

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. - 02,
NOVEMBER 2013.



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



TITLE 400 MW MARIB GTPS PH II

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SCOPE OF ENQUIRY



AIR CONDITIONING SYSTEM SCOPE OF ENQUIRY

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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.

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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">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.	-----

400 MW MARIB GTPS PHASE-II, YEMEN

SECTION - B **PROJECT INFORMATION**

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	Design Ambient temperature for Gas Turbine & Mechanical equipment	45 °C
A		
B	Design Ambient temperature of electrical equipment	50 °C
10.0	Electrical Details	Refer attached Anx-I



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

SECTION C

AIR CONDITIONING SYSTEM

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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 coating 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.



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- 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 areas 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.

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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.

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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	AIR HANDLING UNIT (DOUBLE SKIN TYPE)		
	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	STRIP HEATER PACKAGE		
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		



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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 ³) 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 ³) 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 aluminum facing. and shall be laid with staggered joints, sealed with aluminum tapes. Insulation roll shall be

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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 enamelled 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.

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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, flanges, tees, elbows, blind flanges, reducers, nuts, bolts, washer, gasket, adhesive and other miscellaneous items shall be supplied 15% extra over and above the required quantity as per approved drawing / actual site requirement.		
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 (http://124.124.36.198/wrenchwebaccess/login.aspx).		
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		

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out clearly. The detail design & equipment sizing shall be in the bidder's scope of supply.

10.1.27 The bidder's proposal shall be for equipment in accordance with the Tech. Specification.

10.1.28 Bidder to note that engineering drawings shall be prepared indicating all the accessories (upto the extent of nuts bolts gaskets rivets etc.) required to complete the installation in every respect. Approval shall not be given on the drawings not indicating the complete accessories with sizes and quantities. It may further be noted that all these quantities shall be reflected in the billing break up (BBU). No BBU shall be approved until the BBU covers all the items required and indicated in the drawing.

10.1.29 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. ACCESSORIES FOR MAIN EQUIPMENTS TO BE PROVIDED BY THE SUPPLY VENDOR

Bidder to note that along with all the equipment, necessary accessories required for their complete erection at site as per approved engineering drawings / modified engineering drawing as per site requirement 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 CONDENSING UNITS, AHU, FAN, SPLIT UNITS, RELAY PANEL ETC.

All necessary fittings, accessories, Cadmium plated bolts, nuts, washers, vibration isolation 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 PIPING


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 refrigerant and drain piping.

11.1.3 DUCTING

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 INSULATION

All material and accessories like CPRX / Eqvt adhesive, wire mesh, GI wire, AL cladding, Cadmium plated bolts, nuts, washers, rivets, aluminium sheet for cladding, perforated aluminium sheet and all other accessories required to make the installation

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11.1.5	<p>complete in all respect shall be supplied in adequate quantity for thermal insulation of ducts and pipes and for acoustic insulation.</p> <p>GRILL / DIFFUSER, FIRE DAMPER, VOLUME CONTROL DAMPER</p> <p>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.</p>		
11.1.6	<p>All accessories as elaborated above shall be supplied to make the system complete in all respect. Further, 15 % extra quantity for above accessories shall also be supplied as contingency.</p> <p>Furthermore, if there are any modifications in the drawings due to some site constraints etc. the revised quantity of the accessory materials along with 15 % extra as contingency shall also be supplied by vendor</p>		
11.1.7	<p>Approval of engineering drawing shall not relieve the vendor from supplying any additional item/accessories as elaborated under various section of clause 11 above. Further, any modification in the approved engineering drawing, required in view of change in layout due to site constraints (after approval of engineering drawing) shall also be done by the bidder within a period of maximum 5 days.</p>		
11.1.8	<p>BHEL shall approve/comment drawings/documents within 15 days of each submission. Vendor to resubmit drawings/documents within 7 days taking care of all comments of BHEL/Customer and BHEL shall approve/Comment the same within 15 days.</p>		
12.	<p>DRAWINGS / DOCUMENTS TO BE FURNISHED BY BIDDER ALONG WITH TECHNICAL OFFER</p>		
12.1.1	<p>Space requirement / layout of AC equipment.</p>		
12.1.2	<p>Completely filled Data Sheet of Ventilation system, motor and other instruments attached with the Technical Specification.</p>		
12.1.3	<p>Quality Plans for the equipment, motor, valves, instruments etc, duly signed by the bidder, to be furnished along with the Technical Offer.</p>		
12.1.4	<p>One set of catalogues of equipment offered.</p>		
12.1.5	<p>Three (3) sets of Technical specification (spiral binded) duly signed & stamped by the bidder, to be furnished along with the Technical Offer.</p>		

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CUSTOMER TECHNICAL SPECIFICATION

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VOLUME IV
SECTION 7.3
HEATING, VENTILATION & AIR CONDITIONING SYSTEM

FORMT9-P REV-B

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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.

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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.

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- 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..

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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.

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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.

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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.

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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.

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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.

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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.

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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/m³) 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.

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Only portion of return air ducting passing through non air-conditioned space shall be provided with 25 mm thick (24 kg/m³) 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 .

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7.3.6 SPECIFIED DESIGN DATA

DESCRIPTION	MINIMUM REQUIREMENTS	
	Unit	Data
Ambient outside design conditions		
Summer		
Dry Bulb Temperature	°C	45
Wet Bulb Temperature	°C	35
Winter		
Dry Bulb Temperature	°C	0
Building Pressure		
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

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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 ⁻¹	Central air-cooled DX Air conditioning System.
- Switch gear Building	35 ± 2			
- GTG Building/Enclosure			12 h ⁻¹	
- Cable Spreader Room			6 h ⁻¹	Supply air system exhaust through side wall back draft damper
- Battery Room			20 h ⁻¹	General Exhaust Ventilation with Bifurcated fan
- Toilets (if applicable)	-	-	20 h ⁻¹	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.

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7.3.7 TECHNICAL DATA BY TENDERER

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

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DESCRIPTION	UNIT	DATA
AIR HANDLING UNIT		
No. of AHU's		
Make / model No	-	
Type	-	
Dimensions		
Supply air fan:		
Air quantity	m ³ /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)		
REFRIGERANT CONDENSING UNIT		
Number of refrigeration units	-	
Make / model no	-	
Type	-	
No. of compressors per unit	No.	

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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		
PACKAGE AIRCONDITIONER		
Make Model No.		
Type		
Capacity	kW	
Fan supply air quantity	m ³ /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	

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

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



**TECHNICAL SPECIFICATION FOR
AC SYSTEM(ELECTRICAL PORTION)**

SPECIFICATION NO. PE-TS-372-
VOLUME II B
SECTION-C
REV 01 DATE 29.11.2013
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ELECTRICAL EQUIPMENT SPECIFICATION FOR AC 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 [Electrical Scope between BHEL & Vendor].
- 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 230V AC(supply feeder)/400V AC loads required for the system 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 AC 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 Miscellaneous electrical item
- 4.4 Quality Plan for motors.
- 4.5 Load data format (Annexure-II).

ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
PACKAGE : AC System (CIVIL IN BHEL SCOPE)

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	400V MCC	BHEL	BHEL	1. BHEL will provide single phase 230 V AC (supply feeder)/400V , 3-phase 4-wire supply based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract including power supply equipment (battery charger etc) required for the PLC/control panel (as applicable) for the system supplied by vendor. 2. Interposing relays (RE 302 of Jyoti make or equivalent), if required for PLC and microprocessor based systems, shall be provided by BHEL in MCCs. Requirement of these relays shall be furnished by vendor during detailed engineering stage.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL BHEL* BHEL	1. Sizes and quantity of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL). Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by BHEL*.
4	Any special type of cable like compensating, co-axial, prefab, MICC, fibre optical etc.	Vendor	BHEL*	If required for the system
5	Cable trays, accessories & cable trays supporting system	BHEL	BHEL	
6	Cable glands and lugs for equipments supplied by Vendor	Vendor	BHEL*	1. Cable glands shall be Double compression type, tinned brass, shrouded, complete with necessary armour clamp and tapered washers etc. (suitable for selected cable size). 2. Heavy duty tinned copper lugs (suitable for selected cable size). Lugs for power cables shall be of compression type, whereas lugs for control cables shall be of insulated terminal crimping type.
7	Conduit and conduit accessories	BHEL	BHEL	
8	Lighting	BHEL	BHEL	
9	Equipment grounding & lightning protection	BHEL	BHEL	
10	Below grade grounding	BHEL	BHEL	
11	LT Motors with base plate and foundation hardware	Vendor	BHEL*	Makes shall be subject to customer/ BHEL approval at contract stage.
12	E & C spares, erection & maintenance tools & tackle.	Vendor	-	As per specification
13	Any other equipment/material/service required for	Vendor	BHEL*	

**ANNEXURE – I TO SECTION – C : STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR
(CIVIL IN BHEL SCOPE)**

PACKAGE : AC System

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
	completeness of system but not specified above (to ensure trouble free and efficient operation of the system).			
14	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for C & I systems for vendor supplied equipment shall be furnished during detail engineering by vendor in soft copies in the BHEL cable schedule format.
15	Equipment layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipments requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Electrical equipment layout drawing shall be to BHEL approval.
16	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipments/items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. BHEL* means E & C by BHEL and supervision by vendor.

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. | 220 VDC system | : | 15 kA for 1sec |

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8.8 ELECTRIC MOTORS

8.8.1 General

This specification covers the design, manufacture, supply, erection, testing and commissioning of Motors for various driven equipment and Actuators.

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.

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.

8.8.2 Scope of work

The scope of work shall include but not limited to the following:

- 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

Motors shall conform to IEC and other applicable international standards amended upto date. Equivalent ANSI standards are also acceptable.

8.8.3.1 Motors

Design Features

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.

Inching type motors as per the requirement shall be provided.

The motor rating shall be at least 15% (service factor) over the maximum input power requirement of the driven equipment at rated point.

Continuously operating motors shall be of high efficiency type.

Power supply for AC motors shall be as follows:

- 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

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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.

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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.

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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.

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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.

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8.8.5 Specified Design Data

SECTION : ELECTRIC MOTORS

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 motorsNo. 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)

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8.8.6 Technical Data by the Tenderer

SECTION : ELECTRIC MOTORS

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	%	

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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	-	


FORMTS-P REV-B


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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	

FORMAT-P REV-B

		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :					
				BIDDER/ : VENDOR		TITLE		NUMBER :					
						QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01		SPECIFICATION TITLE					
SL. NO.	COMPONENT/OPERATION	SHEET 1 OF 2	CHARACTERISTICS CHECK	SYSTEM CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			VOLUME III REMARKS
1	2	3		4	5	6	7	8	9	P	W	V	11
1.0	ASSEMBLY		1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
			2.DIMENSIONS	MA	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-		
			3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IEC	MFG.SPEC. RELEVANT IEC	-DO-	2	-	-	
2.0	PAINTING		1.SHADE	MA	VISUAL	SAMPLE	MANUF'R'S SPEC/BHEL SPEC./RELEVANT INTERNATIONAL STANDARD	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-	
3.0	TESTS		1.ROUTINE TEST INCLUDING SPECIAL TEST AS PER BHEL SPEC.	MA	-DO-	100%	RELEVANT IEC/ BHEL SPEC./ DATA SHEET	SAME AS COL.7	TEST REPORT	2	1		NOTE -1 & NOTE-3
			2.OVERALL DIMENSIONS & ORIENTATION	MA	MEASUREMENT & VISUAL	100%	APPROVED DRG/DATA SHEET	APPROVED DRG/DATA SHEET & RELEVANT IEC	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL					PARTICULARS		BIDDER/VENDOR						
					NAME								
					SIGNATURE								


		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :					
				BIDDER/ VENDOR :		TITLE		NUMBER :					
				SYSTEM CAT.		QUALITY PLAN		TITLE :					
SL. NO.	COMPONENT/OPERATION	SHEET 2 OF 2	CHARACTERISTICS CHECK	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION AGENCY	P	W	V	VOLUME III REMARKS
1	2	3	3.NAMEPLATE DETAILS	MA	VISUAL	100%	RELEVANT IEC & DATA SHEET	RELEVANT IEC & DATA SHEET	2	1	-	11	
NOTES:													
1 ROUTINE TESTS ON 100% MOTORS SHALL BE DONE BY THE VENDOR. HOWEVER, BHEL SHALL WITNESS ROUTINE TESTS ON RANDOM SAMPLES. THE SAMPLING PLAN SHALL BE MUTUALLY AGREED UPON 2 WHERE EVER CUSTOMER IS INVOLVED IN INSPECTION, (1) SHALL MEAN BHEL AND CUSTOMERS BOTH TOGETHER. 3 FOR EXHAUST/VENTILATION FAN MOTORS OF RATING UPTO 1.5KW , ONLY ROUTINE TEST CERTIFICATES SHALL BE FURNISHED FOR SCRUTINY.													
<u>Legends for Inspection agency</u> 1. BHEL/CUSTOMER 2. VENDOR (MOTOR MANUFACTURER) 3. SUB-VENDOR (RAW MATERIAL/COMPONENTS SUPPLIER) P. PERFORM W. WITNESS V. VERIFY													
BHEL		PARTICULARS		BIDDER/VENDOR									
		NAME											
		SIGNATURE											
		DATE											
BIDDER'S/VENDORS COMPANY SEAL													

<div></div>		QUALITY PLAN		CUSTOMER :		PROJECT		SPECIFICATION :						
				BIDDER/ : VENDOR		TITLE		NUMBER :						
						SPECIFICATION :								
						TITLE								
SHEET 1 OF 9				SYSTEM		NUMBER PED-506-00-Q-007, REV-03		VOLUME III						
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY		REMARKS			
									P	W	V			
1	2	3	4	5	6	7	8	9	10		11			
1.0	RAW MATERIAL & BOUGHT OUT CONTROL													
1.1	SHEET STEEL, PLATES, SECTION, EYEBOLTS	1.SURFACE CONDITION	MA	VISUAL	100%	-	FREE FROM BLINKS, CRACKS, WAVINESS ETC	LOG BOOK	3	-	-			
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	-DO-	3	-	-			
		3.PROOF LOAD TEST (EYE BOLT)	MA	MECH. TEST	-DO-	-DO-	INSPEC. REPORT		3	-	2			
1.2	HARDWARES	1.SURFACE CONDITION	MA	VISUAL	100%	FREE FROM CRACKS, UN-EVENNESS ETC.	-DO-		3	-	-			
		2.PROPERTY CLASS	MA	VISUAL	SAMPLES	MANFR'S DRG./SPEC BOOK	RELEVENT IEC/SPEC.	SUPPLIERS TC & LOG	3	-	2	PROPERTY CLASS MARKING SHALL BE CHECKED BY THE VENDOR		
1.3	CASTING	1.SURFACE CONDITION	MA	VISUAL	100%	FREE FROM CRACKS, BLOW HOLES ETC.		LOG BOOK	3	-	2			
		2.CHEM. & PHY. PROP.	MA	CHEM & MECH TEST	1/HEAT NO.	MANFR'S DRG./SPEC	RELEVENT IEC/	SUPPLIER'S TC	3	-	2	HEAT NO. SHALL BE VERIFIED		
		3.DIMENSIONS	MA	MEASUREMENT	100%	MANUFR'S DRG.	MANUFR'S DRG.	LOG BOOK	3	-	2			
1.4	PAINT & VARNISH	1.MAKE, SHADE, SHELF LIFE & TYPE	MA	VISUAL	100% CONTINUOUS	MANFR'S DRG./SPEC	MANFR'S DRG./SPEC	LOG BOOK	3	-	2			
BHEL				PARTICULARS		BIDDER/VENDOR								
				NAME										
				SIGNATURE										
				DATE		BIDDER'S/VENDORS COMPANY SEAL								

QUALITY PLAN				CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :													
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER PED-506-00-Q-007, REV-03		SPECIFICATION : TITLE													
SHEET 2 OF 9				SYSTEM		ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION		VOLUME III											
SL. NO.		COMPONENT/OPERATION		CHARACTERISTIC CHECK		CAT.		TYPE/ METHOD OF CHECK		EXTENT OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS	

CUSTOMER :				PROJECT		SPECIFICATION :					
QUALITY PLAN				TITLE		NUMBER :					
BIDDER/ VENDOR				QUALITY PLAN		SPECIFICATION :					
SYSTEM				NUMBER PED-506-00-Q-007, REV-03		TITLE					
CAT.				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		SECTION					
TYPE/ METHOD OF CHECK				REFERENCE DOCUMENT		ACCEPTANCE NORM		AGENCY			
EXTENT OF CHECK				FORMAT OF RECORD		P		W			
V				V		V		V			
1				2		3		11			
1.10	BEARINGS	3.DIMENSIONS	MA	MEASUREMENT	-DO-	-DO-	MANFR'S DRG./ APPROVED DATASHEET	Log Book	3	-	2
		1.MAKE & TYPE	MA	VISUAL	100%	MANFR'S DRG./ APPROVED DATASHEET	MANFR'S DRG./ APPROVED DATASHEET	-DO-	3	-	2
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	BHEL DATA SHEET	BHEL DATA SHEET BEARING MANUF'S CATALOGUES	-DO-	3	-	2
		3.SURFACE FINISH	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	2
1.11	SLIP RING (WHEREVER APPLICABLE)	1.SURFACE COND.	MA	VISUAL	100%	-	-DO-	-DO-	3	-	-
		2.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
		3.TEMP.WITH-STAND CAPACITY	MA	ELECT.TEST	-DO-	MANUF'S SPEC./BHEL SPEC.	MANUF'S SPEC./BHEL SPEC.	-DO-	3	-	2
		4.HV/IR	MA	-DO-	100%	-DO-	-DO-	-DO-	3	-	2
1.12	OIL SEALS & GASKETS	1.MATERIAL OF GASKET	MA	VISUAL	100%	MANUF'S DRG/SPECS	MANUF'S DRG./SPECS.	-DO-	3	-	-
		2.SURFACE COND.	MA	VISUAL	100%	-	FREE FROM VISUAL DEFECTS	-DO-	3	-	-
		3.DIMENSIONS	MA	MEASUREMENT	SAMPLE	MANUF'S DRG	MANUF'S DRG	-DO-	3	-	-
BHEL				PARTICULARS		BIDDER/VENDOR					
				NAME							
				SIGNATURE							
				DATE							
						BIDDER/SVENDORS COMPANY SEAL					

CUSTOMER :				PROJECT		SPECIFICATION :															
QUALITY PLAN				TITLE		NUMBER :															
BIDDER/ VENDOR				QUALITY PLAN		SPECIFICATION :															
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COMPONENT/OPERATION				ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		VOLUME III															
SL. NO.	CHARACTERISTIC CHECK	CAT.	TYPE/METHOD OF CHECK	EXTENT OF CHECK	7	8	9	SECTION													
								AGENCY	W	V											
1		2		3		4		5		6		7		8		9		10		11	
2.0	IN PROCESS																				
2.1	STATOR FRAME WELDING (IN CASE OF FABRICATED STATOR)	1.WORKMANSHIP & CLEANNESS	MA	VISUAL	100%	-DO-	GOOD FINISH	LOG BOOK	3/2	2	-										
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-										
		1.FINISH	MA	VISUAL	100%	-DO-	MANUF'S DRG	GOOD FINISH	LOG BOOK	2	-	-									
		2.DIMENSIONS	MA	MEASUREMENT	-DO-	MANUF'S DRG	MANUF'S DRG	-DO-	2	-	-										
2.2	MACHINING	3.SHAFT SURFACE FLOWS	MA	PT	-DO-	RELEVANT SPEC./ ASTM-E165	MANUF'S SPEC./ BHEL SPEC./	-DO-	2	-	1										
		1.SURFACE PREPARATION	MA	VISUAL	100%	-DO-	MANFR'S SPEC./BHEL SPEC./ SAME AS RELEVANT STAND	BHEL SPEC. SAME AS COL.7	LOG BOOK	2	-	-									
2.3	PAINTING	2.PAINT THICKNESS (BOTH PRIMER & FINISH COAT)	MA	MEASUREMENT BY ELCOMETER	SAMPLE	-DO-	-DO-	-DO-	2	-	-										
		3.SHADE	MA	VISUAL	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-									
		4.ADHESION	MA	CROSS CUTTING & TAPE TEST	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-									
BHEL				PARTICULARS		BIDDER/VENDOR															
				NAME																	
				SIGNATURE																	
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																BIDDER/SVENDORS COMPANY SEAL					

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						SPECIFICATION :						
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COMPONENT/OPERATION		NUMBER PED-506-00-Q-007, REV-03		VOLUME III								
SL. NO.	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			REMARKS	
								AGENCY	P	W		V
1	2	3	4	5	6	7	8	9	10			11
2.4	SHEET STACKING	1.COMPLETENESS	MA	MEASUREMENT	SAMPLE	MANUFR'S SPEC.	MANUFR'S SPEC.	Log Book	2	-	-	(FOR MOTORS OF 2MW AND ABOVE) * ON 10% RANDOM SAMPLE
		2.COMPRESSION & TIGHTENING	MA	MEASUREMENT	100%	-DO-	-DO-	Log Book	2	-	-	
		3.CORE LOSS & HOTSPOT	MA	ELECT.TEST	-DO-	-DO-	-DO-	Log Book	2	1*	1	
2.5	WINDING	1.COMPLETENESS	CR	VISUAL	100%	MANUFR'S SPEC./BHEL SPEC.	MANUFR'S SPEC./BHEL SPEC.	Log Book	2	-	-	FOR MV MOTOR
		2.CLEANLINESS	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		3.IR-HV-IR	CR	ELECT. TEST	-DO-	-DO-	-DO-	Log Book	2	-	1	
2.6	IMPREGNATION	4.RESISTANCE	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	THREE DIPS TO BE GIVEN
		5.INTERTURN INSULATION	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	-	
		6.SURGE WITH STAND AND TAN. DELTA TEST	CR	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
		1.VISCOSITY	MA	PHY. TEST	AT STARTING	-DO-	-DO-	Log Book	2	-	-	
		2.TEMP. PRESSURE VACCUUM	MA	PROCESS CHECK	CONTINUOUS	-DO-	-DO-	Log Book	2	-	-	
		3.NO. OF DIPS	MA	-DO-	-DO-	-DO-	-DO-	Log Book	2	-	1	
BHEL		PARTICULARS		BIDDER/VENDOR								
		NAME										
		SIGNATURE										
		DATE										
						BIDDER'S/VENDORS COMPANY SEAL						

CUSTOMER :			PROJECT		SPECIFICATION :									
QUALITY PLAN			TITLE		NUMBER :									
BIDDER/ : VENDOR			QUALITY PLAN		SPECIFICATION :									
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SYSTEM			ITEM: AC ELECT. MOTORS 55 KW & ABOVE (LV & MV)		VOLUME III									
CAT.			TYPE/ METHOD OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM		FORMAT OF RECORD		AGENCY		REMARKS	
SL. NO.			EXTENT OF CHECK		7		8		9		10		11	
COMPONENT/OPERATION			4		5		6		7		8		9	
1			2		3		4		5		6		7	
2.7			COMPLETE STATOR ASSEMBLY		4.DURATION		MA		-DO-		-DO-		Log Book	
2.8			BRAZING/COMPRESSION JOINT		1.COMPACTNESS & CLEANLINESS		MA		VISUAL		100%		Log Book	
					1.COMPLETENESS		CR		-DO-		-DO-		Log Book	
					2.SOUNDNESS		CR		MALLET TEST & UT		-DO-		Log Book	
					3.HV		MA		ELECT. TEST		-DO-		Log Book	
2.9			COMPLETE ROTOR ASSEMBLY		1.RESIDUAL UNBALANCE		CR		DYN. BALANCE		-DO-		MFG SPEC./ RELEVANT IEC	
					2.SOUNDNESS OF DIE CASTING		CR		ELECT. (GROWLER TEST)		-DO-		MFG. SPEC.	
2.10			ASSEMBLY		1.ALIGNMENT		MA		MEAS.		-DO-		Log Book	
					2.WORKMANSHIP		MA		VISUAL		-DO-		Log Book	
					3.AXIAL PLAY		MA		MEAS.		-DO-		Log Book	
					4.DIMENSIONS		MA		-DO-		-DO-		Log Book	
					5.CORRECTNESS, COMPLETENESS, TERMINATIONS/ MARKING/ COLOUR CODE		MA		VISUAL		100%		MFG SPEC. RELEVANT IEC	
					6. RTD, BTD & SPACE HEATER MOUNTING.		MA		VISUAL		100%		MFG SPEC. RELEVANT IEC	
BHEL			PARTICULARS		BIDDER/VENDOR									
			NAME											
			SIGNATURE											
			DATE											

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8.15 Miscellaneous Electrical Items

8.15.1 General

This specification covers the design, manufacture, supply, erection, testing and commissioning of Miscellaneous Electrical Items.

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.

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.

8.15.2 Scope of work

The scope of work shall include but not limited to the following:

- ✓ Cable Trays and Accessories (Applicable)
- ✗ Cable termination and jointing kits. (Not Applicable)
- ✗ Cable ties, clamps and markers (Not Applicable)
- ✗ Receptacles. (Not applicable)
- ✓ Conduits and accessories. (Applicable)
- ✓ Junction boxes. (Applicable)
- ✓ Cable glands and cable lugs. (Applicable)
- ✗ Fire stop cable sealing system. (Not Applicable)
- ✓ List and supply of Maintenance tools and tackles. (As applicable for this package)
- ✓ List of recommended spare parts as per Section 10.6. NOT APPLICABLE
- ✓ Commissioning spares. (As applicable for this package)

All accessories, fittings, supports, anchor bolts etc. which form part of the equipment or which are necessary for safe and satisfactory installation and operation of the equipment shall be furnished.

8.15.3 Technical Requirements

All the items shall conform to latest edition of relevant IEC standards amended upto date. Equivalent ANSI standards are also acceptable.

8.15.3.1 Cable Trays and Cable Tray Supports

Cable trays shall be pre-fabricated ladder type, made of 3 mm thick sheet steel with hot dip galvanized furnished in standard lengths of not less than 2.5 m. Cable trays of tough FRP

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8.15.3.5 Junction Box

Junction boxes shall be conforming to degree of protection IP55. The boxes shall be of die cast aluminium (LM 6) complete with removable cover plate with gaskets, two earthing terminals, terminal blocks etc.

The boxes shall have provision for wall, column, pole or structure mounting and shall be provided with cable/conduit entry knock outs & terminal blocks.

The terminal blocks shall be mounted securely on brackets welded to the back sheet of the box. The terminals shall be 650 V grade, one piece construction complete with terminals, insulation barriers, galvanised nuts, bolts and washers and provided with identification strips of PVC. The terminals shall be made of copper alloy and shall be of box clamp type.

