant unit shall be through relay based control system. Control panel shall be provided with annunciation, start-stop push buttons, indication lamps & interlocks. The compressor can be started only when its associated condenser fan, AHU fan etc are in operation.

8.1.2 DX condensing unit shall be provided with unit mounted control panel.

8.1.3 Stop / trip Annunciation for all the equipments (Fan, DX condensing unit and safety interlocks) shall be provided in local control panel. Following controls are also required to be built up in the common control panel.

8.1.4 Humidity control based on the humidity stat / transmitter.

8.1.5 Heater temperature control based on Airstat.

8.1.6 Automatic start of standby equipment control.

8.1.7 Sequence interlocks

8.1.8 All the drives of the AC Plant unit shall have the provision of manual starting.

**9. POWER SUPPLY ARRANGEMENT**

The power supply (rated voltage, frequency, phase) of the equipment will be 400 V ± 10%, 3ph, 50 Hz ± 5% or 230 V, 50 Hz single phase AC supply as applicable.


**10. GENERAL**

10.1.1 Base plates, anchor, Cadmium plated bolts, nuts, loose fittings etc. for all equipment like Condensing unit, AHU, package AC, fresh air fans, split AC (outdoor and indoor unit), refrigerant piping etc. and all other equipment as would be necessary for erection and complete anchoring of steel materials for the hangers and duct supports, anchor fasteners etc shall be in the scope of bidder.


10.1.2 Tender drawings enclosed form the part of specification and the bidder shall check and confirm that the space assigned for AHUs, outdoor units etc is sufficient and as per requirement.

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

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


	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 8 OF 10</b>	

10.1.5	Bidder must indicate make of equipment clearly in the offer. The words “equivalent / reputed make” are not acceptable.
10.1.6	Electrical items to be provided by bidder shall be as indicated elsewhere in the specification.
10.1.7	Junction boxes wherever required for cable termination, shall be included in bidder scope.
10.1.8	C&I items to be provided by bidder shall be as indicated elsewhere in the specification.
10.1.9	The bidder shall furnish complete Tech. particulars in data sheet and schedules enclosed in Volume-III of this specification.
10.1.10	Fifteen percent GSS (15%) plain of various sizes shall be supplied extra over and above the fabricated pieces as contingency.
10.1.11	Supports, angles, fasteners, hangers and other miscellaneous items shall be supplied extra over and above the required quantity (Fifteen percent approx.) as contingency.
10.1.12	Bidder shall furnish List of Maintenance Tools & Tackles with unit rates. Bidder shall furnish List of Commissioning spares with unit rates.
10.1.13	Supervision of Erection & Commissioning shall be in Bidder's scope.
10.1.14	Air Conditioning Plant Supplier to furnish characteristic curves for all major equipment offered indicating duty point.
10.1.15	Inserts or any support arrangement for fixing ducting and all other AC equipment like condensing unit, AHU, refrigerant and drain piping, split units indoor and outdoor unit etc shall not be provided by BHEL.
10.1.16	Fixing frame for diffusers and grilles in the scope of AC plant supplier.
10.1.17	AC plant supplier to furnish drawings/documents as per the drgs / documents distribution as per project requirement.
10.1.18	Instruments required for performance testing of various equipment/system of the package shall be arranged by AC plant supplier at site.
10.1.19	All electrical equipment shall be suitable for the power supply fault levels and other climatic conditions indicated in project information/synopsis enclosed.
10.1.20	The bidder shall furnish complete Tech. particulars in data sheet and schedules as specified elsewhere in the specification.
10.1.21	Bidder to note that BHEL reserve the right for drg/doc submission through web based Document Management System. 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.
10.1.22	Internet explorer version – Minimum Internet Explorer 7
10.1.23	Internet speed – 2 mbps (Minimum preferred)
10.1.24	Pop ups from our external DMS IP (124.124.36.198) should not be blocked
10.1.25	Vendor's internal proxy setting should not block DMS application's link ( <a href="http://124.124.36.198/wrenchwebaccess/login.aspx">http://124.124.36.198/wrenchwebaccess/login.aspx</a> ).
10.1.26	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.

	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 9 OF 10</b>	

10.1.27	The bidders proposal shall be for equipment in accordance with the Tech. Specification.
10.1.28	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.
11.	<b>ACCESSORIES FOR MAIN EQUIPMENTS TO BE PROVIDED BY THE SUPPLY VENDOR</b>  Bidder to note that along with all the equipment, necessary accessories required for their complete erection at site as per approved engineering drawings shall be included in adequate quantity along with the respective equipment / material.  Some of the items are listed hereunder, however if any accessory item is not covered in the list below, the same shall not relieve the bidder to include that particular item required to make the installation complete in all respect.
11.1.1	<b>CONDENSING UNITS, AHU, FAN, SPLIT UNITS, RELAY PANEL ETC.</b>  All necessary fittings, accessories, Cadmium plated bolts, nuts, washers, vibration isolaton pads, supports for equipment like AHU, Split units, Package units, hanging arrangements for equipment like split units etc as per approved engineering drawing etc required for complete installation shall be provided with respective equipment in adequate quantity.
11.1.2	<b>PIPING</b>  All accessories like pipe fitting, flanges, supporting arrangement, Cadmium plated bolts, nuts, washers, U-clamps, hanger rods, anchor fasteners, insulated supports for refrigerant piping and other items required to make the installation complete in all respect shall be supplied in adequate quantity for refrigerent and drain piping.
11.1.3	<b>DUCTING</b>  All accessories like supporting arrangement, Cadmium plated bolts, nuts, washers, flanges, hanger rods, anchor fasteners, adhesive, gasket, brazing, canvas, splitter damper and other items required to make the installation complete in all respect shall be supplied in adequate quantity for Ducting.
11.1.4	<b>INSULATION</b>  All material and accessories like CPRX / Eqvt adhesive, wire mesh, GI wire, AL cladding, Cadmium plated bolts, nuts, washers, rivits, aluminium sheet for cladding, perforated aluminium sheet and all other accessories required to make the installation complete in all respect shall be supplied in adequate quantity for thermal insulation of ducts and pipes and for acoustic insulation.
11.1.5	<b>GRILL / DIFFUSER, FIRE DAMPER, VOLUME CONTROL DAMPER</b>  All accessories complete with fixing frames, Cadmium plated bolts, nuts, gaskets, washers, screw etc. with all ancillaries, and other items required to make the installation complete in all respect shall be supplied in adequate quantity for Grill / Diffuser, Fire Damper & Volume Control Damper.



	<b>400 MW MARIB GTPS PHASE-II SPECIFIC TECHNICAL REQUIREMENT AIR CONDITIONING SYSTEM</b>	<b>SPECIFICATION No: PE-TS-372-553-A001</b>	
		<b>VOLUME II B</b>	
		<b>SECTION C</b>	
		<b>REV: 01</b>	<b>DATE : May 2013</b>
		<b>SHEET 10 OF 10</b>	

<b>12.</b>	<b>DRAWINGS / DOCUMENTS TO BE FURNISHED BY BIDDER ALONG WITH TECHNICAL OFFER</b>
12.1.1	Space requirement / layout of AC equipment.
12.1.2	Completely filled Data Sheet of Ventilation system, motor and other instruments attached with the Technical Specification.
12.1.3	Quality Plans for the equipment, motor, valves, instruments etc, duly signed by the bidder, to be furnished along with the Technical Offer.
12.1.4	One set of catalogues of equipment offered.

**VOLUME - IIB**

**CUSTOMER TECHNICAL SPECIFICATION**

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-SPC-700-001	C	7.3
				Sheet No.
				1

(PEC TENDER NO.: 12/2008)

**VOLUME IV**  
**SECTION 7.3**  
**HEATING, VENTILATION & AIR CONDITIONING SYSTEM**

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-SPC-700-001	C	7.3
				Sheet No.
				2

(PEC TENDER NO.: 12/2008)

### Table of Contents

7.3.0	HEATING, VENTILATION & AIR CONDITIONING SYSTEM	3
7.3.1	GENERAL	3
7.3.2	SCOPE OF WORK	3
7.3.3	TECHNICAL REQUIREMENTS	5
7.3.4	EQUIPMENT	7
7.3.5	CONTROL AND INSTRUMENTATION	13
7.3.6	SPECIFIED DESIGN DATA	14
7.3.7	TECHNICAL DATA BY TENDERER	16

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-SPC-700-001	C	7.3
				Sheet No.
				3

### 7.3.0 HEATING, VENTILATION & AIR CONDITIONING SYSTEM

#### 7.3.1 GENERAL

This specification includes, the design, manufacture, supply, erection, testing & commissioning of complete heating, ventilation and air-conditioning.

The proposed Heating, ventilation and air-conditioning 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.

##### 7.3.1.1 Design Ambient Condition

The complete ventilation and air conditioning system, in general, will be designed for an outside ambient temperature of 45 °C dry bulb and 35°C wet bulb temperature. The minimum design winter ambient temperature of 0 °C dry bulb temperature.