The terminals for junction boxes shall be suitable for terminating two (2) nos. 2.5 mm² stranded copper conductors on each side.

8.15.3.6 Cable Glands

Cable glands shall be tinned brass, shrouded, double compression type, complete with necessary armour clamp and tapered washers etc. Cable glands shall match with the different cable sizes.

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8.15.3.7 Cable Lugs

Cable lugs shall be tinned copper lugs suitable for termination of different sizes of HT/LT/ control cables. Lugs for power cables shall be of compression type, whereas lugs for control cables shall be of insulated terminal crimping type.

8.15.3.8 Fire Stop Cable Sealing System (NOT APPLICABLE)

In order to restrict the propagation of cable fire and spread of toxic smoke, the cable entry below switchgear panels/ control panel, cable penetration through walls and cable shafts on the floors need to be sealed by fire seal system.

Fire stop cable sealing shall have two (2) hours fire rating. The sealing compound shall have special property to allow for thermal expansion of cables both under normal and short circuit conditions. The sealing system shall be proven type and tested as per relevant standard.

Necessary fire proof doors in cable spreader rooms shall also be provided.

If required by the fire stop sealing system to achieve the fire rating of 2 hours, cable coating shall be adopted on cables. The coating shall have minimum two hours fire protection rating. Cables at least 1 m before & after the penetration seals shall be suitably coated. Cables shall be sized to take care of any derating due to fire stop sealing.

8.15.3.9 Name plates

Name plates shall be furnished for identification of devices and circuits. All terminals shall have permanent and legible markings.

8.15.4 Drawings, Data & Manuals

To be submitted with the Bid

General arrangement drawing showing constructional features, space required in front, rear, cable entry points etc.

Typical mounting details.

Bill of materials

Technical leaflets on :-

- i) Push buttons and indication lamps
- ii) Terminal blocks
- iii) Cable glands & lugs.
- iv) Ammeters

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

General arrangement drawing showing constructional features; space required in front, rear, cable entry points etc.

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Cross-section with parts list.

Mounting details.

Consolidated bill of materials

Control Schematics

Wiring diagrams.

Any other relevant drawings, document or data necessary for satisfactory installation, operation and maintenance.

Instruction Manuals for Local Control Panel/Local Control Station/Local junction Box

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

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

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8.15.6 Technical Data by the Tenderer

SECTION : MISC. ELECTRICAL ITEMS

8.15.6.1 Cable Trays - ~~Give separately for GI/Tough FRP~~

Make

Type

Thickness

mm

Material

Standard length

m

Weight per metre

kg

Size

mm

8.15.6.2 Cable tray support system

Make

Type

Whether Galvanised

Yes/No

Weight / Metre

kg

Size & Shape

8.15.6.3 Cable Terminations & joining kits

Make

Type

Applicable standard

8.15.6.4 Conduits

Make

Type

Size

mm

Thickness

Mm

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Surface coating	-	
8.15.6.5 Receptacles		
Make	-	
Type	-	
Rating	A	
Applicable standard	-	
Voltage	V	
8.15.6.6 Junction Box		
Make	-	
Type	-	
Size	mm x mm	
Thickness	mm	
8.15.6.7 Cable glands		
Make	-	
Type	-	
Material	-	
Applicable standard	-	
Size	mm ²	
8.15.6.8 Cable lugs		
Make	-	
Type	-	
* Material	-	
Size	mm ²	
8.15.6.9 Fire sealing 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-EPC-700-001	C.	8.15
				Sheet No.
				9

Make

Type

Fire rating

hour

Note :- Data marked * thus shall be filled up by the Bidder along with the offer. Completely filled data sheet are to be submitted by successful Bidder.

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	Sheet No. 141

17.4.5.0 Cabling, Wiring, Junction Boxes

Cabling

Single pair / 2 core cable shall be used for connection of field transmitters / switches to the respective junction boxes respectively. From junction boxes, multipair/multicore cables shall be used upto the CCR. For RTD's single triad/multi triad cables shall be used.

Screened
Control
Cable.

The cables shall be of stranded, tinned copper conductor, PVC insulated, shielding with mylar back aluminium tape with drain wire, GI round wire armoured, HRFRLS PVC inner and outer sheathing, 600V grade-type.

For thermocouples, extension cables shall be used upto the temperature transmitters, where provided. However in very high temperature zones, mineral insulated cables shall be used.

~~The cable trays shall be fabricated from steel sheet - galvanized or coated with other corrosion resistant material. All fittings etc. shall also be of galvanized steel. The cable trays shall be sturdy in design and shall have adequate strength. The cable trays shall not have sharp edges, burrs or projections. Protective covers on trays shall be provided, wherever necessary. Space for atleast 20 percent future cables shall be kept in each tray.~~

Cable tray runs shall be made as straight as possible and shall avoid exposure of the cables to excessive heat, moisture, areas of strong electrical interferences and mechanical drainage. The minimum separation between parallel runs of power and signal wiring shall be 300 mm for L.T. and 1000 mm for H.T. cables.

✓ Wiring

In particular, wiring within cabinets and panels shall be supported on trays or ducts and shall be segregated according to voltage level. Wiring carrying A.C. and D.C. voltage shall also be segregated.

All cabinets, panels, and racks shall be factory wired. Where desks or panels area supplied in more than one section electrical connections between the sections shall be via terminal strips.

Spare cores shall be terminated at terminal strips in such a manner as to give a maximum length of core. These shall be ferruled in a special way to indicate that they are spare cores.

Terminal strips shall be of the screw type. Screw type terminals shall have a metal insert between screw and conductor. In the Central Control Room (CCR) advanced semi-automatic connection techniques (e.g. maxi terminal point, wire - wrap) are preferred. Wire wrap and terminal point connections shall be effected with the aid of an approved semi automatic or automatic, power operated hand tool.

✓ Junction Boxes

In order to simplify local collection of cables and distribution of signals and to centralize connections in the plant, junction boxes shall be provided. The junction boxes shall be designed to the protection class shall be NEMA 4X equipped with the necessary terminal strips, cable glands and attachment components for the connection of the cables. The necessary earthing terminals shall be provided for the earthing of the boxes. In any area

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				Sheet No. 142

subject to the danger of explosion, the necessary explosion - protected boxes shall be provided in accordance with IEC 79 and VDE 0165/170/171 or equivalent.

17.4.6 Instrument Air Piping/Turbing

All pneumatic tubing connecting the instruments shall be in SS 316 unless otherwise agreed by the Purchaser. All instrument air header lines shall be in GI.

The piping ends shall be plugged prior to transportation

17.4.7 Painting

Inside housed desks, panels, cabinets, racks and other control equipment are to be supplied with the same colour of final painting. External surfaces shall be semi-gloss.

Local mounted cabinets, housing Control & Instrumentation equipment shall be protected against rust and corrosion by a protective coating such as galvanized zinc, which shall be applied as a first factory coat.

In all cases where site erection work exposes bare metal, such as the drilling or punching out of holes for cable or pipe entry, these areas shall be protected by the immediate application of a protective first coat similar to the original.

The shade and grade of paint are to be agreed to by the Purchaser and must harmonize with the overall architectural design.

Any machined or bright faces and parts which are not painted (e.g. of valves, fittings or accessories) must be protected against corrosion by suitable agents prior to installation.

After completion of installation and commissioning but before provisional taking over the Contractor shall make good all marks, scratches and damage to the painted surface of all desks, panels and cabinets irrespective of the cause. The Contractor shall also take every reasonable precaution to prevent damage during the course of erection and commissioning. Repairs to paintwork shall be carried out in such a way so as to restore the equipment to its original factory condition and shall be to the satisfaction of the Purchaser.

17.5.0 General Civil Requirements

The design specification covered in Section 10 of Vol V, establish the minimum basic requirements for all Civil structural and Architectural works. However all structures shall be designed for the satisfactory performance of the function for which the same are to be constructed.

With regard to soil and other hydrographic data furnished, it shall be clearly understood that the same are given to the bidders in good faith and as such no claim for extra payment shall be entertained by the Owner, if the actual condition met with during execution are at variance with the data given in tender. The bidder shall fully satisfy himself about the site conditions, nature of soil, ground water, contour levels, etc. prior to the submission of the bid. The bidder shall conduct his own investigations to ascertain the correctness of the data furnished.

17.5.1 Design Calculations and Drawings

Detailed design calculations / design drawings shall be commenced by Contractor only after approval is obtained from the Owner to the basic design criteria submitted by the Contractor. No deviation from the approved design criteria will be permitted unless specifically approved again by the Owner in writing, prior to its adoption.

[illegible]

CABLE SCHEDULE FORMAT

[illegible]

4X100 MW MARIB-II GTPS

TECHNICAL SPECIFICATION (C&I)
FOR AC SYSTEM (RELAY BASED)



BHARAT HEAVY ELECTRICALS LTD
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA

**4X100 MW MARIB-II GTPS****TABLE OF CONTENTS**

SPECIFICATION NO.:

VOLUME II B

SECTION D

REV. NO. 00

DATE : 28-11-2013

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4. Data sheet and wiring diagram for motorized valve actuator
5. KKS philosophy
6. Technical specifications, quality plan and data sheet for LCP
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4X100 MW MARIB-II GTPS

IMPORTANT NOTES

SPECIFICATION NO.:

VOLUME II B

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IMPORTANT NOTES:

1. The controls for AC system shall be Relay based Control cum Annunciation panel with solid state annunciation windows along with product integrated microprocessor panel for the chilling unit.
2. The requirements given below are to be read in conjunction with detailed Technical specification & data sheets-A&B (applicable for Local panels and motorized valve actuator), enclosed elsewhere in the specification. Further in case of any discrepancy in the requirement within the specification noted by the bidder, the same shall be brought to the notice of BHEL in the form of pre-bid clarification. In absence of any pre-bid clarification, the more stringent requirement as per interpretation of customer and Customer contractual specification shall prevail without any commercial implication.
3. The scope of cable shall be referred in Electrical scope split in Electrical specification whereas cable schedule, cable interconnections and wiring diagram for the same shall be in bidders' scope.
4. The bidder to furnish the list of instruments and BOQ of drives/loads along with their bids.
5. Control valves shall have pneumatic actuators.
6. PG/DPG/PS/PT shall have chemical/diaphragm seal as per requirement.
7. Vendor to include Field instrumentation and Field Junction Box (JB's) in his scope of supply. Field instrument specification, Data Sheet and Quality plans are given elsewhere in the C&I Technical specification.
8. Instrument installation drawings are to be provided by Vendor during detailed engineering. All instrument fitting and erection hardware as per instrument installation diagram shall be in vendor's scope.
9. Vendor to submit GA drawing of control panel indicating layout of instruments, construction details, wiring diagram, class of protection for enclosure, paint type, paint color, thickness and material of enclosure sheet, control scheme during detailed engineering.
10. Provision for separate Terminal block/ wiring diagram for Power & control blocks of control panel to be ensured.
11. Vendor to furnish Signal interface between panel & MCC during detailed engineering.



4X100 MW MARIB-II GTPS

IMPORTANT NOTES

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12. The make of the panel, make and the type of relays, selector switches, timers, push buttons, MCBs, lamps, Alarm facia should be in line with customer approved /BHEL approved vendor list. Make of all C&I equipments/ items supplied shall be of reputed make & shall be subject to approval of BHEL/ Customer after award of contract.
13. Layout & space requirement of panel to be specified during detailed engineering. Vendor to specify whether the panel shall be wall/skid mounted. If the panel is very small, wall mounting of panel can be ensured, if applicable.
14. Provision for earthing of the panel to be provided by vendor.
15. Illumination and ventilation requirement of each panel to be furnished. Vendor to ensure that power requirement for illumination is derived from available input power supply only.
16. Electrical load & heat load of each panel to be furnished during detailed engineering.
17. Mimic diagram to be provided during detailed engineering.
18. 20% spare relays of each type, fully wired upto TBs and one number of MCBs of each type to be provided as engineering spares. Commissioning spares to be covered as per Contract specification.
19. All Vendor QPs (if applicable) shall be subject to approval of BHEL/ Customer after award of contract.
20. Vendor shall be responsible for the completeness of the system in all respect. Any requirement not mentioned here and required during detailed engineering shall be supplied by vendor without any commercial / time implication.

STANDARD LIST OF DELIVERABLES OF PEM - C&I DEPARTMENT FOR MAUX PACKAGES							
DOCUMENT NUMBER PE-GL-999-145-I100				SHEET 2 of 2			
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY	CUSTOMER	FROM	USER	REMARKS
INSTRUMENTATION							
1	PE-V9-392-553-I901	INSTRUMENT DATA SHEETS	A	-	VENDOR	C&I	
2	PE-V9-392-553-I902	INSTRUMENT SCHEDULE	I	-	VENDOR	C&I	
3	PE-V9-392-553-I903	INSTRUMENT HOOK UP	A	-	VENDOR	C&I	
4	PE-V9-392-553-I904	FIELD JB TERMINATIONS	I	-	VENDOR	C&I	
5	PE-V9-392-553-I905	QUALITY PLANS (CV,FE, Tx and Analyser)	A	-	VENDOR	C&I	
PLC PANEL							
1	PE-V9-392-553-I911	PLC CONFIGURATION DRAWING	A	A	VENDOR	C&I	
2	PE-V9-392-553-I912	PLC PANEL GA (INTERNAL & EXTERNAL)	A	-	VENDOR	C&I	
3	PE-V9-392-553-I913	CONTROL SCHEMES (BLOCK LOGIC)	A	-	VENDOR	C&I	
4	PE-V9-392-553-I914	PLC INPUT / OUTPUT SIGNAL LIST	I	-	VENDOR	C&I	
5	PE-V9-392-553-I915	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	\$\$	VENDOR	C&I	Refer Notes Below
6	PE-V9-392-553-I916	UPS SIZING CALCULATIONS	I	-	VENDOR	C&I	
7	PE-V9-392-553-I917	BATTERY SIZING CALCULATIONS	I	-	VENDOR	C&I	
8	PE-V9-392-553-I918	CONTROL DESK LAYOUT / GA DRAWING	A	-	VENDOR	C&I	IF APPLICABLE
9	PE-V9-392-553-I919	PLC-OWS/PRINTER FURNITURE BOM	A	-	VENDOR	C&I	
10	PE-V9-392-553-I920	PLC CONTROL ROOM LAYOUT DRAWING	A	-	VENDOR	C&I	
11	PE-V9-392-553-I921	PLC CATALOGUE	I	-	VENDOR	C&I	
12	PE-V9-392-553-I922	PLC QUALITY PLAN & FAT PROCEDURE	A	-	VENDOR	C&I	
13	PE-V9-392-553-I923	LIST OF SIGNAL EXCHANGE WITH DDCMIS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	-	VENDOR	C&I	
14	PE-V9-392-553-I924	PROCESS GRAPHIC MANUSCRIPTS PLC	I	-	VENDOR	C&I	
15	PE-V9-392-553-I925	PROCESS GRAPHIC MANUSCRIPTS FOR DDCMIS	I	-	VENDOR	C&I	
16	PE-V9-392-553-I926	CABLE SCHEDULE & INTERCONNECTION	I	-	VENDOR	C&I	
17	PE-V9-392-553-I927	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	-	VENDOR	C&I	
18	PE-V9-392-553-I928	PANEL HEAT DISSIPATION DATA	I	-	VENDOR	C&I	
19	PE-V9-392-553-I929	MANDATORY SPARES BILL OF MATERIAL	A	A	VENDOR	C&I	
20	PE-V9-392-553-I930	PLC O & M MANUAL	I	-	VENDOR	C&I	
RELAY BASED LCP							
1	PE-V9-392-553-I951	LOCAL CONTROL PANEL DATA SHEET	A	-	VENDOR	C&I	
2	PE-V9-392-553-I952	PANEL EXTERNAL & INTERNAL GA DRAWING	A	-	VENDOR	C&I	
3	PE-V9-392-553-I953	LIST OF HARDWIRED SIGNAL EXCHANGE WITH DDCMIS	A	-	VENDOR	C&I	
4	PE-V9-392-553-I954	LOCAL CONTROL PANEL QUALITY PLAN	A	-	VENDOR	C&I	
5	PE-V9-392-553-I955	MANDATORY SPARES BILL OF MATERIAL	A	-	VENDOR	C&I	
Notes:							
		392 - Project No					
		553 - SI No of MAX Package					
		\$\$ - Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item					

Technical Specifications and Quality plans for Instruments

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Technical Specifications (C&I) for Auxiliary packages

General Instrumentation Design Requirements

• Field Instruments

- a. Analog outputs signals from field instrumentation to the control systems are 4-20 mA dc signals. Instrumentation can be self-powered, or loop powered from the control systems. Self-powered analog signals shall be true "isolated from ground" signals.
- b. Switch contacts for control system inputs shall be snap acting type, potential free with a maximum contact rating of 230V AC, 5A.
- c. Transmitters will be used to provide the required 4 to 20mA signals for all controllers and receivers. Transmitters will be of the electronic, two-wire type, capable of driving an output impedance of 600 ohms minimum at 24 V dc, and will be generally powered from the control system I/O cards.
- d. SMART transmitters' calibration shall be carried out through a PC based System to be located in the computer room.
- e. Pressure, flow, differential pressure, level, temperature, and other miscellaneous transmitter accuracy shall be within 0.1% of calibrated span and shall have repeatability of +0.1% of span or better. Errors caused by change in ambient temperature shall not exceed 0.01% of span per °C change. Temperature variations of +55°C shall not affect the 0.1% accuracy rating nor the 0.1% repeatability.
- f. The plant instrument air supply pressure shall be:
 - 1. Maximum supply pressure 7 kg/cm² (To be confirmed by PEC)
 - 2. Minimum supply pressure 4.5 kg/cm²
- g. All instruments and analysers shall employ RF protection in the system design.
- h. Instrument tags should be permanently attached to the device. If this is not possible, the instrument tag should be fastened to the instrument with stainless steel wire. The wired instrument tag should be supplied as ¾ inch by 3 inch, stainless steel instrument tags. Tag thickness is 1/16 of an Inch and stamped with instrument tag number. Tag number characters are 3/8 inch in height.

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Technical Specifications (C&I) for Auxiliary packages

- i. Speed switches and the actual device should drive transducers, if possible.
 - j. All instrumentation mounted inside, away from direct exposure to the elements, shall be as a minimum NEMA 4 construction unless it is in an environmentally controlled environment (e.g the control room). If the instrument is mounted in an environmentally controlled environment the instrument shall be as a minimum NEMA 1 construction.
 - k. All instrumentation mounted outside, exposed to the elements, shall be as a minimum NEMA 4X construction, unless it is enclosed in a heated instrument enclosure. If the instrument is mounted in a heated instrument enclosure the instrument shall be as a minimum NEMA 4 construction.
 - l. Transmitters and switches shall be grouped and mounted in open racks depending on the location. Individual instruments shall be mounted on stanchion or pipe mounted.

All field instruments junctions boxes & local panels located in hazardous area shall be explosion proof as per the area classification drawing.
 - m. The following metric engineering units shall be used for all instrumentation devices :
 - 1. Pressure – bar (g)
 - 2. Temperature - °C
 - 3. Steam flow – kg/hr
 - 4. Liquid flow – m³/hr
 - 5. Distance – meters (m) or millimeters (mm)
 - 6. Differential pressure – mmH2O
- **Control Valves**
- a. Control Valves are defined as Pneumatic operated modulating valves.
 - b. Instrument air shutoff valve shall be provided on each control valve assembly.
 - c. The following end connections shall be used when weld type connections are specified in the piping line specification:
 - 1. Socket weld end connections: 2 inch and under control valve bodies.
 - 2. Butt weld end connection : 2-1/2 inch and over control valve bodies.
 - d. Valve bodies shall be Globe, single – port unless otherwise required and shall be not more than two nominal sizes smaller than the line in which they are installed.
 - e. Valve body material shall be as specified in the piping line specifications.

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Technical Specifications (C&I) for Auxiliary packages

- f. All integrally mounted instrumentation (cont rollers, positioners, regulators, etc.) to be designed for a maximum instrument air supply pressure of 7kg/cm²g. Minimum instrument air supply pressure is 4.5kg/cm²g. Separate air filter regulators with inlet and outlet gauges shall be provided for each control valve.
 - g. Electro-pneumatic positioners shall be integrally mounted to the control valves. The I/P transducer shall be integral to the positioner.
 - h. Pneumatic controllers for control valves will be limited to control loops that do not require any interface with any receiver installed in the main control room. Pneumatic temperature controllers will have filled bulb type sensing elements. Pneumatic pressure controllers will have Bourdon tube sensing elements.
 - i. It is the intent that the valves shall fail either open or closed or fail lock in the event of failure of air signal or electric signal from any valve component (controller or positioner), as well as failure of the main control air supply or voltage to the solenoid.
 - j. Position transmitters of non-contact, 2-wire 4-20mA DC type shall be provided for modulating control valves. Also in general limit switches shall be provided for control valves.
 - k. Pilot solenoid valves for on-off service control valves are to be designed for 24 Vdc with a minimum orifice size of 1/4 inch.
 - l. Instrument tubing is to be stainless steel, in accordance with the tubing line specifications. Minimum tubing size is 1/4 inch, SS-316.
 - m. Control valve limit switches to be designed to operate at 24 VDC.
 - n. The control valves shall generally have the max. flow handling capacity of 120% and the limit of valve travel shall generally be between 10% and 80%.
 - o. The following shall be specified for control valves.

Max. noise – 85 dBA from 1m. distance.
 - p. The max. permissible outlet velocity shall be as per ISA-S75.01 based on service (liquid, steam or flashing services).
 - q. Whenever fire safe requirement is specified for a Emergency shutdown valve, the valve body as well as the actuator shall meet the testing requirements API 617 latest revision. In addition to above, air volume tank shall also be provided for a storage of air volume with minimum two full strokes of valves. All valve accessories like solenoid valve, limit switches and volume tank etc shall also be enclosed in a certified fireproof enclosure. The cable used for the actuation of the valve shall also be fire resistant (Fire survival to IEC 331). For shutdown valves leakage class VI shall be considered. No by-pass valve or hand wheel shall be used for shutdown valves.
- **Flow Instrumentation**
 - a. Flow Orifice plates will be used for Natural Gas flow to turbine and other critical measurements where weld-in construction is required. Positive displacement flow meters and totaliser will be used for oil flow.
 - b. Orifice plates shall conform to requirements of ASME "Fluid Meters".

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Technical Specifications (C&I) for Auxiliary packages

- c. Flow nozzles shall be of the weld-in holding ring type ASME long radius, with dual wall taps and shall be of stainless steel. Flow nozzles shall be furnished complete with metered runs in accordance with ASME PTC 6.1. Metered pipe run and nozzle shall match the pipe material and size that metered section is to be installed in.
 - d. Orifice plates shall be 316SS, sharp square edge thin plate, and paddle type suitable for installation between raised face orifice flanges. Orifice flanges, gaskets and jacketing screws shall be furnished by the Supplier. Paddle shall be stamped with the orifice ID bore diameter on the upstream side. Orifice flanges will be of the raised face, weld-neck type with 2 or 3 sets of taps as required for redundancy.
 - e. Beta ratios shall be between 0.2 and 0.7. Flow elements (flow nozzle & orifice) sizing shall as per BS-1042/ISO-5167.
 - f. Differential type flow transmitters shall be supplied with three valve manifolds directly mounted to the transmitter.
 - g. Differential type flow transmitters shall be electronic, analog 2-wire transmitters with isolated 4-20 mA dc output signals.
 - h. Square root extraction of the flow signal is performed in the DCS.
 - i. Positive displacement type flow meters shall be used for oil flow measurement.
- **Pressure Instrumentation**
- a. Pressure transmitters are electronic, analog 2-wire transmitters with isolated 4-20mA dc output signals.
 - b. Pressure transmitters will be supplied with integral mounted two valve manifolds.
 - c. All pressure transmitters shall be capable of withstanding their body rating conditions without permanent damage or loss of calibration.
 - d. Differential pressure transmitters of the capacitance type, regardless of the applied service, shall be capable of withstanding a differential pressure equal to full process pressure on either side of the measurement element without damage or loss of calibration.
 - e. Differential pressure transmitters will be supplied with integral mounted three valve manifolds.
 - f. Pressure gauges will be generally 150mm dial, solid front safety case type with blowout back, 1/2" NPT bottom connection, drawn stainless steel case, 316SS bourdon and socket, stainless steel movement, micrometer pointer. Pulsation dampers will be provided for pulsating pressure services. Liquid filled gauges shall be used for all pump discharges, vibrating or pulsating services.
 - g. Pressure switches will generally be snap acting type, DPDT action, with individual "on" and "off" points to be on a calibrated scale or dial.

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Technical Specifications (C&I) for Auxiliary packages

- h. Dual type control switches such as pressure switches having two sets of contacts with independently adjustable set points shall not be used where set point adjustment and deadband are a problem (e.g. low pressure and vacuum applications). If a potential problem exists, two single purpose switches shall be used.
- i. The gauges shall have $\pm 1\%$ accuracy and over range protection of 125%.
- j. The switches shall have the following :

Max. Contact rating	:	230V AC, 5A
Repeatability	:	$\pm 0.5\%$ FSR

- **Temperature Instrumentation**

- a. For temperature up to 300°C 3-wire RTD duplex type, PT 100 type shall be used. For temperature beyond 300°C thermocouples shall be used. Thermocouples shall be manufactured in accordance with the ISA Standard MC96.1, Temperature Measurement Thermocouples. All thermocouples shall be Chromel Alumel (Type K) for $300^{\circ}\text{C} \leq T < 850^{\circ}\text{C}$. R or S type for $T > 850^{\circ}\text{C}$.
- b. The mV signal of thermocouple shall be used as input to the DCS. Cold junction compensation shall be achieved in the DCS
- c. Thermocouples shall have duplex elements and grounded measuring junction.

All thermowell in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermowells that do not meet the acceptance criteria shall be resized or relocated as necessary.
- d. An extension nipple / union / nipple of sufficient length to extend beyond lagging and connection head shall be furnished for each thermocouple assembly. Terminal blocks shall be marked with polarity and connectors shall be resistant to heat, vibration and galling. The cap shall provide a weather tight enclosure and a chain shall be provided to prevent loss of cap. The cap shall be made of cast aluminium.
- e. RTDs of Duplex type furnished by the Supplier shall be of the three-wire type made with 100 ohm platinum resistance elements. They shall be certified to meet the requirements of the International Temperature Scale, calibrated to the IEC-751 standard ($\text{Alpha} = 0.00385 \text{ Ohms/Ohm/}^{\circ}\text{C}$), and be guaranteed to an accuracy to within $+1.1^{\circ}\text{C}$ of this standard. The RTDs shall be contained in an insulated material and a sheath or sleeve of stainless steel SS-316 and shall be so mounted that they can withstand the greatest shocks and vibrations that can be imposed upon them in the system piping without deterioration. Specific information shall be furnished concerning type and accuracy of bridge circuits to be used with the RTDs. RTDs shall be directly connected to DCS without any transmitters.
- f. Unless specified otherwise, each temperature element and thermometer shall be provided with a 1" socket weld type, 316 stainless steel tapered thermowell suitable for the requirements of the given application.
- g. Thermowell immersion length will generally be between 1/3 and 1/2 the distance to the center of the pipe. Where thermowells are installed in lines smaller than 4 inches,

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Technical Specifications (C&I) for Auxiliary packages

the piping shall be expanded to 4 inch size to accommodate the thermowell. Thermowell shall be drilled from solid bar stock.

- h. All thermowell in a high velocity line or duct shall have an ASME PTC 19.3 calculation for determination of the wells resonant frequency. Thermowells that do not meet the acceptance criteria shall be resized or relocated as necessary.
- i. Thermocouple extension wire is to be solid, shielded, twisted pairs.
- j. If intermediate terminal blocks are required in a thermocouple measuring circuit, they need not be the same material as the thermocouple.
- k. Dial thermometers shall be bimetallic, minimum 150mm dial, every angle form, hermetically sealed with external recalibration adjustment, 1/4" OD SS stem, 1/2" NPT connection and SS case.
- l. Temperature switches shall be actuated by filled bulb-type elements equipped with standard-length armored capillary tubing.
- m. Temperature gauges shall have $\pm 1\%$ accuracy and average protection of 125%.
- n. Switches shall have the following:

Max. contact rating	:	230V AC, 5A
Repeatability	:	$\pm 0.5\%$ FSR
Contact type	:	snap acting

- **Level Instrumentation**

- a. Differential pressure transmitters will be used for general service level measurement of all tanks and other pressurized vessels.
- b. Differential pressure type level transmitters are electronic, analog 2-wire transmitters with isolated 4-20 mA dc output signals. Displacer and ultrasonic level transmitters will be 24V DC powered, with isolated 4-20 mA dc output signals powered from the transmitters. Displacer type level transmitters are of torque tube type. Displacer type level transmitters shall be used for lub oil tanks.
- c. Constant head chambers shall be furnished for all differential pressure-type level transmitters used with pressurized vessels. Reservoir piping connections shall be 1/2 inch outlet and a 1/2 inch inlet socket-welded type suitable for the pressure and temperature encountered.
- d. Transparent gauge glasses will be used for low-pressure applications. Transparent or reflex gauges will be used for high-pressure applications. All gauge glasses will be equipped with gauge valves, including a safety ball check. Color less liquid shall be provided with reflex type level Gauges.
- e. Level switches shall generally be cage float type, rated for ANSI B31.1 requirements.
- f.

DP Level transmitters	:	Accuracy- $\pm 0.1\%$
Level switch	:	Contact type – snap acting
		Contact rating – 230 V AC, 5A,
		Repeatability - $\pm 0.5\%$ FSR

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Technical Specifications (C&I) for Auxiliary packages

- **Stack Emission Monitoring System**

The use of individual or multiple prefabricated analyser installations shall be used to reduce site installation work. This prefabrication shall include sample conditioners, analysers, air and electrical distribution, cooling water distribution or coolant circulating system all piped and wired on a common frame. Interconnecting pipe work and accessories shall be of stainless steel. The arrangement shall permit testing of the entire assembly before dispatch to site and shall be arranged for convenient removal from on-line operation to facilitate routine maintenance and calibration.

- **Analysis of flue gas / Stack Analysers**

Appropriate analysers of proven type shall perform the analysis of SOX, NOX, CO, etc. in the flue gas.

The equipment shall be constructed for operation in dusty and humid environments at high ambient and flue gas temperatures. The use of equipment capable of multi-parameter measurement shall be considered.

Analysers provided shall have auto-calibration for zero and span as well as self-diagnostic functions.

If sampling of flue gas is used, sampling probes shall preferably be vertically installed on the top of horizontal flue gas ducts, in order to avoid blockages.

In order to keep the sampling lays to acceptable limits the analysers shall be located close to their sample take-off point, so that easy access to the sample take-off point and to the analysers shall be provided for maintenance.

The flue gas sampling lines shall be heated to prevent condensation and shall not form a siphon in the case where condensate may be collected during heater failure. Condensate drainage facilities shall be provided at the analysers.

Generally, the analysers and the sampling probe equipment shall be suitable for mounting in ambient plant conditions, e.g. within a standard cubicle. However, if not feasible, the equipment shall be mounted in an air-conditioned room or container.

Power failure and system failures of analysers shall be monitored in the central control room by a group alarm.

All the stack analyzers output signals shall be repeated in DCS for alarm & monitoring.

- **Vibration Monitoring System**

Online vibration monitoring system shall be provided with vibration transducers, low noise flexible cables in flexible conduits, terminated in JBs, all interconnecting cables, racks/cabinets, power supplies, calibration equipment, indicators, integrating units, signal conditioning devices and all accessories required for completeness of work.

This shall be also placed in local control center and the signals shall be hard wired /serial connected to turbine control panel for interlock and monitoring purpose.

These vibration parameters shall also be communicated to DCS for control and monitoring purpose.

- **Instrument Cables Design Criteria:**

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All cables shall be FRLS outer sheath, armoured, 7 standard copper conductor, cable (for power cable -solid conductor).

Signal cable	:	Blue colour outer sheath, screened 1.0 Sq.mm for single pair 0.75 Sq.mm for 8/12 pair, individual pair and overall shielded
RTD cable	:	Black colour outer sheath, screened 1.0 Sq.mm for single triad 0.75 Sq.mm for 8 triad, individual triad & overall shielded
Control cable	:	Black colour outer sheath, screened 1.0 Sq.mm for 2 cores 0.75 Sq.mm for 8/12/24/48 cores
Power cable	:	Black colour outer sheath 2.5 Sq.mm For 2/ 3 cores.
Compensating cable	:	Type – KX, yellow colour outer sheath, screened individual and overall, 16 AWG 1/8/12 pair

9.5.0 Documentation

The following documents shall be furnished along with the bid:

- Detailed description of Turbine control panel and DCS offered
- Reference list for the system application in power plants
- Description of closed loop control with block diagram of hardware configuration
- Description of open loop control with block diagram of hardware configuration
- Description of standard software modules for open loop and closed loop control
- Description of data bus system and bus control
- Description of redundancy and back-up/System availability
- Description of Plant Shutdown Procedure
- Description of control room equipment, control desks, VDUs, keyboards etc., remaining conventional instrumentation (important indicators, alarms etc.)
- Description of VDU displays
- Description of power supply
- Detailed listing of all options available within the system and which of these options are included in the offered scope.
- Description of programming aids (configuration) and fault finding (system diagnosis)

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- List with the detailed scope of equipment offered
- List of spare parts
- Requested modifications of the contract specification text.
- DCS, Turbine control system configuration drawings
- Tentative layout of the CCR
- Filled up technical data sheets (Refer clause 9.9.0 of this volume).

The following documents shall be furnished after award of Contract:

- Layout of CCR with operator consoles and panels
- Layout of CER showing distribution of cabinets and racks
- Detailed layout of auxiliary consoles and panels
- Instrument list
- I/O list (DCS)
- Logic diagrams, interlocking diagrams
- Block diagrams and description of main closed-loop control
- Display sheets (Hard copy)
- Technical specifications of all the field Instruments, DCS, PLC, cables, all erection hardware, panels, analysers, etc including the datasheets
- Manufacturers data sheets of all instruments / modules
- List of Alarms & Trips
- Schedule of SER inputs
- Installation drawings
- Instrument Loop diagrams
- Wiring diagrams / Interconnection schedule
- Terminal diagrams
- Cable Schedule (Signals / control / power)
- Users manuals and other reference manuals
- DCS loading details
- Data base configuration
- Factory acceptance test procedure

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- Test certificates
- Certificates from statutory bodies
- Logs and report formats
- Instrument Location Layout drawings (area/elevation wise)
- Junction box schedule
- All other lists and drawings as required
- DCS vendor drawings/documents
- All the above drawings as applicable for the mechanical packages

The Contractor shall ensure that the final draft of all schedules, lists or data sheets for C&I equipment are produced to a uniform format irrespective of whether the source of the above schedules, lists and data sheets is in the main Contractor or a Sub-contractor of the main Contractor. All documents shall carry a uniform numbering system.

9.6.0 Spares

The below spares philosophy is to be read in conjunction with the C&I spares given in this document. Special tools and equipment for the maintenance, inspection and repair of the individual main equipment and auxiliary equipment shall be supplied by the Contractors in sufficient quantity to equip the shift personnel, maintenance personnel and workshop craftsman.

The special tools and equipment for maintenance and repair shall be delivered by the contractor in lockable steel boxes and they shall be marked in an approved manner for identification purposes and a corresponding tool chart shall be supplied with the steel boxes.

10% spare instrument for each type and each range, with a minimum of one, for instruments like field transmitters, field switches, pressure and temperature gauges, solenoid valves etc. shall be provided.

For control valves, float level switches, displacer type level transmitters, level gauges etc. only critical parts shall be provided as spare.

20% or minimum 1 No. of each type of module shall be provided for DCS and Turbine control panel systems.

This spare philosophy shall be applicable for main systems as well as auxiliary systems.

Apart from the above spares, the Contractor shall furnish the list of spares recommended by him for 2 years of trouble free operation of the plant.

9.7.0 Commissioning

The Contractor shall be responsible for installing, checking / calibrating of all the instruments and systems, laying and connecting of all interconnecting cables right from the field to the respective local control panel or central control / electronics rooms, termination of all cables, laying and connecting data highways, testing the system, loop checking from field to receiver instruments / system and commissioning the instruments and systems.

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Technical Specifications (C&I) for Auxiliary packages

C&I Spares :

The Contractor must indicate and include in his scope of supply the following:

- a) All the necessary start up spares
- b) Recommended spares for two (2) years of normal operation of the plant with unit & total prices.

Furthermore the contractor shall also provide a list of recommended spares for five (5) years operation including major overhaul along with the price schedules.

The Purchaser reserves the right to finalise the exact quantities of the recommended spare parts and effect price adjustment on the basis of the unit rates quoted by the Contractor.

The spares ordered by the Purchaser shall be delivered at the site not later than the date of issue of Taking over Certificate.

Price of the recommended spares will not be taken into consideration for the evaluation of the bids. They shall remain firm up to Twelve (12) months from the date of finalisation of EPC contract for the power plant. Purchase of these spares parts will be covered by a separate order which will be issued only after the receipt of the complete instruction manuals for the equipment from the Contractor. Instruction manuals for major plant / equipment shall be submitted by contractor within Six (6) months from date of finalisation of contract. If the submission of O & M manuals are delayed the validity of offer for recommended spares shall be correspondingly extended The bidder should confirm that the recommended spares shall be delivered at site within three months of the placement of order.

All spares supplied under this Contract shall be strictly interchangeable with the parts for which they are intended for replacements. The spares shall be treated and packed for long storage under the climatic conditions prevailing at site e.g small item shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

Each spare shall be clearly marked or labelled on the outside of the packing with its description. When more than one spare part is packaged in a single case, a general description of the contents shall be shown on the outside of such case and a detailed list should be enclosed. All cases, containers and other packages must be suitably marked and numbered for the purpose of identification.

In the schedule of the recommended spares, the bidder shall clearly state and identify separately the spare parts manufactured by the supplier, the spare which are bought out locally from the indigenous manufacturers and the spares which are imported from other countries. The sources of the supplier of the spares not manufactured by the supplier shall be furnished. The complete details of such spares to enable the Purchaser to place orders directly for his future requirements, shall also be furnished.

All spare parts supplied shall be new and unused.

General Requirements

(1) Tendering procedure of spare parts

The tenderer shall prepare in his tender a complete list of recommended spares required for two (2) years of normal operation. The list shall give for each spare part, the number of equipment installed in the plant, the number of spares supplied, the unit price and the total price as well as the grand total. Also, the tenderer shall provide a list of recommended spares for five (5) years operation along with the price schedules.

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(2) Criteria for selection of Spare Parts

The Tenderer shall recommend and propose spares for equipment parts in accordance with the following three categories :

Category - I - Spare parts that are subject to:

- (a) Wear, tear, erosion and corrosion during normal operation.
- (b) Failure that would result in shut down of the equipment.
- (c) Failure that would cause troublesome operation of the equipment.

Category - II - Small parts that are subject to:

- (a) Damage or breakage during routine maintenance or inspection such as gaskets, packings, bolts, t, etc. of general use (mechanical parts)
- (b) Same, such as fuses, lamps, etc. of general use (electrical and instrument parts).

In preparing the spare parts list, the Tenderer shall critically examine the equipment Vendor's recommended spare parts list both to ensure completeness and eliminate items which combine low wear and breakage factors based on anticipated operating conditions (continuous, intermittent or occasional, severe or mild) and short delivery time.

Category - III - Recommended spare parts required for major overhaul, combustion path inspections.

Also the possible interchangeability of parts of similar equipment (pumps, motor, instruments, electrical, etc.) shall be given due consideration.

Fast consumable items like indicating lamps, fuses, etc. shall be easily replaceable by local sources.

(3) Start - up Spare Parts:

Start - up spares are those spares, which may be required during the start-up and commissioning of the equipment and/or system. All spares used until the plant is handed over to the Purchaser shall come under this category. The Contractor shall provide for adequate stock of such start-up spares to be brought by him to the site during the plant erection and commissioning. They must be available at site well in time and can be taken back from there only after the receipt of the Taking Over Certificate.

(4) Spare Parts management System :

It is the Purchaser's intention to implement a general spare part management system for phase-I & II plants . The basis for setting up the data base of this spare part management system is the "SPIR" form (Spare Parts list and Interchangeability Record).

The Contractor shall carefully prepare / fill in the SPIR forms for all spare parts supplied under this contract. Particular emphases shall be placed on :

- (a) Indicating the prime manufacture's real part number.

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(b) Attaching all manufacturer's drawings to the SPIR forms

(c) Providing a true interchangeability record.

(d) Giving realistic price information.

SPIR Forms shall be submitted in required copies at least four months before spare parts delivery. They shall be subject to the Purchaser's approval.

It is recommended that the forms are completed by the equipment manufacturer, for example, on the following items :

(a) Equipment registration number of tag number for each piece of equipment as stated in requisitions and/or purchase orders.

(b) Manufacturer's model, type or other positive identification reference of the equipment / instruments, ordered.

(c) Total number of pieces of identical equipment / instrument as quoted.

(d) Purchasing company's order reference number.

(e) List of all parts which should be carried in stock for normal operation and also list of slow-wearing parts. If an item is interchangeable between two or more units it should be listed once only.

(f) Drawing number of spare parts

(g) Reference numbers/letters or other information which identical each part. Interchangeability with identical parts within the manufacturer's range should be indicated.

(h) Material specification in terms of international codes standards and accepted conventions, not manufacturer's or sub-manufacturer's references.

(i) For each unit or group of identical units, the number of parts fitted in each unit of equipment of instrumentation.

(j) The total number of identical parts in all equipment specified.

(k) Approximate ex-works price per piece of each part in the currency shown at the top of the column.

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17.4.0 General Control and Instrumentation (C&I) Requirements

17.4.1 General

This section applies to the design of the general Control & Instrumentation equipment for the whole plant. The following general requirements shall be strictly observed with regard to design and execution. In the event of contradictions the Contractor shall be responsible for obtaining written clarification from the Purchaser.

This specification does not, however, relieve the supplier of his responsibility for the detailed design and execution of the Control & Instrumentation system. The rules of good engineering practice and the relevant approved standards and regulations shall be observed.

The Control & Instrumentation equipment to be provided shall be suitable for faultless and safe control and supervision of the entire plant.

For specifying the technical requirements for the entire plant the terms 'main systems', 'auxiliary systems' and 'package systems' are used.

Main systems are designated as systems belonging to the main technological process and serving the main purpose of the plant. Generally they require higher control complexity and accuracy, remote control, adjustment and indication, shorter response time and higher reliability. For main systems even short functional interruptions have to be avoided. Examples of main systems are: Gas Turbine, Fuel Gas & Oil System etc.

Auxiliary systems are all such plants with local independent control and instrumentation systems, wherever required.

~~For the control of these systems preferably Programmable Logic Controllers (PLC) may be used. The PLC's shall be interfaced to the data highway of the DCS to enable the data monitoring and the issue of commands from / to the CCR.~~

The equipment shall be installed within local cabinets to be housed in Local Control Rooms (LCR).

Air conditioned local control rooms shall be provided for various packages as applicable

For all items included under the general heading 'main systems', not more than one instrument sub-contractor of international standard shall supply, install and commission all Control & Instrumentation equipment. In order to achieve uniformity of measuring equipment and to restrict the number of different spare parts to a minimum, the Contractor shall, where possible use the same make and type of Control & Instrumentation equipment for similar applications throughout the entire plant, including auxiliary systems, but excluding package systems.

Where it is proposed to use equipment of different manufacturer to that supplied for the main systems, the Contractor must justify this on technical grounds.

As a general rule, measuring points and measuring equipment for protection purposes (e.g. Gas Turbine Protection), shall be separate from and not combined with measuring equipment for other Control & Instrumentation tasks. For flow measurement one common primary element can be used. Signals to be processed in several systems, shall be suitably repeated and mutually decoupled to avoid interaction.

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The material used for all equipment shall correspond to the material of the relevant pipes, tanks etc. and shall fully meet the requirements regarding safety and operational conditions of the media to be measured. Instrument piping to transmitters and sample piping shall be stainless steel.

All field instruments and enclosures and junction boxes shall be weather proof (NEMA 4X) for non-hazardous area and explosion proof and weather proof (NEMA 4 & 7) for hazardous area.

All the equipment shall be suitable for the location in which it shall be mounted and in particular all outdoor equipment shall be suitable for the climatic conditions of Project location.

The spare capacities listed below shall be provided for the following items of the plant:

- 20% in each cabinet, modular frames related to the maximum capacity.
- 20% for multicore cables, terminals in junction boxes and marshalling racks.
- 20% for automation units related to :
 - * Maximum number of inputs / outputs.
- 40% capacity factor of data highway.
- 40% of maximum memory capacity

The above spare capacities shall be available after final commissioning of the plant and shall be suitably distributed. For example, the free space shall be distributed over the utilizable space in cabinets, racks, modular frames etc. in such a way that additional control equipment or modules may be added to any group of controls.

17.4.2 Field Instrumentation

17.4.2.1 Transmitters, Field Switches

All transmitters shall have an impressed output signal of 4 - 20 mA, corresponding from Zero to full range input. The minimum burden of the output shall be 600 ohms. The transmitters shall be of smart type and shall be suitable for field bus connection and/or for digital integration into the DCS.

For all differential transmitters, designated as flow transmitters, integral square root extraction shall be incorporated into the transmitters, so that the transmitter output is linear with the flow.

An output signal indicator shall be provided on the transmitter.

Accuracy equal to or better than $\pm 0.2\%$ of the full span.

Repeatability within a range of $\pm 0.1\%$ of full span.

In the case of failure and return of the supply voltage to the transmitter no false signals endangering the system shall be issued.

All transmitters including temperature transmitters shall be suitable for field installation and shall be proven instruments. The protection class shall be NEMA 4X or better according to IEC 144. All field transmitters shall be suitably grouped and housed in field instrument enclosures.

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Transmitters to be used in hazardous areas shall be explosion proof. Suitable active safety barriers shall be provided.

For the continuous remote position indication of valves, dampers, etc. also transmitters with impressed output signal of 4-20 mA shall be employed. The position sensing shall base on reluctance, capacitance or strain principle.

All transmitters potentially subjected to vacuum shall be capable of withstanding 1.013 bar vacuum without damage.

Diaphragm seals shall be provided to serve as a barrier for corrosive process fluids, slurries or highly viscous oils. The seal shall be of the flanged type, suitable for the same conditions as those for the transmitter. The material shall be minimum 316 SS. The seal shall be provided with a flushing connection.

The binary signals for alarms, interlocks, protection are to be taken from field switches e.g. temperature switches, pressure switches etc. Indicators with integrated limit switches are allowed within package units. Preferably limit switches shall be of the proximity type.

All switches shall be of robust design and reliable performance. Temperature switches, pressure switches, level switches, etc. shall be of snap action and changeover type. The switches shall have an adjustable switching hysteresis.

The set point of each switch shall be adjustable from inside the case, over the full range specified. The deadband (reset point) of each switch shall be adjustable from inside the case. The set point and reset point shall be indicated on the adjusting mechanism.

Each switch shall be housed in a durable metallic case with gasketed cover. The casing shall be NEMA 4X and for applications on the fuel gas or other hazardous areas explosion proof casing shall be used.

The performance of each switch shall be guaranteed to the values stated below. This guarantee shall apply with all accessories installed on the switch.

Accuracy:- All switches shall operate at the indicated set point with an accuracy within 1% of the full scale.

Repeatability:- All switches shall be repeatable within $\pm 0.5\%$ of the adjustable range. Repeatability is defined as the maximum difference in operation for any given identically repeated stimulus with no change in other test conditions.

Drift:- Switches shall not drift due to ambient temperature by more than 0.5% adjustable range.

17.4.2.2 Pressure, Differential Pressure Measurements

Pressure gauges shall be located where they shall be easily observable or shall be combined in groups on local gauge boards or cubicles. Pressure gauges shall have moisture and dust-proof cases and shall be resistant against vibrations.

Tapping points shall generally be in accordance with the specification for the pipeline it belongs to. Tapping points shall be equipped with primary isolating valves mounted directly at the tapping point and having a nominal bore of at least 15 mm.

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A gauge valve combination or multi-way cock shall be provided directly on the pressure gauge connection.

All transmitters for differential pressure shall be provided with:

- a. Valve blocks to be mounted directly at the transmitter enabling isolation of the transmitter from the differential pressure and enabling checking of the transmitter zero point.
- b. Separate blow-off valves for cleaning the active pressure tubes.

The above mentioned valves shall be capable of withstanding upto 1.5 times operating pressure.

Transmitters for remote measurements shall not be mounted directly on the tapping point but shall be arranged at a distance from the tapping point by means of gauge holders. The impulse line between tapping point and pressure gauge shall form a siphon loop, when steam pressure measurements are involved.

All pressure/differential pressure measuring points shall be equipped with a connection for test (thread M 20 x 1.5), which shall be capable of being shut off without isolating the service pressure gauge / transmitter.

Tapping points for pressure gauges, transmitters or pressure switches for heavy fuel oil shall be provided with seal pots, or with separating diaphragms. The tapping point and impulse piping shall be trace - heated upto and including the separating device.

All exhaust gas transmitters and gauges shall be provided with a supply of clean, dry purge air. All transmitters shall be suitably grouped and housed in field instrument enclosures.

17.4.2.3 Temperature Measurements

In general thermocouples shall be used for all remote temperature measurements.

All thermocouples shall be of the mineral insulated type, having insulated hot junctions and stainless steel sheaths. Chromel/alumel thermocouples (Type K) shall preferably be used. Resistance thermometers may be used for motor winding, cooling water and similar applications. All resistance thermometers shall be wired according to the three or four conductor principle.

All thermocouples shall be of the quick response type, ungrounded and of duplex type.

The thermocouples to be provided for exhaust gas temperature shall be so mounted as to be free from all exhaust duct vibration.

Thermometers and thermocouples shall be fitted in protective wells that shall be of the weld in or screwed in type in accordance with the pipeline / tank it belongs to.

The execution and dimensioning of the protective wells shall be in accordance with the approved standards and shall preferably comply with approved standards.

Where more than one temperature measurement task becomes necessary at one (1) single location, individual thermowells with sensors shall be provided at the common place of measurement.

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Thermowells for unoccupied test measuring points shall be arranged with the opening inclined downwards wherever possible. Screw-on protection cover shall be provided for all unoccupied test measuring points.

As far as local conditions or extreme temperature do not necessitate other requirements, screw-in immersion wells for exhaust gas and air shall have a nominal length not less than 0.8 m.

The attachment of the well in the wall of the exhaust gas channel or air duct shall be gas-proof.

For close loop measurement shall be provided Temperature Transmitter for Temperature Element.

For the measurement of temperature of other media the following requirements shall be observed:

Well materials shall be SS 316 for all applications. For the combustion chamber a corrosion and temperature resistant material shall be used.

For all pipework a minimum immersion depth of 55 mm into the internal pipeline cross-section and a minimum distance of 15 mm from the opposite pipe wall shall be observed. If the diameter of the pipeline does not allow the thermometer to be inserted perpendicular to the pipe axis, another solution shall be found in consultation with the Purchaser. When determining the lengths of the insertion and connecting tubes the insulation thickness shall be taken into consideration.

Dial thermometers may only be used for local indication. They shall be mounted vibration free and independent of the equipment foundations. An adequate length of capillary shall be provided for this purpose.

Embedded Resistance Temperature Detectors (RTD's) shall be provided for measuring, winding and bearing temperatures for large drives. Excess temperatures are to be signalled. Also the individual selection and indication of any measuring point must be possible from the CCR.

17.4.2.4 Level Measurements

For the level measurement, transmitters for differential pressure input shall preferably be used, However, if the level measuring range allows level transmitter with a plunger these may be applied.

The requirements for transmitters and for differential pressure measurements are specified in Clauses 17.4.2.1, and 17.4.2.2. Local level indicators for water shall be provided with an illumination device in the case of a sight glass.

The sight glass shall be of robust design and shall be sufficiently protected against mechanical damage. The indication shall be designed so that the water column shall be seen as a whole, i.e. level indicators only showing the level as a point will not be accepted. For cold water tanks indicators using magnetically initiated indication, flags may be used. The level indicators shall be equipped with shut-off valves which enable exchange or replacement of glasses or sealing during operation.

The indicating range of level indicators shall preferably cover the whole vessel/tank, but as minimum requirement it shall cover all switching points of level switches mounted on the tank or vessel.

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17.4.2.5 Flow Measurements

Flow measurement shall unless otherwise specified, be carried out by the differential pressure principle. The requirements for transmitters and for differential pressure measurements are specified under clauses 17.4.2.1 and 17.4.2.2.

In all cases the installation of orifices, nozzles and tapping points etc. shall be in accordance with the specification for the pipes in which they are installed. These tapping points shall be equipped with one, and for high - pressure installations (greater than or equal to 40 bar) two, primary isolating valves.