##### 7.3.1.2 Design Inside Condition

###### *Air Conditioned Space*

The Design inside condition of Central Control room and all other areas except switch gear building shall be maintained at 22°C ± 2°C DB and 50% ± 5% RH.

In the switch gear buildings, higher temperature can be tolerated. These buildings shall be maintained 35°C ± 2°C DB inside temperature and 50% ± 5% RH.

###### *Ventilated Spaces*

The supply air quantity in the ventilated spaces shall be higher of that calculated on air change basis as well as heat load basis. However, a minimum air change of six (6) per hour shall be maintained in all ventilated spaces. All ventilation areas shall be designed such that the maximum difference between indoor and outdoor shall not exceed 5 °C.

#### 7.3.2 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.

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-SPC-700-001	C	7.3
				Sheet No.
				4

### Air Conditioning

The following areas are to be air conditioned:

- All buildings or rooms of Phase-II in which waste heat occurs which is not removed by other means and where, due to the installed equipment, temperature limitations exist, for example Central Control Room, Central Electronic Rooms, Local control rooms, UPS & battery Charger Room, switch gear room, etc.
- All the buildings or rooms in Phase-II intended for human habitation for example offices, etc.

For the above, the air conditioning includes filtering, cooling and dehumidification heating and humidification and the supply of fresh air.

### Ventilation

Ventilation has to be provided for:

- All the buildings or rooms in which waste heat occurs which has to be removed but where temperature ranges do not necessitate air conditioning, for example GasTurbine enclosure/building, cable spreader room, battery rooms, etc.

### 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 the guarantee period, etc as stipulated in Vol. I & Vol. II.
- necessary control, measuring and monitoring instruments/ equipments for proper functioning of system .
- Hot dip galvanised duct work.
- All necessary pipework, expansion joints, valves, automatic actuators, supports, fastenings, etc.
- All necessary base frames, base plates, anchor bolts, supports, covers, etc.
- All necessary painting, corrosion protection and preservation measures as required in relevant section 7.6 of Volume IV.
- Complete detailed labelling of all installations as required in Section 13.0 of Volume II
- Documentation according to section 12.0 of Volume III.
- Spare parts as stipulated in Section 10.0 of Vol. II.
- All consumables as stipulated in Section 3.0 of Vol. II..
- One set of special tools and tackles as stipulated in Section 14.0 of Vol. II.

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-SPC-700-001	C	7.3
				Sheet No.
				5

- All standard equipment and accessories normally included in the supply schedule but not separately listed.

### 7.3.3 TECHNICAL REQUIREMENTS

#### 7.3.3.1 General

The design will be based on the guidelines of ASHRAE and follow standard industrial practice.

Each air conditioning, heating and ventilation plant shall be a self contained, functionally reliable unit, which is suitable for the appropriate building, with respect to performance and choice of system and also with respect to the special arrangement, the dimensions and the weights.

Separate room to be provided for Air Handling Units.. All equipment shall be placed in such a manner that sufficient space (as recommended by the manufacturer) is available for servicing and maintenance.

All equipment, ducts, pipes, controls, etc. shall be fully treated against corrosion and sealed against moisture, sand and dust ingress.

All plant including ducts and pipes as well as machines shall be vibration isolated or otherwise treated that:

- No excessive vibration is felt in the floors or walls of the rooms served by any machine.
- The mechanically induced vibration levels in floors, walls and ceilings of rooms are sufficiently small as to limit the radiation of sound levels to the rooms within acceptable levels.

#### 7.3.3.2 Central DX System

The Central Control room, central electronics room, UPS and switch gear building. in Phase II shall be air-conditioned by an air-cooled DX air-conditioning system.

The air supplied to the control room shall be filtered in two stages (the second being fine filters) cooled, heated and with full humidity control. The DX system shall comprises of the following:

- 2 x 100% Air handling units (with DX cooling coil filter, humidifiers, heaters)
- 2 x 100% Air Cooled DX-condensing unit
- Refrigerant piping valves & accessories
- Air distribution system (GSS ducting, grilles & diffusers, thermal & acoustic insulation)

The room temperature shall be controlled by thermostats sensing the temperature in the return air path. Humidity shall be controlled by electric heaters & pan type humidifiers through space humidistats.

The air shall be distributed via hot-dipped galvanised steel sheet ductwork, insulated and vapour sealed. Air shall be discharged into the room via supply-air diffusers with volume control dampers..