All orifice plates for installation between flanges shall have their own tappings for differential pressure measurements incorporated in the plate. Simple orifice plates with the tappings situated in the pipe are not allowed. The flow direction shall be consistently marked on the orifice by means of an arrow. Two tapping points for each flow element either orifice are to be provided.

In order to achieve exact installation, the firm supplying the orifice plate shall install the orifice plate in their own works in a section of pipe with a length of about 3.5 times the pipe diameter in all cases where weld in type orifices are required. For orifice plates installed in pipes with an inner diameter smaller than 80 mm complete - metre runs shall be supplied as per Iso-5167 or equivalent. The material and dimensions of the piping shall conform to those laid down for the piping concerned. The erection welds shall be executed in such a manner as to avoid turbulence that can affect the measurement.

For the measurement of fuel oil flow turbine type meters or positive displacement meters (PDM) shall be used. For local indication, variable area meters may be used. Vortex flow meters may be used for low pressure, low temperature steam and other applications.

For the measurement in large-diameter pipelines, ultrasonic, magnetic or Pitot tube measuring methods may be used.

Changes in density, pressure or temperature of the measured medium shall be compensated wherever necessary.

17.4.2.6 Analysers

Exhaust Gas Analysers

The exhaust gas analyses includes Nitrous Oxide (No_x), Sulphur Dioxide (SO₂), shall be performed by state-of-the-art equipment. The No_x, SO₂, and CO. Analysers shall be installed within an air-conditioned room/container.

The analysers shall be capable of various range measurements:

They shall include the expected values when the Gas turbine is on full and part load. Care shall be taken to ensure that the sample of gas is clean, dry and representative. A multi-point sampling system shall be provided.

The overall response time of the systems shall be as short as possible. To achieve this the analysers shall be installed near the sampling point. Easy access shall be provided for maintenance.

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The flue gas sampling lines and flanges shall be heated to prevent condensation and shall form no siphon in which condensate may be collected in case of heater failure. Condensate drainage facilities shall be provided at the analysers.

Power failures and system failures of analysers shall be monitored in the CCR by a group alarm per Cabinet. All signals above shall be recorded by conventional recorder and processed also by the DCS.

17.4.2.7 Speed And Vibration Measurements

All speed measurements shall generally employ induction type or magnetic type sensors. Necessary signal amplifier shall also be provided and the connection between the sensors and the amplifiers shall be through special cables. The output of the signal amplifiers shall be standard 4-20 mA DC for continuous measurement. Tripple redundant speed measuring system shall be provided for gas turbine

However, where only a contact closure is required to signal over speed, low speed or zero speed, devices with on - off output action may used with the sensors. It shall be possible to make set point adjustments, may be on a bench at known speed. Manual reset feature also may be provided.

Vibration monitoring equipment for the gas turbine generator or for large drives shall be from the same make and type Bently Nevada or equivalent. Serial interfacing with DCS shall be possible.

17.4.2.8 Measurement of Electrical Values

Within the CCR, indicators for electrical values such as power, voltage, current, frequency, etc., if used, shall be of the milliamp type. Therefore, solid state electronic type transducers shall be provided to convert the output of current and voltage transformers into an impressed direct current in the range 4 - 20 mA. The transducers shall be housed in the switchgear.

For power measurements precision electricity meters for asymmetrical three-phase networks are to be supplied. Connection of the meters shall generally be to 3 x 1A current transformers and 3 x 100 / sqrt. 3 V voltage transformers. The meter accuracy class is to be approximate to the respective transformer classes. Instrument transformers with an accuracy class of 0.5 or better shall be used for metering purposes.

For the purpose of billing for electrical energy and for acceptance tests, an instrument transformer of at least class 0.2 (precision) accuracy and high precision electricity meters of class 0.2 have to be provided. Meters for billing purposes shall be of the approved calibrated type (certified by independent testing stations). All meters for billing purposes are to be provided double 2 x 100% meters.

At all points where power direction reversal is possible, the necessary meters for both directions are to be provided. This applies as a minimum for the power plant unit and for the start-up system input / output metering.

The meters in the local switchgear are to be arranged behind the clear plastic fronts of the Cabinet doors so that the counter readings can be taken without opening the doors.

17.4.2.9 Control Valves, Actuators

Control valves

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REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-EPC-700-001	C	---
				Sheet No. 139

Control valve spindles and internals shall be made of chromium steel and shall have a high resistance to wear and corrosion. Cones and seats shall be hard-faced with materials that are highly resistant to wear and corrosion. Housings shall be made of forged or cast steel. A handwheel incorporating the necessary mechanical changeover facility to local manual operation, local position indicator shall also be provided.

All control valves shall comply with the relevant international standards approved by the Purchaser.

Control valves shall be inspected to ensure that they comply with the specification. Pressure tests shall be carried out on all the valves. Valves shall also be tested for tightness. The leakage values shall be recorded. Seat leakage class shall be as per ANSI / FCI:70-2. The installation of all control valves shall be in accordance with the specification for the associated pipework.

Stem packing materials shall be suitable for the service.

For service above 230°C a finned bonnet shall be provided to keep the packing box at ambient temperature. All seals shall be capable of withstanding full valve design pressure drop in either direction. During shipment, storage and construction all valve stems shall be suitably protected from damage and contamination.

Actuators

Actuators should preferably be Pneumatically operated, however, hydraulic or electric actuators may be used wherever necessary. In all cases where valves are operated pneumatically, electro pneumatic positioners with input signal 0.2 to 1 bar shall be provided. In no case may the signal air (output variable) be used to operate the valve directly. Position transmitters shall be provided for all actuators of main systems regardless of their mode of operation.

Electrical actuators and associated equipment shall be explosion proof type if used in areas associated with low-flash-point fuels and gases, in order to prevent the risk of fire or explosion.

For electrically operated actuators thyristor power controllers shall be provided.

In the event of electrical, hydraulic or pneumatic power failure the actuator shall remain in the position it was in immediately prior to loss of power or assume a position which would be safe for the process. All actuators must be capable for local manual operation.

For the actuator operated by pneumatic or hydraulic auxiliary power special attention shall be paid to adequately dimensioned drives, and care shall be taken to avoid any unintended displacement of the actuator on sudden pressure rises in the piping.

For pneumatically operated actuators an air set consisting of filter and pressure regulator with an output pressure gauge shall be provided for each actuator.

All electrical actuators shall be equipped with the necessary inside housed limit switches and torque switches. These shall be of snap action type, each having changeover contacts.

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For other actuators provision shall be made for later installation of externally mounted limit switches, if required. These Switches shall be housed in robust, dust-and moisture-proof cases and shall be suitable for the ambient conditions local to the equipment on which they are mounted.

17.4.3.0 Local Control Cabinets

These shall be free standing type and fabricated preferably from 2 mm thick cold rolled steel sheet or 3 mm thick hot rolled steel sheet.

The finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filter and two coats of high grade paint.

These shall be of totally enclosed type with removable hinged doors at the side or back for easy maintenance and accessibility of instruments. Adequate illumination and a service socket shall be provided inside each local cabinet. Ingress protections shall be NEMA 4X for local control cabinets.

17.4.4.0 Indicators, Recorders

Indicators

The minimum size for indicators mounted on the various sections of the control desks and panels shall be as per manufacturer's standard.

The minimum accuracy tolerance for the above indicators shall be 1.5% of span.

Panel shall generally be microprocessor based digital indicators having at least 4-digit indications.

Local pressure and temperature indicators mounted on gauge boards shall be of circular type and shall have 150 mm. All local indicators shall be housed in robust dust and moisture proof cases suitable for open air installation.

All instruments mounted in the control rooms shall be rectangular or square type. The exposed metal portions of all cases shall have the same finish, trim and general appearance. Instrument cases shall be dust proof. The glass for indicators, recorders and similar equipment shall be of the non-reflecting, anti-static type and should minimize parallax errors.


Recorders

Flows, pressures and fast changing temperatures shall be recorded on continuous line recorders. Only measurement values subject to slow changes may be recorded on dotted line recorders.


The recorders shall be of microprocessor based, 100mm wide with suitable markings each recorder shall be furnished with chart re-roll, chart tear-off device, internal chart illumination (if locally mounted). Chart speed shall be adjustable. The recorders shall have an integral indicator.

All recorders shall be of fibre pen type.


Where two or more values are recorded by continuous lines on the same chart they shall be distinguished by the use of different and distinctive colours.

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE AND DIFFERENTIAL PRESSURE GAUGES										QUALITY PLAN NO.: PE-QP-999-145-1026			
												VOLUME IIB			
												SECTION D			
												REV. NO. 01 DATE: 16.05.2007			
												Sl. No.	Component / operation	Characteristics Checked	* Category
										P	W	V			
1.0	Material / Components														
1.1	Casing, Bourdon tube, and Movement	1. Chemical composition	MA	Chemical Test	One Sample from each lot	Approved drg. / data sheet / BHEL Spec.	Relevant raw material std.	Test Certificate	3/2	---	2,1#	# Compliance certificate to be verified.			
		2. Workmanship, finish and dimensions	MA	Visual, Measurement	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report / Log Book	3/2	---	2,1#				
1.2	Switch⊕	Contact type & number	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate/ Inspection Report	3	---	2,1#	⊕Applicable for gauge with switch device			
2.0	Assembly	1. Marking – Tag No., Model, Range	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---				
		2. Workmanship	MA	Visual	100%	- do -	- do -	- do -	2	1	---				
		3. Dial size, scale graduation	MA	Visual	100%	- do -	- do -	- do -	2	1	---				
		4. End connections	MA	Measurement	100%	- do -	- do -	- do -	2	1**	1	**10% of total quantity with minimum of 2 piece / type & size			
		⊕5. Switch – contact type & nos.	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---				
3.0	Routine Test	1. Calibration, accuracy, Hysteresis, overload, set point adjustment⊕ / repeatability	CR	Measurement	100%	- do -	- do -	- do -	2	1**	1				


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$ - P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE AND DIFFERENTIAL PRESSURE GAUGES										QUALITY PLAN NO.: PE-QP-999-145-1026 VOLUME IIB SECTION D REV. NO. 01 DATE: 16.05.2007 SHEET 2 OF 2			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		2. Hydraulic Test	CR	Measurement	100%	Approved drg. / data sheet / BHEL Spec.	No Leakage	Inspection Report	2	1**	1				
		⊕3. IR, HV	CR	Measurement	100%	Relevant standard	Relevant standard	- do -	2	1**	1				
4.0	Type Test	1. Enclosure Protection Class	CR	Verification	Each type	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	2	---	1•	•Type Test Certificate to be verified			
		2. Blow out disc	CR	Verification	Each type	- do -	- do -	- do -	2	---	2•				
		⊕3. Switch contact rating	CR	Verification	Each type	- do -	- do -	- do -	2	---	2•				
5.0	Painting	Shade & Finish	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec. / Manufacturer's std.	Approved drg. / data sheet / BHEL Spec. / Manufacturer's std.	Inspection Report	2	---	2				
6.0	Packing	Soundness	MA	Visual	100%	- do -	- do -	- do -	2	---	---				


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$ - P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR PRESS AND DIFF PRESS SWITCHES										QUALITY PLAN NO.: PE-QP-999-145-I031			
				VOLUME IIB											
				SECTION D											
				REV. NO. 01		DATE: 16.05.2007									
				SHEET 1		OF 3									
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	Raw Material/ Component	1. Chem. Composition	MA	Chemical Analysis	1 sample from each lot	BHEL Spec. / Approved data sheet	Relevant material standard	Test Report	3/2	---	2,1	Relevant compliance certificate to be verified.			
		2. Make, Marking, Damage and Cracks	MA	Visual	100%	BHEL spec. / manufacturer standard	BHEL spec. / manufacturer standard	Log Book	2	---	---				
		3. Leakage (Element Conn.)	MA	Pressure Test	100%	Manufacturer standard	No Leak	Log Book	2	---	---				
	Micro Switch	1. No. and type of contacts	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Log Book	3/2	---	2,1				
		2. Continuity	CR	Electrical	100%	Manufacturer standard	To have continuity	Log Book	3/2	---	2,1				
2.0	Final Inspection														
2.1	Assembly	1. Marking: Range, Model, Tag No. Sl.No.	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	10% to be witnessed by BHEL			
		2. Correct assembly, workmanship and finish	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	1	---	- do -			


LEGEND: * CR - Critical characteristics				\$				1 - BHEL			
MA - Major characteristics				P - Agency Performing the Test.				2 - Vendor			
MI - Minor characteristics				W - Agency Witnessing the Test.				3 - Sub-vendor			
				V - Agency Verifying the Test.							

 PEM :: C&I		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1025 VOLUME IIB SECTION D REV. NO. 00 SHEET 1 OF 2 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	Raw Material / Component														
1.1	Resistance sheath	Material composition	CR	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲	▲ Relevant compliance certificate to be verified.			
1.2	Protective Sheath	Material composition	MA	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲				
1.3	Terminal Head	Material composition	MA	Chemical testing	Sample	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1▲				
1.4	Thermowell⊕	1. Chemical properties	CR	Chemical composition	One sample / Lot	Approved data sheet, BHEL Spec.	Relevant material std.	Test Certificate	3,2	---	2,1				
		2. Dimensions (wall thickness concentricity of bore, OD & length)	MA	Measurement	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection report	2	1▲	1	◆ BHEL to witness 25% Samples			
		3. Threading	MA	Thread matching	100%	Approved data sheet/drg., BHEL Spec.	Approved data sheet/drg., BHEL Spec.	Inspection Report	2	2,1▲	1				
		4. Leak Test	CR	Hydro test at 1.5 times design press.	100%	Approved drg., BHEL Spec.	Approved drg., BHEL Spec.	Inspection Report	3,2	2/1	---				
2.0	Final Inspection														
2.1	RTD Assembly	1. Workmanship	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1▲	1				
		2. Marking	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1▲	1				


LEGEND: *		CR	- Critical characteristics		P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR RESISTANCE TEMPERATURE DETECTOR AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-I025				
		Sl. No.		Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
												P	W	V		
VOLUME IIB		SECTION D		REV. NO. 00		DATE: 15.03.99		SHEET 2		OF 2						
2.2	Routine Tests	3.	Dimensions	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	2,1*	1				
		1.	Calibration (Resis Vs. Temp.)	CR	Measurement	100%	Approved drg. IEC : 60751	BHEL Spec. IEC : 60751	Test Report	2	2	1				
		2.	Insulation Resistance	MA	Electrical	100%	IEC : 60751	IEC : 60751	Test Report	2	1	---				
		3.	Resistance Tolerance	MA	Thermal Elect.	100%	IEC : 60751	IEC : 60751	Test Report	2	1	---				
		4.	Thermal Response time	CR	Measurement	Sample	IEC : 60751	IEC : 60751	Test Certificate	2	1	---				
2.3	Type Test	1.	Immersion error Test	MA	Measurement	Sample	IEC : 60751	IEC : 60751	Test Certificate	3/2	---	1				
		2.	Thermoelectric Effect	MA	Measurement	Sample	IEC : 60751	IEC : 60751	Test Certificate	3/2	---	1				
		3.	Vibration Test	CR	Measurement	Sample	IEC : 60751	IEC : 60751	Test Certificate	3/2	---	1				
		4.	Enclosure protection test	CR		Sample	BHEL Spec.	BHEL Spec., Approved data sheet.	Test Certificate	3/2	---	1	• Test certificates to be verified.			
3.0	Packing		Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---				


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LEVEL SWITCHES						QUALITY PLAN NO.: PE-QP-999-145-I033					
				VOLUME IIB									
				SECTION D									
				REV. NO. 00		DATE: 15.03.99							
				SHEET 1		OF 3							
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	Raw Material/ Component												
1.1	Non Wetted Parts	Physical, Chemical properties	MA	Physical, Chemical Analysis	1/ Cast	BHEL Spec/ Approved drg. / data sheet	Relevant material standard	Test Report	3/2	---	2,1*		*Relevant compliance certificate to be verified.
1.2	Float Assembly & Wetted Parts	Physical for float only & chemical properties for all wetted parts including float assembly	MA	Physical, Chemical Analysis	1/Batch	AISI:316 / BHEL spec. / drg. / Approved data sheet	AISI:316 / BHEL spec. / drg. / Approved data sheet / Relevant material std.	Test Certificate	3/2	---	2,1*		
1.3	Chamber	Dimensions & leak tightness	MA	Measurement, visual, hyd. test	100%	BHEL Spec/ Approved drg. / data sheet	BHEL Spec/ Approved drg. / data sheet	Internal inspection report	3/2	2	1		
1.4	Float	Leak tightness	MA	Hyd. test	100%	BHEL Spec/ Approved drg. / data sheet	No leakage	Internal inspection report	3/2	2	1		
1.5	Switch	1.. Make, type and rating	MA	Visual	100%	BHEL / Mfr. spec.	BHEL / Mfr. spec.	Internal inspection report	3/2	---	2,1		
2.0	Final Inspection	2. Contact Continuity	CR	Electrical	100%	BHEL / Mfr. spec.	BHEL / Mfr. spec.	To have continuity	3/2	---	2,1		
2.1	Assembly	1. Marking: Range, Model, Tag No. Sl.No.	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---		


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR LEVEL SWITCHES							QUALITY PLAN NO.: PE-QP-999-145-I033 VOLUME IIB SECTION D REV. NO. 00 SHEET 2 OF 3 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
2.2	Routine Test	2. Correct assembly, workmanship and finish	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	1	---	
		3. Connection	MA	Visual & Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	
		4. Scale Marking	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	1	---	
		5. Cleanliness	MA	Visual	100%	Manufacturer standard	Free from scratches dirt etc.	Log Book	2	1	---	
		6. Overall Dimension	MA	Measurement	100%	BHEL Spec. / Approved drg.	BHEL Spec. / Approved drg.	Inspection Report	2	1	---	
		1. Overload	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1	❖BHEL to witness 25% sample.
		2. Repeatability	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1	
		3. Set point adjustment	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1	


LEGEND: *		CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LEVEL SWITCHES						QUALITY PLAN NO.: PE-QP-999-145-I033						
		Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
											P	W	V	
				4, Differential	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test Report	2	1❖	1	
				5. Contact Rating	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection Report	2	---	1	Manufacturer compliance certificate to be verified.
				6. Insulation Resistance & HV	CR	Electrical	100%	Manufacturer standard	Manufacturer standard	Test Report	2	1❖	1	
2.3	Type Test			1. Weatherproofness	CR	Measurement	1 sample / design	BHEL Spec. / Approved data sheet	IEC : 60529 NEMA-4	Test Report	3/2	---	1	Vendor to furnish test report
3.0	Packing			Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---	


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR THERMOCOUPLE WITH THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1003 VOLUME IIB SECTION D REV. NO. 00 SHEET 1 OF 2 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	Raw Material / Component														
1.1	Thermocouple wires	Material composition	CR	Chemical testing	Sample	BHEL Specs. / Appd. data sht.	Relevant material standards	Test Certificate	3/2	----	2,1▲		▲ Relevant compliance certificate to be verified.		
1.2	Protective Sheath	Material composition	MA	Chemical testing	Sample	BHEL Specs. / Appd. data sht.	Relevant material standards	Test Certificate	3/2	----	2,1▲				
1.3	Terminal Head	Material composition	MA	Chemical testing	Sample	----	Relevant material standards	Test Certificate	3/2	----	2,1▲				
1.4	Thermowell ⊕	1. Chemical properties 2. Dimensions (wall thickness concentricity of bore, OD and length) 3. Threading 4. Leak Test	CR	Chemical test Measurement Thread matching Hyd. test at 1.5 times design press.	Sample 100% 100% 100%	BHEL Specs / Approved data sheet BHEL Specs / Approved drgs. BHEL Specs / Approved data sheet BHEL Specs / Approved data sheet.	Relevant material standard BHEL Specs / Approved drgs. BHEL Specs / Approved data sheet. BHEL Specs / Approved data sheet.	Test Certificate Log Book Inspection Report Inspection Report	3/2 2 2 3/2	----	2,1▲ 1 2,1▲ 2,1				

LEGEND: *		CR	- Critical characteristics	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics	W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics	V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR THERMOCOUPLE WITH THERMOWELL							QUALITY PLAN NO.: PE-QP-999-145-1003 VOLUME IIB SECTION D REV. NO. 00 SHEET 2 OF 2 DATE: 15.03.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
2.0	Final Inspection											
2.1	Thermocouple Inspection	Workmanship Marking Dimensions	MA	Visual	100%	BHEL Specs	BHEL Specs.	Log Book	2	2,1*	1	♦BHEL to witness 25% samples.
			MA	Visual	100%	BHEL Specs	BHEL Specs / Approved drgs.	Log Book	2	2,1*	1	
			MA	Measurement	100%	BHEL Specs / Approved drgs.	BHEL Specs / Approved drgs.	Log Book	2	2,1*	1	
2.2	Routine Tests	1. Continuity and Polarity	MA	Measurement	100%	-----	Compliance	Test Report	2	2,1	---	
		2. Accuracy Test (EMF vs. Temp.	CR	Thermal & Elect	100%	BHEL Specs	Relevant standards	Test Report	2	2,1	---	
		3. Insulation resistance between Element and sheath	MA	Thermal & Elect	100%	-----	Relevant standards	Test Report	2	1	---	
		4. Response Time Test	MA	Thermal & Elect	10%	BHEL Specs / Approved data sheet	Relevant standards	Test Report	2	2	1	
2.3	Type Tests	Enclosure protection test for Head	CR	Testing	Sample	BHEL Specs	BHEL Specs / Approved data sheet	Test Certificate	3/2	----	1	
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---	


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-I001			
												VOLUME IIB			
												SECTION D			
												REV. NO. 00 DATE: 12.10.99			
												SHEET 1 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	RAW MATERIAL INSPECTION														
1.1	Body/Casing, Cable Gland and Mounting Bracket	1. Chemical & Mech. Properties 2. Dimensions 3. Visual 4. Degree of Protection (If applicable) 5. Leak Tightness	MA	Analysis	1 / Lot	Tech. Specn. Data Sheet, Mfr. standard	Tech. Specn. Data Sheet, Mfr. standard	Test certificate	3	---	2	Compliance report verification by BHEL.			
		2. Dimensions	MA	Measurement	10% Min. 3 Nos.	Manufacturer drg.	Manufacturer drg.	Log Book	2	---	---				
		3. Visual	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Log Book	2	---	---				
		4. Degree of Protection (If applicable)	CR	IEC : 60529 IEC : 60079	1 / Type	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3	---	2				
		5. Leak Tightness	MA	Hydro Test	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Log Book	2	---	---				
1.2	Sensor (Diaphragm, Capsule, Bellows, Strain, Gauge, Capacitance etc.)	1. Material Properties (Chemical & Mechanical) 2. Dimension 3. Performance 4. Type Test	MA	Analysis	1 / Lot	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3/2	---	2				
		2. Dimension	MA	Measurement	1 / Lot	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	2	---	---				
		3. Performance	CR	Function	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	2	---	---				
		4. Type Test	CR	Mech. & Elect.	1/Type	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Test certificate	3/2	---	2				

LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics

\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.


1 - BHEL or their agent
 2 - Vendor
 3 - Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-I001 VOLUME IIB SECTION D REV. NO. 00 DATE: 12.10.99 SHEET 3 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
2.0	In-Process Inspection														
2.1	Electrical Unit														
2.1.1	Etched PCB	1. Dimension – Trade width, Gap etc. 2. Defect of undercuts 3. Quality and plating of plating through holes. 4. Screen printing	MA MA CR CR	Measurement Visual Visual Visual	Sample Sample 100% 100%	Manufacturer standard Manufacturer standard Manufacturer standard Manufacturer standard	Manufacturer standard Manufacturer standard Manufacturer standard Manufacturer standard	Inspection report Inspection report Inspection report Inspection report	2 2 2 2	--- --- --- ---	--- --- --- ---	Compliance verification report by BHEL			
2.1.2	Component Mounting and soldering	1. Correctness of components 2. Mounting and orientation 3. Soldering defects and finish	MA MA CR	Visual Visual Visual	100% 100% 100%	Manufacturer standard Manufacturer standard Manufacturer standard	Manufacturer standard Manufacturer standard Manufacturer standard	Inspection report Inspection report Inspection report	2 2 2	--- --- ---	--- --- ---				
2.1.3	Assembled PCBs	Functional check	CR	Electrical checks before & after soaking*	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	---	---				
*Soaking means subjecting PCB (Assembled) at 70 Deg. C for 72 hours at energised condition and rapid temperature cycle test at 70 Deg. C and (-) 20 Deg. C for 30 minutes at each temp. (Five such cycles).															


LEGEND: * CR - Critical characteristics
 MA - Major characteristics
 MI - Minor characteristics


\$ P - Agency Performing the Test.
 W - Agency Witnessing the Test.
 V - Agency Verifying the Test.

1 - BHEL or their agent
 2 - Vendor
 3 - Sub-vendor


<div></div> <div>STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER</div> <div>PEM :: C&I</div>		QUALITY PLAN NO.: PE-QP-999-145-I001										
		VOLUME IIB										
		SECTION D										
		REV. NO. 00 DATE: 12.10.99										
		SHEET 4 OF 7										
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
2.1.4	Conformal coating	Uniformity and finish of conformal coating on both sides	CR	Visual	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	---	---	Compliance verification report by BHEL
2.2	Mounting, Fitting, Assembly of various mechanical parts	1. Correct Mounting	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
		2. Defects	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
		3. Dimensions	MA	Measurement	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
2.3	Interconnection – Sensor to Electronic unit	Correctness of Interconnection	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	
2.4	Interconnection – Pneumatic unit / Electronic unit and output / Local indicator.	Correctness of Interconnection	MA	Visual	100%	Manufacturer standard	Manufacturer standard	Log Book	2	---	---	

LEGEND: * CR - Critical characteristics		\$		P	- Agency Performing the Test.	1	- BHEL or their agent
MA - Major characteristics				W	- Agency Witnessing the Test.	2	- Vendor
MI - Minor characteristics				V	- Agency Verifying the Test.	3	- Sub-vendor


 <p>भारतीय एल्यूमीनियम कार्पोरेशन लि. BHEL PEM :: C&I</p>		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-I001					
												VOLUME IIB					
												SECTION D					
												REV. NO. 00 DATE: 12.10.99					
												SHEET 5 OF 7					
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks					
3.0	Complete Transmitter	1. Workmanship	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		2. Dimension	MA	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		3. Type / Model	CR	Visual	10%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		4. Range	CR	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		5. Calibrated Range	CR	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		6. Local Indicator / Scale marking	MA	Visual	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		7. Process connection type	CR	Measurement	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		8. Wetted parts material	MA	Analysis (Chemical, Mechanical)	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	---	1						
		9. Mounting bracket type	MA	Visual / Dimension	10%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		10. Calibration	CR	Electrical / Pneumatic	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
		11. Soaking	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report / Log Book	2	1	---						
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics												\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.			1 - BHEL or their agent 2 - Vendor 3 - Sub-vendor		

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-I001 VOLUME IIB SECTION D REV. NO. 00 SHEET 6 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
3.2	Acceptance Tests	1. Accuracy	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		2. Repeatability	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		3. Dead Band	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		4. Hysteresis	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		5. HV & IR	CR	Electrical	100%	Manufacturer standard	Manufacturer standard	Inspection report	2	1	1				
		6. Linearity	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		7. Supply voltage variation effect	CR	Electrical	100%	BHEL Spec.	BHEL Spec.	Inspection report	2	1	1				
		8. Temperature variation effect over range	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				
		9. Over range	CR	Electrical	100%	BHEL Spec. / Approved data sheet	BHEL Spec. / Approved data sheet	Inspection report	2	1	1				


LEGEND: * CR - Critical characteristics		\$		P	- Agency Performing the Test.	1	- BHEL or their agent
MA - Major characteristics		W		W	- Agency Witnessing the Test.	2	- Vendor
MI - Minor characteristics		V		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR PRESSURE / DP/LEVEL TRANSMITTER										QUALITY PLAN NO.: PE-QP-999-145-I001 VOLUME IIB SECTION D REV. NO. 00 SHEET 7 OF 7 DATE: 12.10.99			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
3.3	Type Test	1. Surge withstand capability 2. Radio frequency interference 3. Vibration effect 4. Electro Magnetic field effect 5. Degree of protection 6. Explosion proofnecx (If applicable) 7. Dry Heat 8. Damp Heat	CR	Elect. & Mech Elect. & Mech Elect. & Mech Elect. & Mech Mech. & Elect. Mech. & Elect. Thermal Thermal	1 / Type 1 / Type 1 / Type 1 / Type 1 / Type 1 / Type 1 / Type 1 / Type	ANSI-C.37 ANSI-C.37 BHEL Spec. BHEL Spec. IEC : 60529 IEC : 60079 IEC : 60068-2-78 IEC : 60068-2-78	ANSI-C.37 ANSI-C.37 BHEL Spec. BHEL Spec. BHEL Spec. BHEL Spec. ANSI-C.37 ANSI-C.37	Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report Inspection Report	3 3 3 3 3 3 3 3	--- --- --- --- --- --- --- ---	2,1 2,1 2,1 2,1 2,1 2,1 2,1 2,1				
4.0	Packing	1. Packing Material 2. Packeging and Marking	MA	Visual Visual & Measurement	100% 100%	Manufacturer standard Manufacturer standard	Manufacturer standard Manufacturer standard	Log Book Log Book	2 2	--- ---	2 2				


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL or their agent
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 PEM :: C&I		STANDARD QUALITY PLAN FOR LEVEL GAUGES										QUALITY PLAN NO.: PE-QP-999-145-1028 VOLUME IIB SECTION D REV. NO. 00 SHEET 1 OF 2 DATE: 01.11.2000			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
1.0	Material / Components								P	W	V				
1.1	Body, Cover, Interns, Flanges, Gaskets	1. Physical, Chemical Properties 2. Workmanship, finish and dimensions	MA	Physical, Chemical Test Visual, Measurement	One Sample from each lot 100%	Approved drg. / data sheet / BHEL Spec. Manufacturing standards / drgs.	Approved drg. / data sheet / BHEL Spec. Manufacturing standards / drgs.	Test Certificate Inspection Report / Log Book	3/2	---	2,1#	# Compliance certificate to be verified.			
1.2	Glass Tube	Strength, Transparency, dimensions	MA	Toughness & Thermal shock, Visual, Measurement	one sample from each lot 100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate/ Inspection Report	3	---	2,1#				
2.0	Assembly	1. Marking – Tag No., Model, Range	MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---				
		2. Workmanship	MA	Visual	100%	- do -	- do -	- do -	2	1	---				
		3. Scale graduation	MA	Visual	100%	- do -	- do -	- do -	2	1	---				
		4. Glass Opaque painting	MA	Visual	100%	- do -	- do -	- do -	2	1	---	For Reflex type			
		5. Dimensions and end connections	MA	Measurement	100%	- do -	- do -	- do -	2	1	---				
3.0	Routine Test	1. Calibration	CR	Measurement	100%	- do -	- do -	- do -	2	1**	1	***10% quantity with minimum of 1 piece / type & size			
		2. Hydro Test	CR	Measurement	100%	- do -	No Leakage	- do -	2	1**	1				


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

 STANDARD QUALITY PLAN FOR LEVEL GAUGES		QUALITY PLAN NO.: PE-QP-999-145-I028 VOLUME IIB SECTION D REV. NO. 00 DATE: 01.11.2000 SHEET 2 OF 2										
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
4.0	Painting	Shade & Finish	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1	
5.0	Packing	Soundness	MA	Visual	100%	- do -	- do -	- do -	2	---	---	


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics	\$ P W V - Agency Performing the Test. - Agency Witnessing the Test. - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027 VOLUME IIB SECTION D REV. NO. 01 DATE: 16-05-2007 SHEET 1 OF 4				
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
1.0	Raw Material / Component															
1.1	Capillary Bulb and Thermowell	1. Chemical composition	CR	Chemical analysis	one sample/lot	BHEL spec. / approved data sheet	Relevant raw material std.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL				
		2. Marking,	MA	Visual	100%	BHEL spec. / Mfr. Standard	BHEL spec. / Mfr. Standard	Log Book	2	---	---					
		3. Dimensions	MA	Measurement	100%	BHEL spec. / approved doc	BHEL spec. / approved doc	Log Book	2	---	---					
1.2	Casing and Bezel	1. Material	MA	Chemical analysis	Sample	BHEL spec.	BHEL spec.	Test report	3/2	---	2,1	Relevant compliance certificate to be verified by BHEL				
		2. Defects	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Log Book	2	---	---					
		3. Dimension	MA	Measurement	Sample	BHEL spec. / approved doc.	BHEL spec. / approved doc.	Log Book	2	---	---					
		4. Threading	MA	Thread matching	100%	-----do-----	-----do-----	Log Book	2	---	---					
1.3	Dial	1. Size, range, scale length, least-count, spacing and graduation.	MA	Measurement and Visual	Sample	BHEL spec.	BHEL spec.	Log Book	2	---	---					
		2. Colour	MA	Visual	100%	BHEL spec.	BHEL spec.	Log Book	2	---	---					
		3. Resistance to dry heat and hot water	MA	Oven & Bath	Sample	Mfr. Standard	Mfr. Standard	Test report	3/2	---	---					

LEGEND:		* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics	W		- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics	V		- Agency Verifying the Test.	3	- Sub-vendor


 QUALITY PLAN NO.: PE-QP-999-145-I027		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										VOLUME IIB SECTION D REV. NO. 01 SHEET 2 OF 4 DATE: 16-05-2007			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$				Remarks		
									P	W	V				
1.4	Complete sensing element	1. Correct assembly and workmanship. 2. Dimensions 3. Welding & other defects	MA	Visual	100%	Mfr. Standard drawing	Mfr. Standard drawing	Log Book	2	---	---				
1.5	Thermowell ⊕	1. Dimensions of wall thickness, concentricity of bore OD & Length.	MA	Measurement	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Log Book	2	1	1		BHEL to witness 10 % random samples.		
		2. Leak Test	CR	Hyd. test at 1.5 times of design pressure.	100%	BHEL spec. / approved data sheet / Drg.	BHEL spec. / approved data sheet / Drg.	Inspection report	3/2	2,1	1				
		3. Threading	MA	Thread matching	100%	BHEL spec. / approved data sheet / Drg	BHEL spec. / approved data sheet / Drg	Inspection report	2	2,1	1				
2.0	Final Inspection														
2.1	Assembly	1. Correct assembly, workmanship and finish	MA	Visual	100%	BHEL spec. / approved data sheet	BHEL spec. / approved data sheet	Inspection report	2	1	---				

LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics	W	W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics	V	V	- Agency Verifying the Test.	3	- Sub-vendor

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027				
		Sl. No.		Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
												P	W	V		
SHEET		3	OF	4												
VOLUME		IIB														
SECTION		D														
REV. NO.		01		DATE: 16-05-2007												

2.2	Routine Test	1.	Accuracy	MA	Measurement	100%	BHEL spec. / Approved data Sheet.	BHEL spec. / Approved data Sheet.	Test Report	2	1	1	BHEL to witness 10% random Samples.
		2.	Overload	CR	Measurement	10%	125% of FSD for range upto 400 Deg. C. 110% of FSD for range between 400 to 500 Deg. C. 100% of FSD for range above 500 Deg. C.	No Damage	Test Report	2	1	---	

LEGEND: * CR - Critical characteristics		\$		P - Agency Performing the Test.		1 - BHEL	
MA - Major characteristics		W		V - Agency Witnessing the Test.		2 - Vendor	
MI - Minor characteristics		V		- Agency Verifying the Test.		3 - Sub-vendor	


 PEM :: C&I		STANDARD QUALITY PLAN FOR TEMPERATURE GAUGE AND THERMOWELL										QUALITY PLAN NO.: PE-QP-999-145-1027 VOLUME IIB SECTION D REV. NO. 01 DATE: 16-05-2007 SHEET 4 OF 4			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		3. Response Time	MA	Measurement	10%	ASME PTC19.3	ASME PTC19.3	Test Report	2	1	1	BHEL to witness 10% random samples.			
2.3	Type Test	1. Ambient temperature compensation 0-60 Deg. C 2. Weather proofness	MA	Measurement	Sample	Bulb at constant temp. & case temp varied 0-60 Deg. C	No variation in measurement	Test Certificate	2	---	1	Existing test certificate (Not more than 5 year old) shall be furnished.			
			CR	Measurement	Sample	BHEL spec. / Approved data sheet.	BHEL spec. / Approved data sheet.	Test Certificate	3/2	---	1	---do---			
3.0	Packing	Soundness of packing	MA	Visual	100%	BHEL Spec.	BHEL Spec.	Log Book	3/2	2	---	Refer Note-1			


Note: 1. In the absence of BHEL specification for painting, vendor to obtain BHEL's approval on their painting specification / procedure.

LEGEND:		* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
		MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
		MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div><div><div>भारतीय</div><div>BHEL</div></div><div>PEM :: C&I</div></div>		STANDARD QUALITY PLAN FOR TEMPERATURE SWITCH										QUALITY PLAN NO.: PS-QP-999-145-I032			
		VOLUME		IIB											
		SECTION		D											
		REV. NO.		00		DATE: 02.11.2000									
		SHEET		1		OF		2							
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.0	Material / Components														
1.1	Casing, Sensing Element and Thermowell	1. Physical, Chemical Properties 2. Workmanship, finish and dimensions	MA	Physical, Chemical Test	One Sample from each lot 100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Test Certificate	3/2	---	2,1#	# Compliance certificate to be verified.			
1.2	Switch	Contact type & no.	MA	Visual	100%	Manufacturing standards / drgs.	Manufacturing standards / drgs.	Inspection Report / Log Book	3/2	---	2,1#				
2.0	Assembly	1. Marking – Tag No., Model, Range 2. Workmanship 3. Scale graduation 4. Dimensions and end connections	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	- do -	3	---	2,1#				
			MA	Visual	100%	- do -	- do -	Inspection Report	2	1	---				
			MA	Visual	100%	- do -	- do -	- do -	2	1	---				
			MA	Visual	100%	- do -	- do -	- do -	2	1	---				
			MA	Measurement	100%	- do -	- do -	- do -	2	1**	1	**25% quantity with minimum of 1 piece / type & size			
3.0	Routine Test	5. Switch – contact type & nos. 1. Calibration, accuracy, repeatability, overload, set point adjustment, differential	MA	Visual	100%	Approved drg. / data sheet / BHEL Spec.	Approved drg. / data sheet / BHEL Spec.	Inspection Report	2	1**	1				
			CR	Measurement	100%	- do -	- do -	- do -	2	1**	1				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics															
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.															


LEGEND:	* CR	- Critical characteristics	\$	P	- Agency Performing the Test.	1	- BHEL
	MA	- Major characteristics		W	- Agency Witnessing the Test.	2	- Vendor
	MI	- Minor characteristics		V	- Agency Verifying the Test.	3	- Sub-vendor

<div><div>PEM :: C&I</div></div>		STANDARD QUALITY PLAN FOR TEMPERATURE SWITCH										QUALITY PLAN NO.: PS-QP-999-145-I032				
		VOLUME IIB					SECTION D					REV. NO. 00 DATE: 02.11.2000				
		SHEET 2		OF 2												
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
4.0	Type Test	2. HydroTest	CR	Measurement	100%	Approved drg. / data sheet / BHEL Spec.	No Leakage	Inspection Report	2	1**	1	•Type Test Certificate to be verified				
		3. IR, HV	CR	Measurement	100%	- do -	Approved drg. / data sheet / BHEL Spec.	- do -	2	1**	1					
		1. Enclosure Protection Class (weather proof-ness, explosion proof-ness, etc.)	CR	Verification	Each type	- do -	- do -	Test Certificate	2	---	1•					
		2. Ambient temperature compensation (0 - 60°C)	CR	Verification	Each type	- do -	- do -	- do -	2	---	1•					
		3. Switch contact rating	CR	Verification	Each type	- do -	- do -	- do -	2	---	1•					
5.0	Painting	Shade & Finish	MA	Visual	100%	- do -	- do -	Inspection Report	2	1**	1					
6.0	Packing	Soundness	MA	Visual	100%	- do -	- do -	- do -	2	---	---					
<div>LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics</div> <div>\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor</div>																

		STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY										QUALITY PLAN NO.: PE-QP-999-145-1005			
												IIB			
												SECTION D			
												REV. NO. 04 DATE: 12.09.2011			
												SHEET 1 OF 3			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ³			Remarks			
									P	W	V				
1.0	RAW MATERIAL Flow Nozzle, pipe, adapter	Physical, Chemical properties Ultrasonic testing (nozzle only)	MA MA	Physical, Chemical tests Ultrasonic test	One / Heat 100%	AP / DP / SP ASTMA388 & ANSI B 16.34	AP / DP / SP ASTMA388 & ANSI B 16.34	TC TC	3/2 3	2 2	1 1	Refer Note-1			
2.0	IN PROCESS Welding procedure specification (WPS)	Correctness	MA	Scrutiny	100%	EN 287/ ASME IX	EN 287/ ASME IX	Format of ASME	3/2	2	1				
2.2	Procedure Qualification Record(PQR) & Welders qualification	Weld soundness	MA	Physical test / Radiographic Test	EN 287/ ASME IX	EN 287/ ASME IX	EN 287/ ASME IX	Format of ASME	3/2	2	1	Welding to be done by qualified welders. Refer Note-3			
2.3	Weld FIT-UPS	Dimension, Alignment, Orientation.	MA	Measurement & Visual	100%	WPS/Approved drg.	WPS/Approved drg.	IR / Log Book	3/2	2	2				
2.4	Weldments final run	1. Surface defects 2. Sub Surface defects(After PWHT)	MA MA	Penetrant Test Radiographic Test	100% 100%	ASTM 165/ ASME VIII Div I	ASTM 165/ ASME VIII Div I	IR / Log Book	3/2	2	1	100% by Vendor, 10 % by BHEL Films to be reviewed by BHEL.			

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics				IR - Inspection Reports TC - Test Certificates AP - Approved Drawings/doc				DS - Data Sheet SP - Tech. Spec.				MR - Manufacturer records MS - Manufacturer standards				³ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.				1 - BHEL 2 - Vendor 3 - Sub-vendor			
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STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY												QUALITY PLAN NO.: PE-QP-999-145-1005			
												VOLUME IIB			
												SECTION D			
												REV. NO. 04			
												DATE: 12.09.2011			
												SHEET 2 OF 3			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks			
									P	W	V				
2.5	Machining	3 Heat Treatment	MA	Review of HT Chart	100%	ASME SEC. VIII	ASME SEC. VIII	HT Chart	3/2	2	1	100% by Vendor, 10% by BHEL			
		1. Dimensions	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		2. Profile	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		3. Surface finish	MA	Visual	100%	-----	Mirror finish.	IR / Mfd Records	3/2	2	1				
		1. Machining of pipe ID	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		2. Dimensions	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1				
		3. Surface flaw on weld edge preparation (for shop welding)	MA	Penetrant Test	100%	ASTM 165	ASTM 165	IR / TC	3/2	2	1				
3.0	ROUTINE TEST	1. Leak tightness	CR	Hydraulic test(1.5 times Design pressure)	100%	AP / DS	No Leakage	Test Certificate	3/2	2,1	---	Minimum time duration of test shall be ½ hours.			
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics IR - Inspection Reports TC - Test Certificates AP - Approved Drawings/doc DS - Data Sheet SP - Tech. Spec. MS - Manufacturer standards MR - Manufacturer records ^{\$} P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor															


 PEM :: C&I		STANDARD QUALITY PLAN FOR FLOW NOZZLE ASSEMBLY							QUALITY PLAN NO.: PE-QP-999-145-1005						
								VOLUME IIB		SECTION D		REV. NO. 04		DATE: 12.09.2011	
												SHEET 3 OF 3			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		2. Calibration	CR	Measurement	1 per type per size	----	Tech Spec.	TC	2	---	1	Refer note-4			
4.0	FINAL ASSEMBLY	1. Marking – Tag No., direction of flow	MI	Visual	100%	AP / DS	AP / DS	IR	2	---	1				
		2. Workmanship, surface flaw on weld edge preparation on end of pipe (for site welding)	MA	Visual, Penetrant test	100%	ASTM165	No Surface Flaw	TC /IR	3/2	2	1				
		3. Dimensions and end connection	MA	Measurement	100%	AP / DS	AP / DS	IR	3/2	2	1	Refer Note-2 before dispatch			
5.0	PACKING & DISPATCH	Soundness of Packing against transit damage	MA	Visual	100%	SP / MS	SP /MS		2	---	---	Refer Note-5			

NOTE:

1. Test Certificates to be verified by BHEL at final inspection stage.
2. Minimum 2 coats of primer paint to be applied before dispatch.
3. In case of NTPC / LLOYDS / BHEL qualified welders available, then prequalification and WPS, PQR not required, only TC to be verified.
4. CALIBRATION Test to be carried out at IIT-DELHI / IIT- MUMBAI / FCRI or BHEL approved laboratory.
5. Sea Worthy packing ,If applicable
6. Qualification records of the Vendors can be verified.
7. For P91 & P22 material welding should be continuously done. No interruptions shall be allowed.

LEGEND: * CR - Critical characteristics IR - Inspection Reports DS – Data Sheet MR- Manufacturer records \$ P - Agency Performing the Test. 1 - BHEL
MA - Major characteristics TC - Test Certificates SP – Tech. Spec. MS- Manufacturer standards W - Agency Witnessing the Test. 2 - Vendor
MI - Minor characteristics AP – Approved Drawings/doc V - Agency Verifying the Test. V - Sub-vendor


 STANDARD QUALITY PLAN FOR FLOW ORIFICE PLATE		QUALITY PLAN NO.: PE-QP-999-145-1024										
		VOLUME IIB										
		SECTION D										
		REV. NO. 04 DATE: 12.09.2011										
SHEET 1 OF 2												
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks
									P	W	V	
1.0	MATERIAL											
1.1	Orifice Plate	1. Physical, Chemical properties	MA	Physical, Chemical Tests	One / Plate OR One/ Heat	AP / DS / SP	AP / DS / SP	Lab Report	3/2	---	2,1	
		2. Dimensions	MA	Measurement	100%	AP	AP	IR	3/2		1	
1.2	Flanges											
	A. Forgings	Chemical, Mech Properties, UT & Heat Treatment	MA	Chem & Mech UT test	Sample	Material Spec as per ASTM A 388 for UT	ANSI B 16.34	MTC, UT cert, HT cert	3/2	---	1	
	B. Machining	Dimensions	MA	Measurement	100 %	AP / DS	AP / DS	IR	3/2	---	1	
2.0	IN PROCESS											
	Machine	1. Dimension	MA	Measurement	100%	AP	AP	IR	3/2	2	2	
		2. Surface finish	MA	Visual	100%	-----	Mirror Finish	-----	3/2	2	---	
		3. Surface flaw on machined surface	MA	Penetrant test	100%	ASTM 165 /	No surface flaw	IR / TC	3/2	2	1	
3.0	ASSEMBLY and FINAL INSPECTION											
		1. Overall dimensions	MA	Measurement	100%	AP	AP	IR	3/2	2,1	---	
		2. Marking, Tag no. Direction of flow	MA	Visual	100%	AP / DS	AP / DS	IR	3/2	2	1	
		3. Calibration	MA	Performance Test	One per type	-----	SP	TC	3/2	---	1	
		4. Painting	MA	Visual	100%	SP / MS	SP / MS	IR / MR	3/2	----	1	
LEGEND: * CR - Critical characteristics IR - Inspection Reports DS - Data Sheet MR- Manufacturer records \$ P - Agency Performing the Test. 1 - BHEL MA - Major characteristics TC - Test Certificates SP - Tech. Spec. MS- Manufacturer standards W - Agency Witnessing the Test. 2 - Vendor MI - Minor characteristics AP - Approved Drawings/doc V - Agency Verifying the Test. 3 - Sub-vendor												

 STANDARD QUALITY PLAN FOR FLOW ORIFICE PLATE		QUALITY PLAN NO.: PE-QP-999-145-1024										
		VOLUME IIB										
		SECTION D										
		REV. NO. 04 DATE: 12.09.2011										
		SHEET 2 OF 2										
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^s			Remarks
									P	W	V	
4.0	PACKING	Soundness of Packing against transit damage	MA	Visual	100%	SP / MS	SP / MS	----	3/2	----	----	

NOTE:


1. All test reports & dimension reports shall be verified by BHEL wherever verification is by BHEL at the time of Final Inspection.
2. Minimum 2 coats of primer paint to be applied before dispatch.
3. CALIBRATION Test to be carried out at IIT-DELHI / IIT- MUMBAI / FCRI or BHEL approved laboratory.
4. Sea Worthy packing ,if applicable

LEGEND:											
* CR	- Critical characteristics	IR	- Inspection Reports	DS	- Data Sheet	MR	- Manufacturer records	^{\$} P	- Agency Performing the Test.	1	- BHEL
MA	- Major characteristics	TC	- Test Certificates	SP	- Tech. Spec.	MS	- Manufacturer standards	W	- Agency Witnessing the Test.	2	- Vendor
MI	- Minor characteristics	AP	- Approved Drawings/doc					V	- Agency Verifying the Test.	3	- Sub-vendor


 PEM :: C&I	STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I-006			
											VOLUME IIB			
											SECTION D			
											REV. NO. 06 DATE: 05.09.2013			
											SHEET 1 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
									P	W	V			


1.0 MATERIAL												
1.1	Body & Bonnet casting / forgings, plug, valve stem, seat ring/cage.	1. Physical, Chemical properties	MA	Physical, Chemical tests	One/Heat(HT Batch)	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Test Certificate	3	---	2,1	
		2. Heat Treatment	MA	Review of H.T. Chart	Each H.T.	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Test Certificate	3/2	2	1	
		3. Internal quality of castings	MA	RT for Body & UT for Bonnet(NDT)	100%	ASME B 16.34	ASME B 16.34	Test Report / FILM	3/2	2	1	Only for rating ANSI 900 and above. Applicable for Body and Bonnet only. For Lower rating only if called for in specification.
	4. Surface Quality		MA	1. Visual 2. MT/PT	100% 100%	Relevant standard ASME B 16.34	Relevant standard ASME B 16.34	Test Certificate Test Certificate	3/2	---	2,1	
									3	2	1	After Machining on machined surface only

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics												
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.												
PT - Dye penetrant Test MT- Magnetic Test												
RT- Radiographic Test UT - Ultrasonic Test												
1 - BHEL 2 - Vendor 3 - Sub-vendor												

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I 006				
		Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
											P	W	V			
SHEET 2 OF 7												DATE: 05.09.2013				
		5. Pressure test for shell	MA	Hyd. Test	100%	ISA-S-75.19/ ASME B 16.34	ISA-S-75.19/ ASME B 16.34	Test Certificate	2	2	1	For Body & Bonnet after machining				
1.2	Diaphragm	1. Surface Quality	MA	Visual	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2,1					
		2. Hardness	MA	Measurement	100%	Mfr. standard	Mfr. standard	Test Certificate	3/2	---	2,1					
		3. Endurance / Life cycle	MA	Cyclic test 10,000 cycles	One / Type	10,000 cycles/ Mfr. standard.	No damage	Test Certificate	3/2		2,1					
1.3	Spring	1. Composition	MA	Chemical- Analysis	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2,1					
		2. Mech. Properties	MA	Mech. Test	One sample/ Heat	Material spec. / Mfr. standard	Material spec. / Mfr. standard	Test Certificate	3	---	2,1					
		3. Performance	MA	1. Stiffness ratio 2. Scragging 3. Cyclic test (Endurance) 4. Dimension (Measurement)	100% 100% One / type One sample/ Lot	Material spec. / Mfr. standard Material spec. / Mfr. standard 10,000 cycles Mfr. standard	Material spec. / Mfr. standard Material spec. / Mfr. standard Appd Drg	Test Certificate Test Certificate Test Certificate Record	3 3 3 3	---	2,1 2,1 2,1 2,1					


LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics				RT- Radiographic Test UT - Ultrasonic Test	PT - Dye penetrant Test MT- Magnetic Test	\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I-006 VOLUME IIB SECTION D REV. NO. 06 DATE: 05.09.2013 SHEET 3 OF 7			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
1.4	Electrical items [Limit switches, Solenoids, Position Transmitter(if provided externally)]	1. Routine Test	MA	HV, IR, Continuity function	100%	Rele. Standards	Rele. Standards	Test Certificate	3	---	2,1	In case TC is not available, Actual test shall be conducted			
		2. Degree of protection	MA	NEMA Tests	One sample / type	Approved Data sheet	Approved Data sheet	Test Certificate	3	---	2,1				
1.5	Pressure Gauges	1. Performance	MA	Review of calibration certificates	100%	Mfr. Standard	Mfr. Standard	Test Certificate	3	---	2,1				
		2. Marking	MA	Visual	100%	Mfr. standard	Mfr. standard	Records	3	---	2,1				
2.0	IN PROCESS INSPECTION														
2.1	After machining, i, Body ii Bonnet iii Plug iv Valve Stem v seat ring/cage	1. Surface flaws	MA	Visual & MT/PT	100% (on accessible surfaces)	ASME B 16.34	ASME B 16.34	Test Records	2	---	1	Butt weld ends shall be included.			
		2. Dimensional checks	MA	Measurement	100%	Mfr. Standard	Mfr. Standard	Records	2	---	1				
		3. Hard facing (wherever applicable)	MA	Hardness Measurement	One sample/Lot	Mfr. Standard	Mfr. Standard	Records	2	---	1				
2.2	Lapping	Machining surface contact	MA	Blue Matching	One sample/lot	-----	Proper Physical Contact	---	2	---	---				
3.0	TESTS ON COMPLETED VALVE														
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics \$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test. 1 - BHEL 2 - Vendor 3 - Sub-vendor															

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)											QUALITY PLAN NO.: PE-QP-999-145-I 006					
													VOLUME IIB					
													SECTION D					
													REV. NO. 06			DATE: 05.09.2013		
													SHEET 4 OF 7					
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks						
									P	W	V							
3.1	Actuator Chamber	Leakage & Strength	MA	Pneumatic test	100%	Mfr. Standard	No Leakage	Test Certificate	2	1	1	Refer Note-4						
3.2	Body	Leakage and Pressure test (Body Mount Leakage)	MA	Hydro test	100%	ISA - S-75.19	No Leakage	Test Certificate	2	1	1	Refer Note-4						
3.3	Seat leakage test for completed valve	Seat Leakage	MA	Pneumatic Test	100%	FCI-70.2	FCI-70.2	Test Certificate	2	1	1	Refer Note-4						
4.0	OPERATION TEST ON COMPLETED VALVE (Final inspection)	1. Valve Travel	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		2. Opening/Closing time	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		3. Linearity/cam characteristic	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		4. Repeatability	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		5. Hysteresis	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		6. Sensitivity	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		7. Accuracy (Overall)	MA	Measurement	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Report	2	1	1	Refer Note-4						
		8. Control Valve characteristics / CV Test	MA	♦ Measurement (Press. vs. discharge and opening 0-100% in steps of 10%)	One per type	As per specs/ Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Certificate	2	--	1	♦ Size = Body & port size Or Body size & CV for non std port. Refer Note 1.						