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-SPC-700-001	C	7.3
				Sheet No.
				6

The return air quantity shall be 90% of supply air quantity.. This shall ensure that the space remains under positive pressure, thus reducing the infiltration of outside air into the conditioned space.

Return air shall be routed back via return air grilles into the space above false ceiling which shall act as a return air plenum and further via hot-dipped galvanised ducts if required.

### 7.3.3.3 Unitary Airconditioning System

Local control room, Battery charger room and office areas shall be airconditioned by independent air-cooled packaged air conditioner unit split type airconditioner units:

Unitary air-conditioning system shall comprise of

- Floor standing vertical packaged unit, or ceiling/wall mounted direct split indoor unit.
- Outdoor mechanical draft air-cooled condenser
- Interconnecting refrigerant piping, valves and accessories.
- Air distribution system comprising of GI sheet Ducting grilles, and diffusers for packaged air conditioner units,
- Integral/duct mounted electric heaters (where applicable)
- Integral/duct mounted pan type humidifiers (where applicable)

The room temperature control shall be achieved by one or more room thermostat putting ON/OFF the packaged or split unit or by scheduling the packaged or split units where multiple units are provided. Humidity shall be controlled by Duct mounted pan humidifiers & Electric Duct Heaters through Room humidistats.

Split unit shall be either ceiling suspended ductable or wall mounted / floor standing direct type to suit space interiors.

Outdoor air cooled condenser units shall be either wall-mounted or ceiling mounted according to building structure.

All ducted packaged for control room shall be provided with duct mounted filters, electric duct heater, pan type humidifiers in the supply air ducting.

### 7.3.3.4 Ventilation System

#### GTG Enclosure/Building

The GTG hall shall be provided with general supply and exhaust ventilation system. Filtered air from centrifugal fans shall be distributed by means of ducting to the GTG hall. Exhaust shall be through roof mounted exhaust axial flow fans.



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-SPC-700-001	C	7.3
				Sheet No.
				7

### Cable Spreader Room

Cable spreader room shall be provided with dry pressurised ventilation. The supply air shall be cleaned from sand & dust by wall mounted fan filter units and distributed directly or via galvanised sheet ducting and supply air grilles. Exhaust shall take place through door / windows or high side wall mounted backdraft dampers

### Battery Room

The battery room shall be ventilated by a FRP-coated, explosion-proof belt-driven axial flow fan with air drawn from the neighboring rooms or directly drawn from the outside. All ductwork and equipment in contact with the battery room air shall be of plastic material or plastic-coated.

### Toilet /Shower/Locker Rooms

A separate extract system shall be provided in all cases. Make-up air shall enter the toilets through door or wall grilles.

### Other Pump Rooms (if any)

Pump rooms shall be provided with general exhaust ventilation by providing adequate no of roof/ wall mounted exhaust fan of suitable capacity each and intake shall be through louvers.

## 7.3.4 EQUIPMENT

### 7.3.4.1 Air handling units (AHU)

The draw-through Horizontal flow air handling units shall comprise the following combinations housed in a galvanized sheet metal or aluminium casing:

Mixing Box, Dampers, filter, DX-cooling coil Electric, heating coil, Electric steam humidifier and fan section.

The air-handling unit casing shall comprise a rigid frame with single skin sheet metal panels with thermal/acoustic insulation on the inside. The sheet metal skins shall be minimum of 1.6 mm thick suitably stiffened and braced to eliminate distortion and drumming. The insulation shall be minimum 12mm thick and have a thermal conductivity of less than 0.04 w/m k. The maximum face velocity shall not exceed 2.5 m/sec. The AHU shall be of sectionalized construction.

The prefilter section shall comprise 50mm thick washable filter panels suitably arranged in holding frames. The filters shall have a minimum efficiency of 95 % down to 10 micron size

The fine filter, section shall comprise 150/300 mm thick (5ply) synthetic non-woven washable filter panels, suitably arranged in holding frames. The filters shall have a minimum efficiency of 95 % down to 5 micron size

A differential pressure gauge shall be fitted across the filter. The design "clean" and "dirty" filter conditions shall be clearly marked.

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-SPC-700-001	C	7.3
				Sheet No.
				8

The DX cooling and dehumidifier coil shall be standard staggered tube arrangement and be fabricated from continuous Aluminium fins mechanically bonded to seamless copper tubes and return bends. DX coil shall be provided with suitable refrigerant distributor and return header. Return header shall be made of MS heavy grade. An insulated condensate drain pan with a trapped discharge pipe to suit the prevailing negative pressure shall be provided. Coils shall be tested at the manufacturer's works to a pressure of 700 kPa.