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics				\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor
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<div><div><div></div><div>भारत पेट्रोल</div><div>BHEL</div></div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I-006				
												VOLUME IIB				
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency ^{\$}			Remarks				
									P	W	V					
		9. Operation of limit switch & solenoids and other accessories	MA	Function	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Report	2	1	1	On assembled valve Refer Note-4				
		10. Overall dimensions	MI	Visual and dimensional	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Records	2	1	1	Refer Note-4				
		11. Pre defined valve position in case of air failure	MA	Visual	100%	As per spec & Appd drg	As per spec & Appd drg	Test Certificate	2	1	1					
		12. Cleanliness, painting, stamping (for direction of flow), Tag No.	MA	Visual and dimensional	100%	Approved drg. / data sheet	As per specs/ Approved drg. / data sheet	Test Certificate	2	1	1					
5.0 AUXILIARY ITEMS (Performance test of auxiliary items shall be performed on the completely assembled valve)																
5.1	Positioner	Overall leakage after assembly including Nozzles leakage	MA	Leak Test (in the steady state input signal)	100 %	Mfr. Standard	No leakage	Test Certificate	3/2	---	1	Overall leakage including tubing				
5.2	Air filter regulator	1. Normal air consumption	MA	Measurement	Each type	Mfr. Standard	No leakage	Test Certificate	3/2	---	1					
		2. Overall leakage	MA	Visual (soap solution)	100 %	Mfr. Standard	No leakage	Test Certificate	3/2	---	1					
5.3	Air lock relay	Performance Test	MA	Leakage test	100%	Mfr. Standard	No leakage	Test Certificate	3/2	---	1					
5.4	Electronic position transmitter(not applicable if provided integral to smart positioner)	1. Accuracy	MA	Operation	100%	Approved data sheet /	Approved data sheet /	Test Certificate	2	1	1					
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.																
1 - BHEL 2 - Vendor 3 - Sub-vendor																

<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I-006				
												VOLUME IIB				
												SECTION D				
										SHEET 6		OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
5.5	Current to Pneumatic converter(not applicable for smart positioner)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	2	---	2,1					
		2. Degree of Protection	MA	NEMA test	Each type	Relevant Standard	Relevant Standard	Test Certificate	3	---	2,1					
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1					
		4. Hysterisis	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1					
5.6	Smart Positioner (As Applicable)	1. Physical Verification Make/Model	MA	Visual	100%	Approved drg. / data sheet	Approved drg. / data sheet	Test Certificate	2	---	2,1					
		2. Degree of Protection	MA	IP/NEMA test	Each type	Relevant Standard	Relevant Standard	Test Certificate	3	---	2,1					
		3. Linearity	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1					
		4. Hysterisis	CR	Measurement	100%	Approved drg. / data sheet / BHEL specn.	Approved drg. / data sheet / BHEL specn.	Inspection Report	2	---	1					
		5. Calibration with Hand Held Communicator	MA	Measurement	Each type	Approved data sheet / Mfr. Standard	Approved data sheet / Mfr. Standard	Test Certificate	2	1	1					
6.0	PAINTING	Soundness of Painting	MA	Visual and Measurement	100%	BHEL specn. / Mfr. Standard	BHEL specn. / Mfr. Standard	Inspection Report	2	---	---	Refer Note-2				
7.0	PACKING	Soundness of Packing against transit damage	MA	Visual	100%	Mfr. Standard	Mfr. Standard	Inspection Report	2	---	---	Refer Note-3				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.																
PT – Dye penetrant Test MT- Magnetic Test																
RT- Radiographic Test UT - Ultrasonic Test																
1 - BHEL 2 - Vendor 3 - Sub-vendor																

 PEM :: C&I		STANDARD QUALITY PLAN FOR CONTROL VALVE (PNEUMATIC)										QUALITY PLAN NO.: PE-QP-999-145-I 006			
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Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				

NOTES:

1. In case valid CV test certificate for a similar control valve(Same type, Same size, Same CV) is not submitted to BHEL by the vendor, CV test shall be conducted at FCRI/Any govt. approved laboratory/ BHEL approved Laboratory.
2. In the absence of BHEL spec. for painting, vendor to obtain BHEL's approval on their painting specification / procedure.
3. Sea worthy packing shall be provided, if applicable.
4. The quantum of check shall be 100% for manufacturer and 10% for BHEL/BHEL nominated inspection agency.
5. Copies of all TC's(Test Certificates) for materials duly correlated with Heat Nos., TC's for electrical items and mechanical tests(Leak/Operation) shall be submitted to BHEL for verification and acceptance.

LEGEND:	* CR	- Critical characteristics	RT- Radiographic Test	PT - Dye penetrant Test	\$ P - Agency Performing the Test.	1 - BHEL
	MA	- Major characteristics	UT - Ultrasonic Test	MT- Magnetic Test	W - Agency Witnessing the Test.	2 - Vendor
	MI	- Minor characteristics			V - Agency Verifying the Test.	3 - Sub-vendor

**Data sheet and Wiring Diagram
for
Motorized Valve Actuator**



SPECIFICATION FOR MOTORISED VALVE ACTUATOR

SPECIFICATION NO.: PE-SS-999-145-I007

VOLUME II B

SECTION D

REV. NO. 02

DATE: 17.09.07

SHEET 1


OF 3


Data Sheet A & B

DATA SHEET-A
(TO BE FILLED BY PURCHASER)

DATA SHEET-B
(TO BE FILLED-UP BY BIDDER)

GENERAL *	* PROJECT	400 MW MARIB GTPS-II		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	<input type="checkbox"/> ON / OFF	<input type="checkbox"/> INCHING	
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	<input type="checkbox"/> GLOBE <input type="checkbox"/> GATE <input type="checkbox"/> REG. GLOBE <input type="checkbox"/> BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:55		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR INCHING(REGULATING) SERVICE 150 STARTS/HR MINIMUM		
HANDWHEEL	* REQUIRED	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
	* ORIENTATION	<input type="checkbox"/> TOP MOUNTED <input type="checkbox"/> SIDE MOUNTED		
	TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT.		
	ACTUATOR APPLICABLE WIRING DIAGRAM	<input checked="" type="checkbox"/> ENCLOSED (BIDDER TO CONFIRM) A: <input type="checkbox"/> DRG. NO. 3-V-MISC-24227 R00 B: <input type="checkbox"/> DRG. NO. 3-V-MISC-24550 R00 C: <input type="checkbox"/> DRG. NO. 3-V-MISC-24283 R00 D: <input checked="" type="checkbox"/> DRG. NO. 4-V-MISC-90271 R11		
	COLOUR SHADE	<input type="checkbox"/> BLUE (RAL 5012) ENAMEL <input type="checkbox"/>		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER <input type="checkbox"/> 230 V <input type="checkbox"/> 110 V		
	@ ENCLOSURE CLASS OF MOTOR	<input type="checkbox"/> IP 65 <input type="checkbox"/> IP 67 <input type="checkbox"/> FLAME PROOF <input type="checkbox"/> IP 55, TOTALLY ENCL, SELF VENTILATED.		
	@ INSULATION CLASS	<input type="checkbox"/> CLASS-B <input type="checkbox"/> CLASS-F		
	@ WINDING TEMP PROTECTION	<input checked="" type="checkbox"/> THERMOSTAT (3 Nos., 1 IN EACH PHASE) <input type="checkbox"/>		

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR		SPECIFICATION NO.: PE-SS-999-145-I007		
			VOLUME II B		
			SECTION D		
			REV. NO.	02	DATE: 17.09.07
			SHEET	2	OF 3
Data Sheet A & B					
DATA SHEET-A (TO BE FILLED BY PURCHASER)				DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED			
INTEGRAL STARTER	INTEGRAL STARTER	<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED			
	TYPE OF SWITCHING DEVICE	<input type="checkbox"/> CONTACTORS <input type="checkbox"/> THYRISTORS			
	TYPE	<input type="checkbox"/> CONVENTIONAL <input type="checkbox"/> SMART (NON-INTRUSIVE)			
	IF SMART				
	a) SERIAL LINK INTERFACE	<input type="checkbox"/> INTEGRAL <input type="checkbox"/> FIELD MOUNTED			
	b) SERIAL LINK PROTOCOL	<input type="checkbox"/> FOUNDATION FIELD-BUS <input type="checkbox"/> PROFI-BUS <input type="checkbox"/> TCP/IP <input type="checkbox"/>			
	c) SERIAL LINK MEDIA	<input type="checkbox"/> TWISTED PAIR Cu-CBL <input type="checkbox"/> CO-AXIAL Cu-CBL <input type="checkbox"/> OFC			
	d) HAND HELD PROGRAMMER	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	e) MASTER STATION	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	f) MASTER STN INTRFACE WITH DCS	<input type="checkbox"/> MODBUS <input type="checkbox"/> TCP/IP			
	g) DETAILS OF SPECIAL CABLE	<input type="checkbox"/> ENCLOSED <input type="checkbox"/> NOT REQUIRED			
	STEP DOWN CONT. TRANSFORMER	<input type="checkbox"/> REQUIRED			
	OPEN / CLOSE PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	STOP PB	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	INDICATING LAMPS	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	LOCAL REMOTE S/S	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	STATUS CONTACTS FOR MONITORING	<input type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED			
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL, TORQUE SWITCH OPTD. MID WAY)			
INTERPOSING RELAY (Applicable for integral Starter)	INTERPOSING RELAYS	REQUIRED			
	INTERPOSING RELAY (QUANTITY)	<input type="checkbox"/> 2 NOs. <input type="checkbox"/> 3 NOs.			
	DRIVING VOLTAGE	<input checked="" type="checkbox"/> 20.5 – 24V DC <input type="checkbox"/> _____ V DC			
	DRIVING CURRENT	<input checked="" type="checkbox"/> 125mA MAX <input type="checkbox"/> _____ mA MAX			
	LOAD RESISTANCE	<input checked="" type="checkbox"/> > 192 ohms - <25 k ohms <input type="checkbox"/> > _____ ohms - < _____ ohms			
TORQUE SWITCH (Not Applicable for Smart Actuator)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN / CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos. / <input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos			
	CONTACT TYPE	2 NO + 2 NC			
	RATING	5A 240V AC AND 0.5A 220V DC			
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE			
	ACCURACY	+3% OF SET VALUE			
LIMIT SWITCH (Not Applicable for Smart Actuator)	MFR & MODEL NO.	BIDDER TO SPECIFY			
	OPEN : INT : CLOSE	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2 Nos.	2 Nos. (ADJ.)	<input checked="" type="checkbox"/> 1 No. <input type="checkbox"/> 2Nos.	
	CONTACT TYPE	2 NO + 2 NC			
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC			

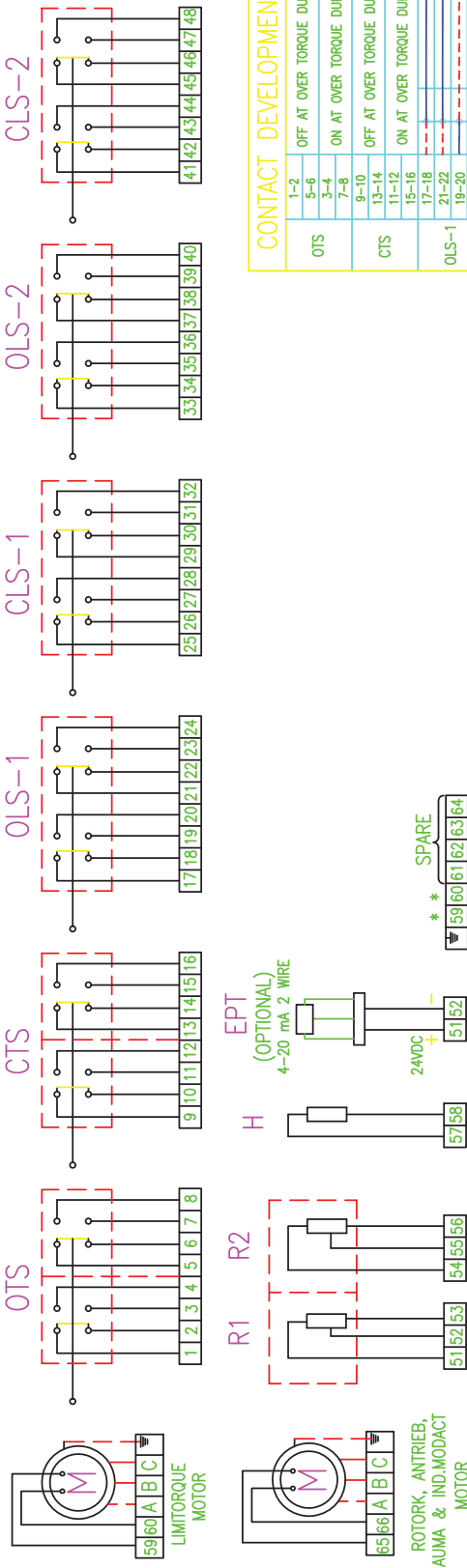
	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.: PE-SS-999-145-I007		
		VOLUME	II B	
		SECTION	D	
		REV. NO.	02	DATE: 17.09.07
		SHEET	3	OF 3
Data Sheet A & B				
DATA SHEET-A (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty)	REQD FOR INCHING DUTY		
	MFR & MODEL NO.	BIDDER TO SPECIFY		
	TYPE	<input checked="" type="checkbox"/> ELECTRONIC (2 WIRE) R/I CONVERTER <input type="checkbox"/> ELECTRONIC (2 WIRE) CONTACTLESS		
	SUPPLY	<input checked="" type="checkbox"/> 24V DC <input type="checkbox"/>		
	OUTPUT	<input checked="" type="checkbox"/> 4-20mA		
	ACCURACY	$\pm 1\%$ FS		
SPACE HEATER	@SPACE HEATER	REQUIRED		
	@ POWER SUPPLY			
	@ RATING			
TERMINAL BOX	MOTOR TERMINAL BOX	REQUIRED		
	ACTUATOR TERMINAL BOX	REQUIRED		
	ENCL CLASS MTR T.B. / ACTUATOR T.B.	<input type="checkbox"/> IP 65 @ <input type="checkbox"/> <input type="checkbox"/> IP65 <input type="checkbox"/>		
	@ EARTHING TERMINAL	REQUIRED		
	PLUG & SOCKET(9 PIN) (FOR COMM, LS/TS FEED BACK, PoT)	<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED <input type="checkbox"/> 2 NOS. <input type="checkbox"/>		
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:-----		
	@ SPACE HEATER CABLE GLAND	SIZE:-----		
	OTHER CONTROL CABLE GLANDS-1	<input type="checkbox"/> 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)		
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE :-----		
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY		_____ Kg.

NOTES:

- SCOPE:** DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
- CODES & STANDARDS:** DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATIONAL STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
- TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
- CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
- THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION. THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
- THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
- THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

NAME SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
				NAME
				SIGNATURE
				DATE
NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @ = TO BE FILLED BY ES				



* - SPARE FOR ROTORK, AUMA, ANTRIEB & IND.MODACT

SWITCHES - ALL ARE POTENTIAL FREE AND TWO PAIR OF CONTACTS CAN BE USED FOR DIFFERENT SUPPLY THERMOSTAT - 65-66 (ROTORK, AUMA, ANTRIEB & IND.MODACT), 59-60 (LIMITORQUE).

EPT - ELECTRONIC POSITION TRANSMITTER (POTENTIOMETRIC TYPE, FOR INCHING DUTY)

THERMOSTAT TERMINALS - TERMINATED IN MOTOR TB IN ANTRIEB & IND.MODACT AND IN MAIN TB IN OTHER MAKES

CTS - TORQUE SWITCHES FOR CW ROTATION (CLOSE) - 2 NO+2 NC

OTS - TORQUE SWITCHES FOR CCW ROTATION (OPEN) - 2 NO+2 NC

OLS-1, OLS-2 - LIMITSWITCHES FOR POSITION OPEN - 2 NO+2 NC

CLS-1, CLS-2 - LIMITSWITCHES FOR POSITION CLOSE - 2 NO+2 NC

OTS, CTS - TWO INDEPENDENT SWITCHES IN ANTRIEB & ANTRIEB

OLS-2 & CLS-2 - CAM DISC IN ROTORK & ANTRIEB

R1-R2- POTENTIOMETER 2 x 100 OHMS

H - SPACE HEATER 1ø 240V AC SUPPLY


M - MOTOR 3ø 415V 50 Hz AC SUPPLY

CONTACT DEVELOPMENT DIAGRAM	
1-2	OFF AT OVER TORQUE DURING OPENING TRAVEL
5-6	ON AT OVER TORQUE DURING OPENING TRAVEL
3-4	OFF AT OVER TORQUE DURING CLOSING TRAVEL
7-8	ON AT OVER TORQUE DURING CLOSING TRAVEL
9-10	OFF AT OVER TORQUE DURING OPENING TRAVEL
13-14	ON AT OVER TORQUE DURING OPENING TRAVEL
11-12	OFF AT OVER TORQUE DURING CLOSING TRAVEL
15-16	ON AT OVER TORQUE DURING CLOSING TRAVEL
17-18	---
21-22	---
19-20	---
23-24	---
25-26	---
29-30	---
27-28	---
31-32	---
33-34	---
37-38	---
35-36	---
39-40	---
41-42	---
45-46	---
43-44	---
47-48	---
TERMINAL	VALVE POSITION
FULL OPEN	a
INTERMEDIATE	b
FULL CLOSE	c
SWITCH NO.	
INDICATES CONTACT CLOSED	
INDICATES CONTACT OPEN	

CONTACT RATING: 5A AT 250V AC & 0.5A AT 220V DC

BHARAT HEAVY ELECTRICALS LTD.	
UNIT: HIGH PRESSURE BOILER PLANT.	
TIRUCHIRAPPALLI 620014.	
365-139	TITLE
N.P.ESWAR	INTERNAL WIRING DIAGRAM
KARUNACHALAM	FOR
P.LOGANATHAN	ELECTRICAL VALVE ACTUATORS (AC)
09.09.2000	(DRAWN FOR INTERMEDIATE POSITION OF VALVES)
11	DATE
09.09.2000	CONTACT DEV. FIG. ADDED.
REV	DATE
APPD	DESCRIPTION
CHED	APPD
DATE	CHED
11	DATE
4-V-MISC-90271	DRAWING No.
11	REV

RETRACED WITH REVISION 11

	DOCUMENT TITLE KKS NUMBERING PHILOSOPHY
	4X100MW GTPS, MARIB PHASE-II

KKS NUMBERING PHILOSOPHY

For identifying (tagging) an instrument / equipment in Power plant KKS numbering scheme is used. The purpose is to assign a unique number to every equipment in the power plant. For C&I equipment unique number are to be provided up to the signal level so that a unique number Input / Output exist in DCS for every signal.

Normally KKS number is a 10 digit alpha-numeric code and is typically split into the following:


X	X	X	A	A	Y	Y	B	B	B
---	---	---	---	---	---	---	---	---	---

First three digits indicate the Sub-System. The Code for the major system are given as per **Annexure-1**.

Fourth and Fifth digits are the **Numerical Keys at System Code Level** and used to distinguish between main systems having same Alpha Codes.

Sixth and Seventh digits are the **Equipment / Apparatus / Measuring Circuit Code**. The code of various Equipment / Apparatus / Measuring Circuit is shown in **Annexure-2**

Eight, Nine and tenth digits are the **Numerical Keys at Equipment / Apparatus / Measuring Circuit Code** and used to distinguish between various instruments in the same sub-group. Numerical keys at System / Equipment / Apparatus / Measuring Circuit is shown in **Annexure-3**.

	DOCUMENT TITLE
	4X100MW GTPS, MARIB PHASE-II

ANNEXURE-1

List of System / Sub-System Codes used in Power Plant:

- 1) Compressed air system : QEA, QEC
- 2) Ventilation System : SAA TO SAZ
- 3) Fire Detection & Protection System + Fire Water pumps : SGM, SGN, SGO, SGP
- 4) Sewage Treatment : SJA TO SJZ
- 5) Pre-treatment Plant : GBI, GBM, GBV
- 6) RO DM Plant : GCI, GCM, GBV
- 7) AC SYSTEM: QKA,QKBupto QKZ

ANNEXURE-2

Standard Equipment Codes:

AA	Valves including drives, also hand operated
AB	Seclusions, Lock, Gates, Doors
AC	Heat Exchanger
AE	Turning, Driving, Lifting equipment
AF	Continuous conveyors, Feeders
AG	Generator Units
AH	Heating and Cooling Units
AK	Pressing and Packaging equipment
AM	Mixer, Stirrer
AN	Blower, Air Pumps / Fans, Compressor Units
AP	Pump Units
AT	Purification, Drying, Filter
AV	Combustion Equipment e.g. grates

Standard Apparatus Codes:

BB	Vessels and Tank
BF	Foundation
BG	Boiler Heating Surfaces
BN	Injector, Ejector
BP	Flow and throughput limitation equipment (Orifice)
BQ	Holders, Carrying Equipment, Support
BR	Piping, Ducts, Chutes, Compensator
BS	Sound Absorber
BU	Insulations, Sheatings



DOCUMENT TITLE

KKS NUMBERING PHILOSOPHY

4X100MW GTPS, MARIB PHASE-II

Standard Measuring Circuits Codes:

CD	Density
CE	Electrical Quantities
CF	Flow, throughput
CG	Distance, Length, Position
CK	Time
CL	Level
CM	Humidity
CQ	Analysis (SWAS)
CS	Speed, Velocity, Frequency
CT	Temperature
CY	Vibration, Expansion

ANNEXURE-3**Numerical Keys****A) Numerical Keys at System Code Level**


- i) Use 10, 20, 30, To distinguish between main systems having same Alpha Codes. Examples:
 - a) Main Steam (Left) and Main Steam (Right)
 - b) BFP – A/B/C
 - c) ID Fan – A/B, FD Fan A/B, AH – A/B
- ii) For branch off from main system path having code say 10, keep the same alpha code and use 11, 12, 13 etc. Similarly for other branch off from main system path having code say 20, keep the same alpha code and use 21, 22, 23 etc and shall carry on further in the same way.
- iii) If the branch off from main system / sub system path is used for some other system, where different alpha codes can be applied, then in that case the said branch line will be designated by the alpha codes of the system to which it is providing the input.

B) Numerical keys at Equipment Code level:

There are three numerical keys available for each type of equipment code. Following has been agreed upon considering present practice, better flexibility and ease in sorting.

- i) Valves and Dampers --- *Equipment Code – AA*

N1N2 N3

DOCUMENT TITLE			
	KKS NUMBERING PHILOSOPHY		
	4X100MW GTPS, MARIB PHASE-II		
Motorised (<i>on/off duty</i>)	-	0	01 to 50
Motorised (<i>inching duty</i>)	-	0	51 to 99
Pneumatic (Control)	-	1	01 to 50
Motorised (<i>thyrestor Control</i>)	-	1	51 to 99
Sol. Operated (Open / Close duty (Valves, NRVs, Gate)	-	2	01 to 99
Hydraulic	-	3	01 to 99
NRV (Without actuation)	-	4	01 to 99
Manual	-	5	01 to 99
Manual	-	6	01 to 99
Relief & Safety Valves	-	7	01 to 99
Reserve	-	8	01 to 99
Reserve	-	9	01 to 99
ii) Field Instruments			
Field Transmitters & Analog Signals	-	0	01 to 99
Field Switches & Binary Signals	-	1	00 to 99
PG Test Point	-	4	00 to 99
Gauges	-	5	00 to 99
Automatic Turbine Tester (ATT)-HWR	-	2	00 to 99
(Reserved for protection Signals used by Hardwar)			
Example of Numerical Key Usage:			
<p>In line with the philosophy adopted for Valves / Dampers /instruments etc. pumps and fans in the main systems (having different system code) can be numbered as AP/N100 and as AP/N101, 102, Where system code is same.</p>			

Technical Specification, Datasheets, Quality Plan for Local Control Panel



SPECIFICATION FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS -999- 145 -054A

VOLUME II B

SECTION D

REV. NO. 03

DATE : 16-09-2013

SHEET 1 OF 6

1.0 SCOPE

This specification covers the Design, Manufacture, Inspection and Testing at the manufacturer's works, proper packing for transportation and delivery to Mumbai port CHA Godown of the Local Control Panels required for control and monitoring of the Auxiliary Plant & Equipment.

2.0 CODES AND STANDARDS

- 2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant International standards. Control and relay panels shall conform to relevant IEC standards as amended upto date as per Section 8.13, Volume-V. Equivalent ANSI standards are also acceptable.
- 2.2 As a minimum requirement, the following latest edition of relevant standards shall be complied with for C&I Instruments and Local Control Panel: IEC/ISA/BS/ASME. The contractual Specification shall over ride this specification in case of any mismatches.

3.0 TECHNICAL REQUIREMENTS

Details of various Control panel components shall be as per Section 8.13, Volume-V attached. The contractual Specification shall over ride this specification in case of any mismatches.

3.1 Panel Construction

- 3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps/LED cluster, relays, timers and other devices required for operation and monitoring of the equipment locally.
- 3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffeners as necessary shall be provided.
- 3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel

Frame thickness: Not less than 3.0mm

Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments) 1.6 mm for doors and Not less than 2.0 mm for others

Panel Height: Not less than 2365 mm (Refer data sheet-A (No. PES-145A-DS1-0))

Gland plate thickness: 3.0mm

Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

- 3.1.5 The panel shall be provided with rear doors with integral lockable handle. The door when locked shall be held at minimum three places. The door width shall not be more than 550mm. The doors shall be provided with suitable stiffeners to prevent buckling. The handle shall be on the right side of the door. The door shall be removable type with concealed hinges to facilitate maintenance work. Suitable pocket inside the door shall be provided for keeping the drawings / documents. Double door shall be provided with suitable glass windows, as per the requirement.

- 3.1.6 Suitable neoprene gasket shall be provided on all doors and removable covers. Suitable ventilation system along with louvers shall be provided at bottom and top of the doors covered with removable wire mesh.



SPECIFICATION FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS -999- 145 -054A

VOLUME II B

SECTION D

REV. NO. 03

DATE : 16-09-2013

SHEET 2 OF 6

- 3.1.7 The class of protection shall be in accordance with IP-42 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).
- 3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.
- 3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145A-DS1-0) shall be supplied alongwith the Panel.
- 3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function. No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.
- 3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.
- 3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm² size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.
- 3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm² to 2.5mm² external cables. **The TB points in terminal block shall be cage clamp type / screw type.** The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm **height from finished floor.** **The panel shall have ten (20) percent spare terminal.**
- 3.1.14 The interior of each panel shall be suitably illuminated through fluorescent **lamps / tube lights with shrouded cover of minimum 15W** operable on 240V 50 Hz AC power supply through panel door switch.
A 15 Amp. 3-pin Power receptacle shall be provided.
- 3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.
- 3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm² size.



SPECIFICATION FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS -999- 145 -054A

VOLUME II B

SECTION D

REV. NO. 03

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SHEET 3 OF 6

- 3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.
- 3.1.18 Vendor shall furnish electric load and heat load list (in case panel is to be placed in ac environment) of each panel.
- 3.2 Hazardous Area Panel Requirement
- 3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.
- 3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.
- 3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.
- 3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.
- 3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.
- 3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).
- 3.3 Control & Monitoring devices
- 3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.
- 3.3.2 Alarm Annunciator System
- It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.
- 3.3.3 Relays
- The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.



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3.3.4 Timers

The timers shall be electronic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However, minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable.

3.3.5 Control / Selector Switches

Switches shall be Rotary Cam type with minimum of 5 Amps AC & 2 Amp DC continuous current rating. Selector switches shall be stay put type while control switches shall be spring-return-to-neutral type. Contact configuration and rating shall be as per the control function requirement. The switches shall be lockable type wherever specified. Each switch shall be provided with engraved plates indicating the switch position / functions.

3.3.6 Push Buttons / Indicating Lights

The push buttons shall be momentary action self-resetting type, however stop P.B. for unidirectional drives shall be provided with manual reset facility. Its contact configuration & rating shall be as required for the control function but minimum 2 NO + 2 NC of 5 Amp. AC rating. It shall have round coloured projecting tab and engraved escutcheon plate / inscription plate. Colour coding of push buttons shall be as under:

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge	Left Hand Side
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test	Right Hand Side

Indicating lights shall be suitable for direct connections across specified power supplies. It shall be fitted with built in resistance to prevent circuit tripping on shorting of lamp filament. It shall be fitted with LED cluster type lamp replaceable from front.

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped	Left Hand Side
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy	Right Hand Side

3.3.7 Ammeters

Ammeter shall be 96 x 96 mm size, 90 deg. deflection, 1.5% accuracy, 1 Amp. CT operated or with 4-20mA input and Flush mounting type as called for in the data sheet-A (No. PES-145-54A-DS1-0). Ammeters for motors shall have six (6) times folded scale at upper end to enable motor starting current indication

3.3.8 Miniature Circuit Breaker (MCB)

These shall be instantaneous magnetic trip type for short circuit in addition to current time inverse delayed thermal trip feature for over current protection. The housing of MCB shall be made of non-ignitable, high impact material. It shall have minimum short circuit rating of 9 KA for AC Voltages and 4 KA for DC Voltages.

3.3.9 Makes of various instruments / devices shall be as given below

1.	Alarm Annunciators	:	Procon / IIC
2.	Ammeters	:	AEP / IMP
3.	Control / Selector Switches	:	Alsthom / Kaycee / Siemens / L&T
4.	Push Buttons / Indicating Lamps	:	Siemens / L&T / Teknic / Alsthom
5.	Auxiliary Relays	:	Jyoti / Siemens / L&T / OEN
6.	Timers	:	L&T / Alsthom / Bhartiya Cutler Hammer
7.	MCBs	:	S&S Power Engg. / Indo Asian / MDS
8.	Terminal Blocks	:	Jyoti / Elmex



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4.0 TESTING AND INSPECTION

4.1 The bidder shall adopt suitable quality assurance program to ensure that the equipments offered will meet the specification requirements in full.

4.2 BHEL's standard Quality Plan for LCP is enclosed with the specification. The bidder shall furnish his acceptance to BHEL's QP and submit the signed and stamped copy of QP along with the offer.

4.3 The vendor shall conduct the following tests as a minimum requirement:

4.3.1 Routine Tests

1. High Voltage (H.V.)
2. Insulation Resistance (I.R.)
3. Functional

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

The bidder shall supply all commissioning spares and consumables 'as required' during Start-up, as part of the main equipment supply.

5.2. Mandatory Spares

The bidder shall offer alongwith main offer, the Mandatory Spares as specified elsewhere in the specification. The Mandatory Spares offered shall be of the same make and type as the main equipment.

5.3. Recommended Spares

The bidder shall furnish a list of Recommended Spares indicating the normal service expectancy period and frequency of replacement; quantities recommended for 3 years operation alongwith unit rate against each item to enable BHEL/BHEL's Customer to place a separate order later, if required.

6.0 DRAWINGS AND DOCUMENTS

6.1 The bidder shall furnish the following documents in required number of copies along with the bid :

1. Data Sheet no. PES-145A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

6.2 The vendor shall furnish the following documents in required number as agreed after the award of contract:

1. Data Sheet No. PES-145A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs



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7.0 MARKING AND PACKING

7.1 Marking:

A stainless steel name –plate shall be permanently fixed on each equipment giving its tag/serial number and salient technical specification.

7.2 Packing:

Sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing. Equivalent or better packing methods may be deployed subject to approval of the BHEL. Vendor shall submit the packing procedure for its equivalent for BHEL's approval during detailed engineering.

8.0 APPLICABLE DATA SHEET FORMS

This document shall be read with one or more of the following data sheet forms :

- | | | |
|-----------------------------------|---|-------------------------------|
| - Data sheet A&B for Local Panels | : | Data sheet no. PES-145A-DS1-0 |
| - Data sheet C for Local Panels | : | Data sheet no. PES-145A-DS2-0 |

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8.13 CONTROL AND RELAY PANEL

8.13.1 General

This specification covers the design, manufacture, supply, erection, testing and commissioning of Control and Relay Panel.

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.

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.

8.13.2 Scope of work

The scope of work shall include but not limited to the following:

- 1 set of Relay Panel for Gas Turbine Generators, Gas Turbine Generator Transformers & GTG Unit Auxiliary Transformers.
- Generator Control Panels
- Plant Electrical Control System.
- Control panels required for off site areas.
- List of recommended spare parts as per Section-10.0, Vol.-II.
- Commissioning spares.

8.13.3 Technical requirements

Control and Relay panels shall conform to relevant IEC Standards as amended upto date. Equivalent ANSI standards are also acceptable.

8.13.3.1 Relay Panel

The control and relay panel shall be of free standing, floor mounting, sheet steel enclosed, with a degree of protection of not less than IP 31. The panel shall be fabricated out of CRCA sheet steel of not less than 2 mm thickness. The panels shall be located in air-conditioned central control room.

All instruments, relays etc. shall be flush mounted on the front of the panel.

Panel wiring shall be carried out with 1000 V grade PVC insulated wires with a minimum size of 2.5 sq. mm copper for control and 1.5 mm² for voltage circuits.

Terminal blocks shall be of stud type. Atleast 20% spare terminals shall be provided on each panel.

Panels shall be provided with space heater, illumination lamp, 5/15A 3 pin 230V AC socket point etc. A continuous copper bus of minimum size 50 x 6 mm shall be provided in

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the panel for earthing. Equipment mounted inside the panel shall be securely connected to earth bus by copper wires of size 2.5 mm² minimum.

Apart from the signals available in the CRT, solid state microprocessor based MWH, MVARH meters for Generators, generator transformers and unit auxiliary transformer shall be provided. Energy meters shall be suitable for measuring unbalanced loads in 3 phase circuit. MWH meter shall have accuracy class of 0.5 or better and MVARH meter shall be of accuracy class of 3.0 or better.

Protection

All protective relays shall be of Numerical type suitable for flush mounting. The relay panel equipment shall be of modern design and shall have been operating successfully in atleast three power stations. Prototype equipment will not be accepted.

Generator protection shall be through 100% redundant microprocessor based numerical integrated protection relays i.e. almost all the protection functions of Generator shall be performed by single protection relay & such two relays shall be provided. The protection functions which are not covered in integrated Generator numerical protection relay shall be provided by using separate numerical relay.

Typical metering and protection for Generator and Unit Auxiliary Transformer Drg no. 00-7195-E-202 is enclosed. Additional protection if any to meet the system requirement shall also be provided.

The Bidder shall furnish, install and co-ordinate the setting of all relays to suit the requirements of protection, operation and interlocks as broadly indicated below. Unit concept shall be adopted in the design of the protection system.

All operation, control, interlock shall be carried out by DCS. It shall also be possible to interact manually/electrically from local for maintenance of every equipment.

The hardware design for the protection and associated equipment shall use latest state-of-the art technology and shall be static, modular in nature. Where design is based on microprocessor technology, adequate self testing / monitoring/diagnostic facilities shall be provided.

The relays shall be designed to perform satisfactorily under highly noisy electrical environment. Sufficient degree of high frequency disturbance immunity and impulse voltage withstand capacity shall be built into electronic designs as stipulated in relevant standards.

The relays shall function satisfactorily being located indoors in non-A.C. physical environment.

Relay characteristics shall be co-ordinated for proper functioning in conjunction with associated relays.

Tripping shall be done through separate potential free contacts. High speed lock-out relays shall be used where requisite number of potential free contacts are not available.

The minimum requirements of various protections have been generally indicated below for Bidder's reference.

Generator Transformer

The transformer protection shall be divided into two groups as described below.

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However, the Bidder shall check and offer his recommended relay test its for use with the various relays specified in the specification.

Name Plate

Nameplates of approved design shall be furnished for each panel and for each instrument or device mounted on the panel.

The material shall be aluminium alloy / lamicaid or approved equal, 3 mm thick, with black letters on white background.

The nameplates shall be held by self tapping screws. The size of nameplate shall be approx. 20 mm x 75 mm for equipment and 40 mm x 150 mm for the panels.

The nameplates for panels shall be provided both on the front and on the rear.

Instrument and devices mounted on the face of the panels shall also be identified on the rear with the instrument or device number. The number may be painted on or adjacent to the instrument or device case.

Illumination, Space Heating and Receptacles

Each panel shall be provided with interior illumination lamp with door switch, space heater with thermostat and 5A, 3 pin receptacle with plug.

Lamp, heater and receptacle circuits shall be suitable for available A.C. supply and furnished with individual ON-OFF switch.

The lamp shall be located at the ceiling and guarded with protective cage. Space heater shall be located near the floor so as not to pose any hazard to service personnel.

AC/DC Power Supply

The following power supplies shall be made available to each protection panel:

A.C. Supply	:	Single Feeder
D.C. Supply	:	Double Feeder

The Bidder shall provide isolating switch fuse units for the incoming AC/DC power supplies and run bus wires for power distribution to different panels.

Fuse/MCB and link shall be provided for individual circuits for protection and also for isolation from bus wire without disturbing other circuits.

The Bidder shall group the fuse/MCB requirements in each panel in a neat, orderly and easily accessible fuse blocks or distribution panel.

Alarm relays shall be provided to annunciate failure of incoming A.C. and D.C. power supplies to each protection panel.

Recorders

Recording meters shall be switchboard type mounted on a withdrawable or swing-down carriage for easy access.

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The chart drive is by synchronous motor with spring reserve for 8 hours to maintain recording during A.C. power failure.

Chart speed shall be 75mm/hr. for normal service and 200 mm/hr. with change of wheel for testing. Chart width shall not be less than 100 mm.

Recorders shall be provided with scaled indication for direct reading of primary quantities and high/low alarm contacts with adjustable set points.

Recorders shall be furnished with charts, ink and all necessary accessories for 6 months service at 75 mm/hr. speed.

For instrument transformers, accuracy class shall be as follows or better :

	CT	PT
- Differential Protection	Class PS	-
- Other Protections	5P 20	3 P
- Restricted earthfault protection	Class PS	-
- AVR / Synchronising	0.5	0.5
- Performance testing	0.2	0.2

8.13.3.2 Control Panels

The specification of control panel shall be as given in 8.13.3.1. The degree of protection shall not be less than the IP 52.

Indicating meters shall be 96 mm square in size, 240° scale having an accuracy of ± 1.5 . All necessary ammeter, voltmeter, power factor meter etc shall be provided.

Push buttons shall be of heavy duty, shrouded, push to actuate type. The contacts shall be rated to carry 1A at 220 V DC.

The panel shall have provisions of cable entry from the bottom. Bottom plate shall be provided to make entry dust tight.

Indicating lamps shall be of filament type with series resistor or LED type.

All control fuses shall be of HRC cartridge link type.

Annunciator shall be of static type suitable for operation at 220 V DC. Common test, reset, acknowledge push buttons and audible alarm shall also be provided.

8.13.3.3 Control Philosophy for Main Plant

The complete control, indication annunciation and supervision of the Electrical Systems for the Power Plant shall be performed from DCS only. GTG shall be synchronised from generator control panel and DCS. Necessary auto-synchroniser, check synchronising relays shall be provided.

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The main control and monitoring functions of the electrical equipment shall be integrated into the DCS in order to minimise the required control and monitoring activities. Also the main automating and interlocks shall be realised in the main DCS. Safety relevant interlocks and protection shall be hardwired.

The main circuit breakers shall be operated and indicated remotely by the DCS. Emergency off operation of all breakers shall be possible locally at the related switchgear. All feeders to electric motors will be operated and monitored from the main DCS. Other equipment is interlocked with the main DCS for indication of the essential status and general fault signals. The main DCS shall display all the main analog and binary signals of the auxiliary power supply system on a graphic monitor.

Main and check meters shall be provided at generator system.

All the interlocks necessary for safe and reliable operation of the switchgears shall be provided within the switchgears and relay panels.

Measurements/indications of various parameters of generator, transformer, 6.6 kV & 400V switchgears, excitation system parameters, UPS and DC system etc. shall be wired through transducers & interposing relays to the DCS system.

Status (ON, OFF and Trip) of 6.6 kV, 400V breakers shall be monitored through DCS on CRT.

Following shall also be monitored through DCS on CRT

- Status (ON, OFF & Trip) of all motors operated through CRT
- Status (ON, OFF & Trip) of UPS & DC system
- Operation of all protection relays for 6.6 kV system
- Operation of protection relays of Generator, Generator Transformer and Unit Auxiliary Transformer, Station Auxiliary Transformer.
- Operation of transformer protection mounted on transformers for all HT and LT transformers.
- Excitation system and AVR parameters.
- Trip circuit healthy for all breaker operated feeders.

For DCS controlled feeders, ready to start feed back shall be made available from switchgear / MCC. Main control room shall accommodate electrical auxiliary control panel, Gas turbine generator transformer protection panels, RTCC panels and Unit auxiliary transformer protection panels, generator control & protection panels, generator AVR panels and UPS.

8.13.4 Drawings, Data & Manuals

To be submitted with the Bid

- a) Typical General Arrangement drawing of the Protection Panel
- b) Bill of Materials

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c) Technical leaflet and Catalogues on :

- i) Protection Panel
- ii) Relays
- iii) Meters
- iv) Auxiliary Devices
- v) Switches

d) Type test certificates on each equipment

To be submitted for Approval and Distribution (After award of Contract)

- a) Dimensional general arrangement of the protection panel showing equipment disposition and identification.
- b) Foundation plan and loading diagram, clearly showing panel fixing arrangement, floor opening for cable entry etc.
- c) Schedule of materials and label inscriptions.
- d) Block logic diagrams for turbine, unit & generator protection scheme.
- e) Block logic diagrams for operation of 400KV and 33KV circuit breakers and disconnect switches under different operating conditions.
- f) Detailed control schematics clearly showing terminal and wire numbering.
- g) Three-line diagrams for meter and relay connections.
- h) Back of board wiring diagram showing all equipment and devices in their relative physical positions and all wiring upto the terminal blocks.

Equipment/Device and terminals shall be identified with designations/ numbers as per approved schematic and connection diagrams.

i) Relay setting calculation and recommended settings.

Instruction Manuals for Protection Panel, associated relays and other devices.

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 herein are 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.

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8.13.5 Specified Design Data

Description	Unit	Data
SECTION : CONTROL & RELAY PANEL		
8.13.5.1 Relay Panel		
Type of Relays – Protective relays	-	Numerical
Other relays		Static / digital
Enclosure	-	Minimum IP 31
Sheet Steel thickness	mm	Not less than 2 mm
8.13.5.2 Control Panel		
Enclosure	-	IP 42
Sheet steel thickness	mm	Not less than 2 mm
Type of control		As per Specification

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8.13.6 Technical Data by the Tenderer

Description	Unit	Data
SECTION : CONTROL & RELAY PANEL		
8.13.6.1 Relay Panel		
General		
* Name of Manufacturer	-	
Type of mounting for relays	-	
* IEC standards to which the relays confirm	-	
Overall dimensions / weight of panel	mm / kg	
Construction		
Degree of protection	-	
Sheet metal thickness	mm	
Ground bus material	-	
Ground bus size	-	
Internal Wiring		
Wire type	-	
Voltage grade	-	
Conductor material	-	
Conductor size	mm ²	
Maximum rating of contacts for auxiliary and output relays		
Voltage	V	
Continuous current	A.D.C	
Make & Carry for 1 sec	A.D.C	
Breaking capacity		
- Resistance	W	
- Inductive	W	

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Description	Unit	Data
Burden	VA	
No. of hand reset output	-	
Trip Circuit Supervision Relay		
* Make	-	
* Type	-	
Rating		
No. of output contacts	-	
Lockout relay (Hand reset type)		
No of contacts		
Lockout Relay (Hand Reset Type)		
No. of contacts		
8.13.6.2 Control Panel		
* Make	-	
* Type	-	
Degree of protection	-	
Sheet metal thickness	mm	
Ground bus material	-	
Ground bus size	mm	
Internal wiring		
Wire type	-	
Voltage grade	V	
Conductor material	-	
Conductor size	mm ²	

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Description	Unit	Data
Instruments & Meters		
Make	-	
Type	-	
Applicable standard	-	
Accuracy class	-	
Scale length		
Case size		
Burden	VA	
(For each type of meter, above information to be given separately)		
Energy Meter		
Make	-	
Type	-	
Applicable standard	-	
Accuracy class	-	
Case size		
Burden	VA	
Suitable for 3 phase, 3 wire, unbalanced load	Yes/No	
Transducers		
Make	-	
Type	-	
Input		
Output		
Accuracy		
Burden	VA	


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Description	Unit	Data
Overload capacity		
- Continuous		
- Short time		
(For each type of transducers above information to be given separately)		
Control Switches		
Make	-	
Type	-	
Voltmeter / Ammeter Selector Switches		
Make	-	
Type	-	
Indicating Lamp		
Make	-	
Type	-	
Size		
Push Button		
Make	-	
Type	-	
No. of NO + NC Contacts	-	
Contact rating		
Size		
Terminal Blocks		
Make	-	
Type of Terminal	-	

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Description	Unit	Data
Space Heater		
Make	-	
Type	-	
Rating	W	
Cubicle Illumination		
Rating	W	
Door switch operated	Yes/No	
Static Annunciator		
Make	-	
Type	-	
Applicable standard	-	
No.of lamps/ windows	-	
Size of window		
Letter size		
Series Resistor		
- Value	Ohms	
- Built-in or external	-	
Overall dimensional details		
Catalogue enclosed	Yes/No	
Note :- Data marked * thus shall be filled up by the Bidder along with the offer. Completely filled data sheet are to be submitted by successful Bidder.		

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Data Sheet A & B				
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL	MANUFACTURER			
	CONSTRUCTION		<input checked="" type="checkbox"/> FOLDED <input type="checkbox"/> WELDED	
	ENCLOSURE SHEET THICKNESS (As per Section 8.13, Volume V of contract specification)	FRONT	<input type="checkbox"/> 2.0 mm	
		OTHER	<input type="checkbox"/> 2.0 mm	
		DOOR	<input type="checkbox"/> 1.6 mm	
		HEIGHT	<input type="checkbox"/> 2365 mm for stand alone panels. <input type="checkbox"/> Other	
OTHER		<input type="checkbox"/> Load bearing sheet front shall have 3mm thickness		
TECHNICAL	INPUT POWER SUPPLY * (As per Electrical specification) (ANY OTHER POWER REQUIREMENT TO BE DERIVED FROM THIS SUPPLY ONLY)		<input type="checkbox"/> 240V 50 Hz AC <input type="checkbox"/> 220V DC <input type="checkbox"/> 415V 3 PHASE 3W <input type="checkbox"/> 400V 3 PHASE 4W	
	NO. OF FEEDERS (As per Electrical specification)		<input type="checkbox"/> ONE <input type="checkbox"/> TWO	
	STARTER WITH MCC		<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED	
	IPR POSITION		<input checked="" type="checkbox"/> MCC <input type="checkbox"/> RELAY PANEL	
	CONTACT RATING OF RELAY		<input checked="" type="checkbox"/> 5 Amp, 230 V AC <input checked="" type="checkbox"/> 0.25 Amp, 220V DC	
	CONTROL SUPPLY		<input type="checkbox"/> 110V AC <input type="checkbox"/> 220V AC <input type="checkbox"/> 220V DC <input type="checkbox"/> Other. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____ NOS. (AS REQUIRED)	
	TEMP SCANNER (IF REQUIRED –NO. OF CHANNELS TO BE SPECIFIED UNDER SEC-C)		<input type="checkbox"/> REQUIRED <input checked="" type="checkbox"/> NOT REQUIRED	
	PAINT TYPE (As per Annex-1, Section 7.6, Volume IV of contract specification)		<input type="checkbox"/> EPOXY ENAMEL <input type="checkbox"/> EPOXY POWDER COATED	
	MIMIC (TYPE OF MIMIC- MATERIAL, THICKNESS TO BE SPECIFIED DURING DETAILED ENGG.)		<input checked="" type="checkbox"/> REQUIRED <input type="checkbox"/> NOT REQUIRED	
	PANEL COLOUR (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		<input type="checkbox"/> LIGHT GREY <input type="checkbox"/> OPALINE GREEN	
	FINISH (EXTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		<input type="checkbox"/> MATT <input type="checkbox"/> GLOSSY <input type="checkbox"/> SEMI GLOSSY	
	PANEL COLOUR (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		<input type="checkbox"/> WHITE <input type="checkbox"/> CREAM <input type="checkbox"/> OFF WHITE	
	FINISH (INTERNAL) (As per Annex-1, Section 7.6, Volume IV of contract specification)		<input type="checkbox"/> MATT <input type="checkbox"/> GLOSSY <input type="checkbox"/> SEMI GLOSSY	
	CLASS OF PROTECTION		<input checked="" type="checkbox"/> IP-55 (FOR INDOOR SERVICE) <input checked="" type="checkbox"/> IP-67 (FOR OUTDOOR SERVICE) <input type="checkbox"/> ANY OTHER	
	CONTROL HARDWARE		<input checked="" type="checkbox"/> RELAY BASED	
	FOUNDATION ARRANGEMENT		<input type="checkbox"/> FOUNDATION BOLTS <input type="checkbox"/> ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)	(Vendor to specify)	

	DATA SHEET FOR LOCAL PANELS		SPECIFICATION NO.: PE-SS-999-145-054A	
			VOLUME	
			SECTION	
			REV. NO. 02	DATE: 16.09.2013
TAG No. Qty.....		Data Sheet No.: PES-145A-DS1-0		
Data Sheet A & B				
DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
	PANEL TYPE	<input type="checkbox"/> PRESSURISED <input type="checkbox"/> UNPRESSURISED As per Requirement		
	CABLE GLAND	<input checked="" type="checkbox"/> DOUBLE COMPRESSION		
	AMMETER (TYPE OF INPUT) *	<input type="checkbox"/> 1 Amp CT <input type="checkbox"/> 4-20 mA		
	SCOPE OF SUPERVISION FOR ERECTION & COMMISSIONING	<input type="checkbox"/> APPLICABLE <input checked="" type="checkbox"/> NA		
	* TO BE CO-ORDINATED WITH PEM ELECTRICAL			
NAME DESIGNATION SIGNATURE DATE	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL NAME: SIGNATURE: DATE:
	AANCHAL CHOUDHARY	SACHIN SRIVASTAVA	MA MANSOORI	
	SR.ENGR	DY.MNGR	D. GM	
	16.09.2013	16.09.2013	16.09.2013	



DATA SHEET FOR LOCAL PANELS

SPECIFICATION NO.: PE-SS-999-145-054A

VOLUME

SECTION

REV. NO. 02

DATE: 16.09.2013

SHEET 3 OF 3


TAG No. Qty.....