The fan shall be a DIDW centrifugal type. It shall be driven with V-belts by a totally enclosed motor. The fan discharge velocity shall not exceed 10m/s. All fans shall be suitable for 2 years continuous operation without servicing.

The washable filters for the air handling unit shall have a minimum life of at least 12 months.

#### 7.3.4.2 Refrigerant Condensing Unit (Air cooled)

Refrigerant Compressor :

The refrigerant compressor shall be Reciprocating Open / Semihermatic type suitable for Refrigerant F-134 A (Friendly with environment) with drive package ( for open type compressor only ), Suction and discharge valves, capacity control system, crank case heater etc.,. Each compressor shall incorporate electric/hydraulic actuation of cylinder unloading mechanism to provide a minimum, where possible, of four steps of capacity control.

Refrigerant Condenser

The condenser shall be designed to provide atleast 2 degrees subcooling under rated condition. The condenser shall sized to contain the entire refrigerant charge in accordance with ANSI - ASHRAE 15 standard. The condenser fan shall be axial flow type.

Refrigeration plant Accessories:

All major Items of plant shall be dried at the factory and filled with a holding charge of refrigerant or inert gas and openings shall be sealed. A dehydrator shall be fitted in the refrigerant pipework and arranged that the drier cartridge can be replaced when the refrigeration circuit is charged.

A control panel shall be provided to house all gauges and controls. The panel shall contain all necessary terminal strips to facilitate external wiring.

Refrigerant Circuits:

All refrigerant circuits shall be assembled, tested and charged with refrigerant at the manufacturer's works. Refrigerant pipework at site shall be avoided as far as possible.

All refrigerant pipework shall conform to ANSI B 31.5 standard and shall be of refrigerant quality, soft copper tube with socketed fittings and soldered joints to the size recommended by the equipment manufacturer.

Flexible connections shall be fitted at each compressor. These shall be corrugated flexible bronze tube, armoured with phosphorus bronze and braiding of the same bore as the line in which they are fitted and suitable for the test pressure.

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-SPC-700-001	C	7.3
				Sheet No.
				9

Pipework shall be designed and run so that any oil in the compressor discharge refrigerant, which passed through the oil separator (which fitted), is carried through the system and returned. At any point a large quantity of oil may accumulate, an oil separator returning the oil to the compressor shall be provided.

Pipework in refrigerant suction gas and low pressure liquid line shall be thermally insulated with 50 mm thick expanded polystyrene or equivalent with vapour and weather barriers, and shall be fixed as per insulation, manufacturer standard.

Valves required for compressor, liquid receiver etc. shall be of diaphragm or bellows type or shall be packed valves complete with seating and a seal cap.

Control Panel:

Unit shall be equipped with a control panel including the following:

- Gauges to indicate set oil pressure, condenser pressures.
- Switches to permit manual or automatic operation of cooling Tower fans and condenser cooling water pump and system switch to initiate system in sequence.
- Anti-shortcycle relay timer for compressor motor.
- High motor temperature, high discharge pressure, low suction pressure, low oil pressure cut-outs, all factory-wired to independently stop compressor motor. Each of these cut-outs shall have individual pilot lights and manual reset.
- Units shall be designed to start, run and stop automatically without special attention at all ambient where required by conditions.

#### 7.3.4.3 Package air Conditioning unit.

Unit suitable for outdoor and internal installation. casing of galvanized sheet metal, weather-proofed or stove-enameled against corrosion, evaporator side with sound and thermal insulation.

Compressor hermetically sealed, on anti-vibration mounts, direct evaporator cooling coil, cooling coil and condenser of seamless copper fins, forward curved Centrifugal fans for evaporator including direct-coupled motor and axial-flow fans for condenser;

Refrigerator circuit with refrigerant filling F-134 A (Friendly with environment), refrigerant drier and thermostatic expansion valves. Local control panel housing necessary safety interlocking contacts, contactors, switches & annunciation windows.

#### 7.3.4.4 Split type air conditioning unit

Outdoor unit consisting of rotary / scroll compressor, on anti-vibration mounts, axial flow fan air cooled condenser of seamless copper with aluminium fins, design & construction. Casing of galvanised sheet metal weather proofed or stored enameled against corrosion.

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-SPC-700-001	C	7.3
				Sheet No.
				10

Indoor unit consisting of direct expansion cooling and dehumidifying coil 3 speed forward curved DIDW centrifugal motor unit, insulated drain pan, coarse filter panel, casing of aesthetically designed ABS moulded plastic construction for direct mounting unit or galvanised sheet steel casing weather proofed or stoved enameled against corrosion in case of ductable type.

Refrigeration circuit with R-22 refrigerant filling, refrigerant drier, thermostatic expansion valves unit control panel barrier all control interlocks, power supply contactor etc.

#### 7.3.4.5 Supply Air System

The suction of the air shall be through an inlet louvre. A backward curved centrifugal fan shall be employed for conveying the air.

All parts including fan of this system coming in contact with moist air shall be epoxy painted and also the fan shaft which shall be epoxy painted.

Filtering efficiency and velocity across the unit shall be 90% down to 10 microns (minimum) and 2.5 M/sec respectively.

Local control panel housing all control & interlocking contacts, switches and annunciation window lamps.

#### 7.3.4.6 Centrifugal Fans:

Centrifugal fans for Ventilation System shall be DIDW non-overloading type. Fan shall be driven with V-belt by a totally enclosed motor and the fan outlet velocity shall not exceed 16 m/sec.

Impeller shall be die formed aerofoil or laminar type of self cleaning and non-overloading characteristics. The impeller shall be statically and dynamically balanced according to ISO standard.

The fan casing shall be of welded construction and provided with flanges on inlet & outlet side for duct connection.

The fan impeller & casing etc. shall be protected by a suitable corrosion resistant finish such with epoxy painting. All fans shall be suitable for 2 years continuous operating without servicing in between.

#### 7.3.4.7 Axial Flow Fan

Directly driven axial flow fans with die cast aluminium impeller dynamically balanced, fitted with three-phase induction motor.

The fan casing shall be of galvanized steel material, fan shall be provided with rain protection hood (for roof exhausted) exhaust / inlet cowl. Bird-screen, back-draft damper, (where necessary) grouting frame and cadmium plated fixing bolts.

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-SPC-700-001	C	7.3
				Sheet No.
				11

#### 7.3.4.8 Fan Filter Unit

Unit consisting of either axial flow or centrifugal fans, prefilter section, louvres, casing etc. The prefilter section shall comprise of 50 mm thick washable filter panel suitably arranged in holding frames. The filter shall have a minimum efficiency of 95% down to 20 microns size.

The unit casing shall be galvanised sheet steel construction, weather proofed, or stored enameled against corrosion with mounting frames or facility to either fix on support with the wall or suspend from ceiling. The casing shall be provided with an outlet flange to facilitate duct connection.

#### 7.3.4.9 Air Distribution System

##### Ductwork

Ductwork shall be detailed and fabricated in accordance with ASHRAE standards and the installation work shall be in accordance with ASHRAE/SMACNA.

All connections to equipment shall be made with angle-flanged joints plate and for long runs, angle-flanged joints shall be included at 10 meter intervals.

All ductwork support ties to the structure shall be made resilient with the use of 12mm thick mn thick non-intercellular neoprene strip, gaskets or washers. All ductwork connections to air handling equipment shall be made via 15 cm long connections of rubber impregnated canvass material.

Bends and offsets shall have a minimum throat radius equal to the width of the duct. Where shorter radius bends than the width of the duct are taken internal splitters or turning vanes shall be used.

Adequately-sized air-tight access doors with quick release fasteners shall be provided where necessary.

##### Supports for Ductwork

Supports shall generally comprise hot-dipped galvanized mild steel sections and drop rods assembled in a suitable manner to permit adjustment for height and alignment of the ducts, and to prevent the transmission of vibration and/or noise.

Ducts shall be supported by the stiffening angles or angle flanges but where this is impractical, supporting angles shall be fixed to the ducts. All ductwork shall be supported in such a manner that no weight is imposed upon the plant to which it is connected.

All mild steel sections used for the construction of ductwork supports shall be hot-dip galvanized.

##### Supply and Exhaust Air Grilles

In conventional attractive design, lamellas adjustable, aerofoil shape, broad front frame to allow airtight mounting. Frame and lamella made from steel with agreed stove enamel finish, conserved in nature colour. Covered screw mounting with use of mounting frame.

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-SPC-700-001	C	7.3
				Sheet No.
				12

Air-flow control by means of counter-moving, coupled lamellas, with sets of adjustable air deflection blades and an opposed blade damper located at the rear, adjustable from the front side, made of phosphatized sheet metal and varnished black.

#### Supply and Exhaust Air Diffusers

Square construction for mounting in false ceilings. Air vanes in lamella form for air distribution to all sides, made from powder coated extruded aluminium with agreed finish, Connection boxes in air-foiled construction made of galvanized sheet metal with built-in throttling device and connecting piece.