Data Sheet No.: PES-145A-DS1-0


Data Sheet C

DATA SHEET-C FOR LOCAL PANEL
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)


GENERAL	MANUFACTURER		
	CONSTRUCTION		<input type="checkbox"/> FOLDED <input type="checkbox"/> WELDED (As per requirement EDN)
	ENCLOSURE SHEET THICKNESS	FRONT	
		OTHER	
		DOOR	
		HEIGHT	
OTHER			
TECHNICAL	INPUT POWER SUPPLY		
	NO. OF FEEDERS		
	CONTACT RATING OF RELAY		
	TEMP SCANNER		
	CONTROL SUPPLY		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		
	PAINT TYPE		
	PANEL COLOUR (EXTERNAL)		
	FINISH (EXTERNAL)		
	TYPE OF MIMIC MATERIAL OF MIMIC THICKNESS OF MIMIC		
	PANEL COLOUR (INTERNAL)		
	FINISH (INTERNAL)		
	CLASS OF PROTECTION		
	CONTROL HARDWARE		
	FOUNDATION ARRANGEMENT		
	WEIGHT OF PANEL (Kg.)		

	DATA SHEET FOR LOCAL PANELS			SPECIFICATION NO.: PE-SS-999-145-054A	
				VOLUME	
				SECTION	
				REV. NO. 02	DATE: 16.09.2013
TAG No. Qty.....			Data Sheet No.: PES-145A-DS1-0		
Data Sheet C					
DATA SHEET-C FOR LOCAL PANEL (TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)					
	PANEL TYPE				
	CABLE GLAND				
	AMMETER (TYPE OF INPUT)				
	SCOPE OF SUPERVISION				
NAME SIGNATURE DATE	PREPARED BY		CHECKED BY		APPROVED BY
	AANCHAL CHOUDHARY		SACHIN SRIVASTYAVA		MA MANSOORI
	16.09.2013		16.09.2013		16.09.2013
					COMPANY SEAL NAME: SIGNATURE: DATE:

<div></div> <div>STD QUALITY PLAN NO.: PE-QP-999-145-1056</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL											
		VOLUME IIB											
		SECTION D											
		REV. NO. 01 DATE: 22-02-2008											
		SHEET 1 OF 7											
		PEM :: C&I											
Sl. No.	Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks	
									P	W	V		
1.0	INCOMING Sheet Steel (CRCA & HR)	1. Chemical Composition	MA	Chemical analysis	Sample	Relevant standard	Relevant standard	Test Certificate	3	---	2		
		2. Bend Test	CR	Mech. test	Sample	Relevant standard	Relevant standard	Log Book	2	---	---		
		3. Surface finish	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		4. Waviness	MA	Visual	100%	Factory Standard	No Waviness	Log Book	2	---	---		
		5. Thickness	MA	Measurement	100%	BHEL Spec.	BHEL Spec.	Log Book	2	---	---		
		6. Mill marking	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	1		
2.0	Flats / Angles / Channels	1. Dimensions	MA	Measurement	Sample	Relevant standard	Relevant standard	Log Book	2	---	---		
		2. Surface Defects	MA	Visual	100%	Factory Standard / Sample	Factory Standard / Sample	Log Book	2	---	---		
		3. Straightness	MA	Measurement	100%	Factory Std.	Factory Std.	Log Book	2	---	---		
		4. Mill marking	MA	Visual	100%	Relevant standard	Relevant standard	Log Book	2	---	1		
3.0	Cables / Wires	1. Visual / Surface defects	MA	Visual	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---		
		2. IR and HV	MA	Electrical	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---		
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics													
\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.													
1 - BHEL 2 - Vendor 3 - Sub-vendor													

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056				
		VOLUME IIB														
		SECTION D														
		REV. NO. 01										DATE: 22-02-2008				
		SHEET 2										OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
4.0	Electrical Components like Annunciator Transformers Lamps Switches PBs Contactors Relays Timers Space Heaters Thermostat Indicating meters etc.	3. Conductor a) Resistance b) Size c) Sheet colour	MA MA MA	Electrical Measurement Visual	100% 100% 100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	2	---	---	---				
		4. Type / Routine Test Certificates	MA	Verification	100%	BHEL Spec. and Relevant standard	BHEL Spec. and Relevant standard	Log Book	3	---	---	2				
		1. Verification at make and Type	CR	Visual	Sample	BHEL Spec. and BOM	BHEL Spec. and BOM	Log Book	2	---	---	---				
		2. Verification of Test Certificates	CR	Scrutiny of Type / Routine T.Cs.	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
		3. Operation / Functional check	CR	Electrical	Sample+100%@	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---	+ for relay & contactors only			
		4. I.R.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---	@ for all components except relays & contactors.			
		5. H.V.	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
		6. Calibration	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	1					
		7. Pick up / Drop off Voltage	MA	Electrical	100%	Relevant standard & Catalogue	Relevant standard & Catalogue	Log Book	2	---	---	---				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics																
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STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056					
										VOLUME		IIB			
										SECTION		D			
										REV. NO.		01		DATE: 22-02-2008	
										SHEET		3		OF 7	
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
5.0	Misc. Components like Gaskets, Terminal Blocks etc.	1. Verification of Type / Make	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---				
		2. Surface defects	MA	Visual	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---				
		3. IR / HV on Terminal Blocks	MA	Electrical	Sample	BHEL Spec. & Mfrs. Catalogue	BHEL Spec. & Mfrs. Catalogue	Log Book	2	---	---				
6.0	IN PROCESS Blanking / Bending / Forming	1. Dimensions	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---				
		2. Surface defects after bending	MA	Visual	100%	Factory Standard	Factory Standard	Log Book	2	---	---				
7.0	Nibbling / Punching	1. Cutout Sizes	MI	Measurement	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---				
		2. Deburring	MA	Visual	100%	Approved Mfr. drgs.	Approved Mfr. drgs.	Log Book	2	---	---				
8.0	ASSEMBLY Frame Assembly & Sheet fixing	1. Dimensions	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2				
		2. Alignment	MA	Measurement	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2				
		3. Welding Quality	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2				
		4. Surface defects	MA	Visual	100%	Approved drg. / Mfr. Standards	Approved drg. / Mfr. Standards	Log Book	2	---	2				
LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics										\$			P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.	1 - BHEL 2 - Vendor 3 - Sub-vendor	

<div></div> <div>PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056				
												VOLUME IIB				
												SECTION D				
												REV. NO. 01 DATE: 22-02-2008				
												SHEET 4 OF 7				
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks				
									P	W	V					
9.0	Pre-treatment and Painting	1. Pretreatment Process 2. Process parameters like bath temp. concentration etc. 3. Dipping / Removal Time 4. Surface quality after every dip 5. Primer after phosphating 6. Putty Application & Rubbing after primer 7. Paint first coat 8. Putty Application and Rubbing after first coat of paint 9. Paint second coat	MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Measurement	Periodic	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Measurement	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual, Thickness	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
			MA	Visual, Thickness, Scratch test Colour adhesion	100%	Factory Standard & Relevant standard	Factory Standard & Relevant standard	Log Book	2	---	1					
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LEGEND: * CR - Critical characteristics
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 V - Agency Verifying the Test.


1 - BHEL
 2 - Vendor
 3 - Sub-vendor

 STD QUALITY PLAN NO.: PE-QP-999-145-1056		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										VOLUME IIB SECTION D REV. NO. 01 SHEET 5 OF 7 DATE: 22-02-2008			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$				Remarks		
									P	W	V				
10.	Panel Wiring	1. Wiring Layout 2. Wiring Termination (Crimped Lugs) 3. Ferrule numbers 4. Colour of wiring 5. Size of Conductor	MA MA MA MA MA	Visual Visual Visual Visual Measurement	100% 100% 100% 100% 100%	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs. Approved drgs. & Specs.	Log Book Log Book Log Book Log Book Log Book	2 2 2 2 2	--- --- --- --- ---	--- --- --- 1 1				
11.	Component Mounting	1. Correct components 2. Fixing	MA MA	Visual Visual	100% 100%	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Approved drgs., Specs. & BOM Approved drgs., Specs. & BOM	Log Book Log Book	2 2	--- ---	--- ---				
12.	FINAL Final Inspection	1. Workmanship 2. Component layout (neatness, accessibility & safety) Mounting / Proper fixing of all components 3. Components identification Marking / Name plates	MA MA MA	Visual Visual Visual	100% 100% 100%	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Factory Standard BHEL approved drg. / Spec. BHEL approved drg. / Spec.	Inspection Report Inspection Report Inspection Report	2 2 2	1 1 1	1 1 1		At Random by BHEL, based on 100 % internal test reports by Mfr.		


LEGEND: * CR - Critical characteristics
MA - Major characteristics
MI - Minor characteristics

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V - Agency Verifying the Test.

1 - BHEL
2 - Vendor
3 - Sub-vendor

 STD QUALITY PLAN NO.: PE-QP-999-145-1056		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										VOLUME IIB SECTION D REV. NO. 01 SHEET 6 OF 7 DATE: 22-02-2008			
Sl. No.	Component / operation	Characteristics Checked	* Category	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks			
									P	W	V				
		5. Dimensions	MA	Measurement	100%	BHEL approved drg. / Spec., BOM	BHEL approved drg. / Spec., BOM	Inspection Report	2	1	1	At Random by BHEL, based on 100 % internal test reports by Mfr.			
		6. Door functioning	MA	Functional	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		7. Paint Shade	CR	Visual	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		8. Paint Thickness	CR	Measurement	100%	BHEL approved drg. / Spec.	BHEL approved drg. / Spec.	Inspection Report	2	1	1				
		9. Workmanship of Gaskets	MA	Visual	100%	Factory Standard	Factory Standard	Inspection Report	2	1	1				
		10. Wiring Layout	MA	Visual	100%	BHEL approved drg.	BHEL approved drg.	Inspection Report	2	1	1				
		11. Wire Termination	MA	Pulling manually	Sample	----	Firm termination	Inspection Report	2	1	1				
		12. Continuity	MA	Electrical	100%	----	Continuity OK	Inspection Report	2	1	1				

LEGEND: * CR - Critical characteristics MA - Major characteristics MI - Minor characteristics		\$ P - Agency Performing the Test. W - Agency Witnessing the Test. V - Agency Verifying the Test.		1 - BHEL 2 - Vendor 3 - Sub-vendor	
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<div> PEM :: C&I</div>		STANDARD QUALITY PLAN FOR LOCAL CONTROL PANEL										STD QUALITY PLAN NO.: PE-QP-999-145-1056			
Sl. No.		Component / operation	Characteristics Checked	* Cate gory	Type/Method of Check	Extent of Check	Reference documents	Acceptance Norms	Format of Records	Agency \$			Remarks		
										P	W	V			
SHEET 7		OF 7													
13.	TYPE TEST		Degree of Protection	CR	Mech. Protection	Sample	BHEL approved spec., drg relevant IEC-60947, IEC-60079	BHEL approved spec., drg relevant IEC-60947, IEC-60079	Type Test Certificate	3	---	1			
14	ROUTINE TEST		IR before & after HV Test	CR	Electrical	100%	BHEL approved spec., drg., BOM & relevant standard	BHEL approved spec., drg., BOM & relevant standard	Test Report	2	1	1			
15	FUNCTIONAL TEST		1. Control Logic Operation	CR	Electrical	100%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1			
			2. Instrument Calibration	CR	Electrical	10%	BHEL approved spec. / drg.	BHEL approved spec. / drg.	Inspection Report	2	1	1			
			3. Temperature rise	CR	Electrical	100%	BHEL approved spec/drg. & relevant standard	BHEL approved spec/drg & relevant standard	Inspection Report	2	1	1			

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--	--	---	--	--	--

Specification for Paint 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-EPC-700-001	C	Sheet No. 142

subject to the danger of explosion, the necessary explosion - protected boxes shall be provided in accordance with IEC 79 and VDE 0165/170/171 or equivalent.

17.4.6 Instrument Air Piping/Turbing

All pneumatic tubing connecting the instruments shall be in SS 316 unless otherwise agreed by the Purchaser. All instrument air header lines shall be in GI.

The piping ends shall be plugged prior to transportation

17.4.7 Painting

Inside housed desks, panels, cabinets, racks and other control equipment are to be supplied with the same colour of final painting. External surfaces shall be semi-gloss.

Local mounted cabinets, housing Control & Instrumentation equipment shall be protected against rust and corrosion by a protective coating such as galvanized zinc, which shall be applied as a first factory coat.

In all cases where site erection work exposes bare metal, such as the drilling or punching out of holes for cable or pipe entry, these areas shall be protected by the immediate application of a protective first coat similar to the original.

The shade and grade of paint are to be agreed to by the Purchaser and must harmonize with the overall architectural design.

Any machined or bright faces and parts which are not painted (e.g. of valves, fittings or accessories) must be protected against corrosion by suitable agents prior to installation.

After completion of installation and commissioning but before provisional taking over the Contractor shall make good all marks, scratches and damage to the painted surface of all desks, panels and cabinets irrespective of the cause. The Contractor shall also take every reasonable precaution to prevent damage during the course of erection and commissioning. Repairs to paintwork shall be carried out in such a way so as to restore the equipment to its original factory condition and shall be to the satisfaction of the Purchaser.

17.5.0 General Civil Requirements

The design specification covered in Section 10 of Vol V, establish the minimum basic requirements for all Civil structural and Architectural works. However all structures shall be designed for the satisfactory performance of the function for which the same are to be constructed.

With regard to soil and other hydrographic data furnished, it shall be clearly understood that the same are given to the bidders in good faith and as such no claim for extra payment shall be entertained by the Owner, if the actual condition met with during execution are at variance with the data given in tender. The bidder shall fully satisfy himself about the site conditions, nature of soil, ground water, contour levels, etc. prior to the submission of the bid. The bidder shall conduct his own investigations to ascertain the correctness of the data furnished.

17.5.1 Design Calculations and Drawings

Detailed design calculations / design drawings shall be commenced by Contractor only after approval is obtained from the Owner to the basic design criteria submitted by the Contractor. No deviation from the approved design criteria will be permitted unless specifically approved again by the Owner in writing, prior to its adoption.

FICHTNER
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PROJECT	SUBJECT	TENDER DOC. NO.	REV	SECTION
REPUBLIC OF YEMEN PEC – ME	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.6
400 MW MARIB GTPS – II				SHEET NO.
				16

ANNEX - 1
PAINT SYSTEM - COASTAL AND MARINE ENVIRONMENT

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	ON SITE
1	Structural steel work, piping (oil + water), tanks outside surface, transmiss, towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Intermediate	1	P7	35 100	x	x
				Finish	1	F2	50		x
						Total min. dft	220		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20 20		x x
						Total min. dft	135		
3	Structural steelwork, piping, uninsulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	

FICHT-4803877-v1-Sec-7_6_Cleaning_protective_coating_and_painting_RRB.DOC

APM / ME

FICHTNER
Volume - IV

PROJECT	SUBJECT	TENDER DOC. NO.	REV	SECTION
REPUBLIC OF YEMEN PEC – ME	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.6
400 MW MARIB GTPS – II				SHEET NO.
				17

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	APPLICATION ON SITE
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Intermediate	1	F12	20		x
				Finish	1	F12	20		x
				Prime	2	P6	35	x	
				Finish	1	F6	100		x
5 (a)	Structural steel work in the battery rooms,	Ambient	Sa 3	Total min. dft			170		
				Prime	2	P8	30	x	
				Finish	2	F6	100	x	
				Total min. dft			260		
(b)	Uninsulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2	P3	35	x	
				Finish	2	F6	100	x	
				Total min. dft			270		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	APPLICATION ON SITE
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35 35	x x	
				Finish	2	F6	100 100		x x
						Total min. dft	270		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50	x	
							50	x	
				Finish	2	F3	30 30		x x
						Total min. dft	160		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30	x	
				Finish	3	F7	30	x	
							125 125 125		x x x
						Total min. dft	435		
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125 125 125		x x x
						Total min. dft	500		

FICHT-4803877-v1-Sec-7_6_Cleaning_protective_coating_and_painting_RRB.DOC

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM NO. OF COATS	GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION IN SHOP	ON SITE
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
				Finish	3	F3	50	x	
						Total min. dft	30 30 30 190		x x x
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
				Finish	2	F6	50	x	
						Total min. dft	100 100 300		x x

* For Details of Primer and Finish coats, refer Annex to paint systems.

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SECTION 7.6
CLEANING, PROTECTIVE COATING AND PAINTING

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7.6.0 CLEANING, PROTECTIVE COATING AND PAINTING

7.6.1 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and system. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop
- Cleaning before painting and/or corrosion protection (application of prime coat)
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

Codes and Standards

Internationally recognized codes and standards with purchasers approval shall be followed for the work covered by this contract.

Surface Preparation Standards

The following standards shall be followed for surface preparations:

- Swedish standard Institution - SIS-05 5900-1967 (Surface preparation standards for painting steel surfaces).
- Steel structures painting council, U.S.A. (Surface Preparation Specifications (SSPC-SP).
- British Standards Institution (Surface Finish of Blast cleaned steel for painting) BS-4232.
- National Association of Corrosion Engineers, U.S.A. (NACE).
- Various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

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The contractor shall arrange, at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning
- d) Application of paints and the recommended limit on time intervals between coats.
- e) Shelf life for storage.

Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.

Equipment

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment & air compressors etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange at his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

7.6.2 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Owner is prepared to consider alternative methods provided they achieve the necessary surface condition.

Surface condition:

The Metal surfaces shall be clean and free of mill scale, rust, dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only, abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

Removal of abrasive and debris:

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After cleaning, abrasive and debris shall be thoroughly removed from components.

7.6.3 Alternative Chemical Cleaning at Manufacturer's Works

The procedure shall comprise:

Pre-treatment
Acid treatment

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

7.6.4 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

7.6.5 Weather Conditions

Painting shall be done only when the surface temperature is above 5°C. surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc., before drying, shall be permitted to dry and the damaged area of primer shall be removed and the surface prepared and primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

7.6.6 Surface Preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired, so as to obtain a clean, dry, even surface to receive the priming or finishing coat (s) as called for in the

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painting schedules. Sharp edges should be rounded, especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surfaces should be blast cleaned whenever possible.

Surface preparation methods

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 59 00 or Steel Structures Painting Council, SSPC, Vis 1, or DIN 55928, section 4.

(a) White metal blast cleaning: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal. Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour and correspond in appearance to the prints designated Sa 3.

(b) Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

(c) Commercial Blast Cleaning Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasing is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmesphere for longer life of the paint systems.

(d) Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

The adhesivity of residual coatings in the transition zone has to be tested even after the application of the primer.

(e) very thorough mechanical scraping and wire burshing St 3

St 3 very thorough scraping and wire-burshing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for st 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

(f) Thorough scraping and wire brushing: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned

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with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

Table-1 (Surface Preparation Standards)

Surface preparation method	SIS 055900	DIN 55928, Part 4	BS 4232 only for blasting	SSPC-Vis
blasting acc.to item (a)	Sa 3	first quality	white metal	SP 5
blasting acc. to item (b)	Sa 2 1/2	second quality	near white	SP 10
blasting acc.to item (c)	Sa 2	Third quality	Commercial Blast	SP 6
derusting acc to item (f)	St 2	—	Hand tool/ power tool Cleaning	SP 2
acc. to items (e)	St 3	—	Power tool Cleaning	SP 3
Flame jet cleaning	F1	—	Flame cleaning	SP 4
Pickling	Be	—	Pickling	

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar g at the nozzle shall be used.

After blast-cleaning, all accumulated grit, sand, dust, etc., must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

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In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

7.6.7 Rub Down and Touch up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirit is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

7.6.8 Non Compatible Shop Coat Primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units/equipment, shop primer shall be as per the paint system given for particular environment.

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In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled off before application of tie coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

7.6.9 Paint Materials

Plant and equipment shall be painted according to the colour scheme followed in Phase-I

7.6.10 Storage

All paints and painting material shall be stored only in rooms to be provided by the contractor and approved by Engineer for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separated from adjacent buildings. A signboard bearing the words "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMMABLE - DANGER - NO SMOKING" shall be clearly displayed outside. All paints should be stored in the safest manner so that no container rolls down and causes accidents. The shelf life of the paints should be ensured so that the paint materials are not in storage and use after the date of expiry.

7.6.11 Preparation of Coating Materials

All container shall remain un-opened until required for use.

Primers and paints which have livered, gelled or otherwise deteriorated shall not be used.

The oldest primer or paint of each kind shall be used first.

All ingredients in any container shall be thoroughly mixed before use, and shall be agitated frequently during application to keep the primer in suspension.

Primer or paint mixed in the original container shall not be transferred until all settled pigment is incorporated into the body of the liquid.

Mixing in open containers shall be done in a well ventilated area.

Primer or paint shall be mixed in a manner ensuring the breakdown of all lumps, complete dispersion of pigment and uniform composition.

Two-component primers shall be mixed in accordance with the manufacturer's instructions.

Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions.

When use of thinners is permitted, it must be added to the primer or paint during mixing.

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7.6.12 Application

Health and safety of work

The supplier has to check all painting work to be carried out according to the specification of the paint supplier further to all relevant prescriptions and regulations concerning the health and safety of work.

The paint supplier has to present a written specification including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.

7.6.13 Safety Requirements

Protection of the blast cleaner operator's eyes and respiratory system should be given prime consideration in any open blast cleaning operation. Airfed helmets, respiratory filters, air conditioned hoods etc. should be provided in sufficient number to the blast cleaning operators to avoid the harmful effect of blast cleaning abrasives. Also, an automatic shut-off device which will shut-off the air supply to the blasting machine should be installed which will prevent the dangerous whipping of an operating blast hose if an operator becomes disabled.

Methods

Temporary corrosion protections are to be completely removed prior to applying the definite one.

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.

All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not be painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

7.6.14 Dry Film Thickness (DFT)

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To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following table. The dft is given in microns (millionths of a metre).

7.6.15 Protective Coatings and Paint Systems

The type and number of protective coats for any item requiring painting are to be in accordance in the attached tables "Paint Systems" (Annex-1).

Alternative to the 'paint system' specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.

7.6.16 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the requirements of Phase-I.

Ground Colour shall be applied throughout the entire length for uninsulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc. Ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

- At battery limit points
- Intersection points & change of direction points in piping ways.
- Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.
- For long stretch/yard piping at 50 M interval.
- At start and terminating points.

Identification Sign

Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer.

Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed. The size of the arrows shall confirm to relevant standards.

Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer.

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Colour Bands

The width of colour band shall conform to the requirements of Phase-I

Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes shall be made as per the requirements of Phase-I

7.6.17 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stenciled on all the pipe lines of more than one location as directed by Engineer, size of letters printed shall be as per applicable codes & standards

Identification of storage tanks: The storage tanks shall be marked as detailed in the respective drawing.

7.6.18 Inspection and Testing

All painting materials including primers and thinners brought to site by the contractor for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batchwise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor.

The paints shall be tested as per applicable codes & standards approved by the Owner.

The painting work shall be subject to inspection by Engineer at all times. In particular, following stagewise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- a. Surface preparation
- b. Primer application
- c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra coat to owner.

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7.6.19 Primer Application

After surface preparation, the primer should be worked by brush application to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer.

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Elcometer for measuring the Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting, Holiday detectors and pinhole detectors for checking the painted surface discontinuities should be provided by the contractor.

At the request of Engineer, the contractor shall make arrangements for paint manufacturer to provide expert technical service at site as and when required. This service should be free of cost and without any obligation to the Purchaser, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

Final inspection shall include measurement of paint dry film thickness, check of finish and workmanship. The thickness should be measured at as many points/locations as decided by the Engineer and shall be within + 10% of the dry film thickness.

7.6.20 Guarantee

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

7.6.21 Scope of areas to be Painted and Painting Systems

The paint system adopted shall be suitable for Coastal and Marine environment as given in Annex - 1.

Primers and finish coats for any particular paint system shall be from same manufacturer in order to ensure compatibility.

7.6.22 Galvanizing

Galvanizing works shall conform in all respect to applicable standards and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with applicable standards.

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Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably by blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with relevant applicable standards. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants. The weight of zinc coating per unit area has to be noted in the manufacturing documents.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m².

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor is achieved. care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts shall be hot dip galvanized and subsequently centrifuged. Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is to be done as per the relevant standards.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with relevant standards.

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with applicable codes, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with relevant standards.

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After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

7.6.23 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminium on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to relevant applicable standards. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, millscale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable roughness can be achieved by blast cleaning acc. to BS 4232. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to relevant standards.

Testing of the spray coated layer are to be carried out in accordance with relevant standards.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating acc. to relevant applicable standards including the corresponding warranties and tests if sprayed metal coating will be applied.

7.6.24 Safety of Work

All precautions connected with this type of application of corrosion protection have to be in accordance with relevant standards.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to relevant standards.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding using e.g. scotch britt to turn the foam to grey color,
- steam blasting,

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ANNEX - 1

PAINT SYSTEM - COASTAL AND MARINE ENVIRONMENT

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM		GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS			IN SHOP	ON SITE
1	Structural steel work, piping (oil + water), tanks outside surface, transmiss, towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Intermediate	1	P7	35 100	x	x
				Finish	1	F2	50		x
						Total min. dft	220		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20 20		x x
						Total min. dft	135		
3	Structural steelwork, piping, uninsulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION					
				COAT	NO. OF COATS				IN SHOP	ON SITE				
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Intermediate	1		F12	20		x				
				Finish	1		F12	20 115		x				
				Prime	2		P6	35	x					
								35	x					
				Finish	1		F6	100		x				
Total min. dft							170							
5 (a)	Structural steel work in the battery rooms,	Ambient	Sa 3	Prime	2		P8	30 30	x x					
				Finish	2		F6	100 100		x x				
				Total min. dft							260			
				(b)	Uninsulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2		P3	35 35	x x	
								Finish	2		F6	100 100		x x
Total min. dft							270							

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM		GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS			IN SHOP	ON SITE
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35 35	x x	
				Finish	2	F6	100 100		x x
						Total min. dft	270		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50 50	x x	
				Finish	2	F3	30 30		x x
						Total min. dft	160		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30 30	x x	
				Finish	3	F7	125 125 125		x x x
						Total min. dft	435		
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125 125 125 125		x x x x
						Total min. dft	500		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	COAT	PAINT SYSTEM		PER COAT MICRONS Dft	APPLICATION	
					NO. OF COATS	GENERIC TYPE		IN SHOP	ON SITE
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
							50	x	
				Finish	3	F3	30		x
							30		x
							30		x
						Total min. dft	190		
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
							50	x	
				Finish	2	F6	100		x
							100		x
						Total min. dft	300		
* For Details of Primer and Finish coats, refer Annex to paint systems.									