Ceiling diffusers shall be of the adjustable eyelash deflection blade type and shall have an opposed blade damper located at the rear. The diffuser shall be fixed to the ductwork by a purpose-made sub-frame assembly.

#### Fire Dampers

To shut off fire section in air-conditioning plants, fire dampers with fire rating of 90 minutes designed as per UL-555. The chamber housing shall be made of galvanized sheet metal, lamellas made of special insulating material, lamella bearings in stainless steel resp. brass sleeves, serving and control elements arranged on the outside such as levers, and position indicators, manual release, notching arrangement, inspection door, thermal release by melting solder at 72°C, electrical position switch for indicating damper position on the switch board with a contact (potential-free contacts) for fire alarm to a central supervision tableau.

#### Isolating Dampers

Consisting of frames of galvanized sheet metal, air foiled lamellas, adjustable from the outside by a lever and positioning device.

Lamella clutches by aluminium cogs mounted inside, bearing sleeves closed to the outside, including mounting flange for connection to an air-duct or mounting into an A/C-chamber.

#### Air Quantity Regulating Flaps

Air quantity regulating flaps for balancing, during first step of operation, of the mathematically--determined air quantities in each duct branch. These throttling devices shall be arranged in supply air ducts as well as in return air ducts.

#### Weather Louvers

Consisting of hot-dipped galvanized angle-iron frame with built-in rain-rejecting galvanised iron or aluminium lamellas as well as bird protection screen of galvanized iron. Mounting frame of galvanized profile steel.

#### Thermal Insulation

The Entire Supply air ducting for air conditioning system shall be insulated with 25 mm (24 kg/m<sup>3</sup>) resin bonded fibre glass thermal insulation. The Portion of supply air ducting passing through outdoor / non air-conditioned space shall also be insulated with 50 mm thick resin bonded fibre glass thermal insulation respectively.

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-SPC-700-001	C	7.3
				Sheet No.
				13

Only portion of return air ducting passing through non air-conditioned space shall be provided with 25 mm thick (24 kg/m<sup>3</sup>) resin bonded fibre glass thermal insulation.

Insulation shall be fixed as per manufacturer's recommendation. The fibre glass insulation roll shall have 0.5 mm thick aluminium facing. and shall be laid with staggered joints, sealed with aluminium tapes. Insulation roll shall be attached to ducts with Bitumen (85/25 or 85/40) or CPRX sticking compound and insulation. Due care shall be taken to avoid damage to vapour arrestor & insulation.

#### Acoustic Insulation

Acoustic Insulation of 12 mm thick rigid fibre glass board covered with 1 mil thick fibre glass cloth or Kraft paper shall be provided on the inside of supply ducting upto 6 mt from each airconditioning system air handling units/fan coil units.

### 7.3.5 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 malfunctioning of instruments or any probable operational mistakes. Technical features of the controls and instruments shall basically comply with applicable general requirement of Section- 9.0 of Vol. V.

It must be possible to start the Air-conditioning and ventilation plant from local skid/floor/wall mounted control cum annunciation panels. Only those alarms which are required to indicate malfunctions or failure of the Air-conditioning & Ventilation Plant shall be transmitted to the central control room.

Instrumentation has to be provided as far as required for safe and satisfactory operation and supervision of the plant. Adaptation of the specified scope and design of the control and instrumentation equipment shall be done where needed for matching the special versions and requirements of apparatus and plant equipment.

All necessary interfaces for interlocking / tripping of HVAC starter panels from fire detection system shall be considered by HVAC system supplier. Also necessary cabling for the same shall be included by HVAC system supplier .

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-SPC-700-001	C	7.3
				Sheet No.
				14

### 7.3.6 SPECIFIED DESIGN DATA

DESCRIPTION	MINIMUM REQUIREMENTS	
	Unit	Data
<b>Ambient outside design conditions</b>		
<b>Summer</b>		
Dry Bulb Temperature	°C	45
Wet Bulb Temperature	°C	35
<b>Winter</b>		
Dry Bulb Temperature	°C	0
<b>Building Pressure</b>		
Minimum positive pressure shall be maintained	pa	40
Central Control, Electronic Panel, UPS Room, GTG Building/Enclosure	pa	40
Switchgear Room & Cable Spreader Rooms	pa	40



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-SPC-700-001	C	7.3
				Sheet No.
				15

Space	Dry Bulb Temp. °C	Relative Humidity %	Minimum Fresh Air charges	Remarks
- Control Room, Central Electronics Room, UPS and Battery Charger Room	22 ± 2	50 ± 5	1 h <sup>-1</sup>	Central air-cooled DX Air conditioning System.
- Switch gear Building	35 ± 2		12 h <sup>-1</sup>	
- GTG Building/Enclosure			12 h <sup>-1</sup>	General Exhaust Ventilation
- Cable Spreader Room			6 h <sup>-1</sup>	Supply air system exhaust through side wall back draft damper
- Battery Room			20 h <sup>-1</sup>	General Exhaust Ventilation with Bifurcated fan
- Toilets (if applicable)	-	-	20 h <sup>-1</sup>	General Exhaust Ventilation

**Note :** In addition to the above air changes the ventilation system fresh air quantity shall be selected based on the design maximum inside condition and actual heat load present in the ventilated space which ever is higher.

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-SPC-700-001	C	7.3
				Sheet No.
				16

## 7.3.7 TECHNICAL DATA BY TENDERER

Sl. No.	Space	Type of Airconditioning / Ventilation System	Equipment Type	Capacity	Qty

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-SPC-700-001	C	7.3
				Sheet No.
				17

DESCRIPTION	UNIT	DATA
<b>AIR HANDLING UNIT</b>		
No. of AHU's		
Make / model No	-	
Type	-	
Dimensions		
Supply air fan:		
Air quantity	m <sup>3</sup> /h	
Fan static pressure	pa	
Motor power required	kW	
Motor speed	rpm	
Cooling & dehumidifying Coil capacity	kW	
Electric Heater capacity	kW	
Electric steam humidifier capacity	kg/hr	
Primary Filters (coarse filters):		
Type		
Efficiency of filters (to ASHRAE 52)		
Secondary Filters (Fine filters):		
Type		
Efficiency of filters (to ASHRAE 52)		
<b>REFRIGERANT CONDENSING UNIT</b>		
Number of refrigeration units	-	
Make / model no	-	
Type	-	
No. of compressors per unit	No.	

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-SPC-700-001	C	7.3
				Sheet No.
				18

DESCRIPTION	UNIT	DATA
Refrigerant duty		
Total power input at 100 % load	kW	
Energy efficiency ratio		
100 % load		
75 % load		
50 % load		
25 % load		
Compressor motor speed	rpm	
Type capacity controller		
<b>PACKAGE AIRCONDITIONER</b>		
Make Model No.		
Type		
Capacity	kW	
Fan supply air quantity	m <sup>3</sup> /hr	
Fan static pressure	mmWC	
Required motor power	kW	
Compressor:		
Type		
No. of compressor		
Required motor power	kW	
Air Cooled Condenser		
Fan Capacity		
Fan motor power	kW	
Condenser capacity	kW	
Electric duct heater capacity	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-SPC-700-001	C	7.3
				Sheet No.
				19

DESCRIPTION	UNIT	DATA
Pan type humidifier capacity	kg/hr	
<b>SPLIT AIR CONDITIONER</b>		
Make / Model No.		
Type		
Quantity		
Compressor		
Type		
No. of compressor		
Cooling capacity each	kW	
Required motor power	kW	
Air cooled condenser		
Fan capacity	m <sup>3</sup> /hr	
Required motor power	kW	
Indoor fan coil unit		
Fan capacity	m <sup>3</sup> /hr	
Fan static head	mmWC	
Cooling coil capacity	kW	
Electric heater capacity	kW	
Pan type humidifier capacity	kg/hr	
<b>SUPPLY AIR SYSTEM</b>	-	
Supply air:		
Air quantity	m <sup>3</sup> /h	
Fan static pressure	pa	
Motor power required	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-SPC-700-001	C	7.3
				Sheet No.
				20

DESCRIPTION	UNIT	DATA
Air Filter:		
Pressure loss in main air stream		
Make type		
Circulating Water Pump:		
Make / Type		
Flow rate	m <sup>3</sup> /hr	
Total Head	MWC	
Pump speed	RPM	
Required Motor Power	kW	
Total Makeup water Required	m <sup>3</sup> /hr	
<b>ROOF EXTRACTORS</b>	No.	
Make		
Air quantity	m <sup>3</sup> /hr	
Fan static pressure	pa	
Required Motor power	kW	
<b>WALL MOUNTED EXHAUST FANS</b>		
Make		
Air Qty.	m <sup>3</sup> /hr	
Fan Static Pressure	pa	
Required Motor Rating	Kw	