	QUALITY PLAN	CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
		BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION TITLE			
	SHEET 1 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	AGENCY W	AGENCY V	REMARKS
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**			**11**
1.0	ASSEMBLY	1.WORKMANSHIP	MA	VISUAL	100%	MANUF'S SPEC	MANUF'S SPEC	-DO-	2	-	-	
		2.DIMENSIONS	MA	-DO-	-DO-	MFG. DRG./ MFG. SPEC.	MFG. DRG./ MFG. SPEC.	-DO-	2	-	-	
		3.CORRECTNESS COMPLETENESS TERMINATIONS/ MARKING/COLOUR CODE	MA	VISUAL	100%	MFG.SPEC./ RELEVANT IS	MFG.SPEC. RELEVANT IS	-DO-	2	-	-	
2.0	PAINTING	1.SHADE	MA	VISUAL	SAMPLE	MANUFR'S SPEC/BHEL SPEC./RELEVANT 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%	IS-325/ 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 IS	INSPN. REPORT	2	1	-	NOTE -1 & NOTE-3
BHEL			**PARTICULARS**		**BIDDER/VENDOR**							
			NAME									
			SIGNATURE									

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :			
			BIDDER/ VENDOR :			QUALITY PLAN NUMBER PED-506-00-Q-006, REV-01			SPECIFICATION : TITLE :			
		SHEET 2 OF 2	SYSTEM			ITEM AC ELECT. MOTORS BELOW 55KW (LV)			SECTION			VOLUME III
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY P	W	V	REMARKS
1	2	3	4	5	6	7	8	9	10			11
		3.NAMEPLATE DETAILS	MA	VISUAL	100%	IS-325 & DATA SHEET	IS-325 & DATA SHEET	INSPN. REPORT	2	1	-	

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.

Legends for Inspection agency

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

GENERAL TECHNICAL REQUIREMENTS

FOR

LV MOTORS

SPECIFICATION NO.: PE-SS-999-506-E101 Rev 00

1.0 INTENT OF SPECIFIATION

The specification covers the design, materials, constructional features, manufacture, inspection and testing at manufacturer's work, and packing of Low voltage (LV) squirrel cage induction motors along with all accessories for driving auxiliaries in thermal power station.

Motors having a voltage rating of below 1000V are referred to as low voltage (LV) motors.

2.0 CODES AND STANDARDS

Motors shall fully comply with latest edition, including all amendments and revision, of following codes and standards:

IS:325	Three phase Induction motors
IS : 900	Code of practice for installation and maintenance of induction motors
IS: 996	Single phase small AC and universal motors
IS: 4722	Rotating Electrical machines
IS: 4691	Degree of Protection provided by enclosures for rotating electrical machines
IS: 4728	Terminal marking and direction of rotation rotating electrical machines
IS: 1231	Dimensions of three phase foot mounted induction motors
IS: 8789	Values of performance characteristics for three phase induction motors
IS: 13555	Guide for selection and application of 3-phase A.C. induction motors for different types of driven equipment
IS: 2148	Flame proof enclosures for electrical appliance
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 12824	Type of duty and classes of rating assigned
IS: 12802	Temperature rise measurement for rotating electrical machnines
IS: 12065	Permissible limits of noise level for rotating electrical machines
IS: 12075	Mechanical vibration of rotating electrical machines

In case of imported motors, motors as per IEC-34 shall also be acceptable.

3.0 DESIGN REQUIREMENTS

3.1 Motors and accessories shall be designed to operate satisfactorily under conditions specified in data sheet-A and Project Information, including voltage & frequency variation of supply system as defined in Data sheet-A

3.2 Motors shall be continuously rated at the design ambient temperature specified in Data Sheet-A and other site conditions specified under Project Information
Motor ratings shall have at least a 15% margin over the continuous maximum demand of the driven equipment, under entire operating range including voltage & frequency variation specified above.

3.3 Starting Requirements

3.3.1 Motor characteristics such as speed, starting torque, break away torque and starting time shall be properly co-ordinated with the requirements of driven equipment. The accelerating torque at any speed with the minimum starting voltage shall be at least 10% higher than that of the driven equipment.

3.3.2 Motors shall be capable of starting and accelerating the load with direct on line starting without exceeding acceptable winding temperature.

The limiting value of voltage at rated frequency under which a motor will successfully start and accelerate to rated speed with load shall be taken to be a constant value as per Data Sheet - A during the starting period of motors.

3.3.3 The following frequency of starts shall apply

i) Two starts in succession with the motor being initially at a temperature not exceeding the rated load temperature.

ii) Three equally spread starts in an hour the motor being initially at a temperature not exceeding the rated load operating temperature. (not to be repeated in the second successive hour)

iii) Motors for coal conveyor and coal crusher application shall be suitable for three consecutive hot starts followed by one hour interval with maximum twenty starts per day and shall be suitable for mimimum 20,000 starts during the life time of the motor

3.4 **Running Requirements**

3.4.1 Motors shall run satisfactorily at a supply voltage of 75% of rated voltage for 5 minutes with full load without injurious heating to the motor.

3.4.2 Motor shall not stall due to voltage dip in the system causing momentary drop in voltage upto 70% of the rated voltage for duration of 2 secs.

3.5 **Stress During bus Transfer**

3.5.1 Motors shall withstand the voltage, heavy inrush transient current, mechanical and torque stress developed due to the application of 150% of the rated voltage for at least 1 sec. caused due to vector difference between the motor residual voltage and the incoming supply voltage during occasional auto bus transfer.

3.5.2 Motor and driven equipment shafts shall be adequately sized to satisfactorily withstand transient torque under above condition.

3.6 Maximum noise level measured at distance of 1.0 metres from the outline of motor shall not exceed the values specified in IS 12065.

3.7 The max. vibration velocity or double amplitude of motors vibration as measured at motor bearings shall be within the limits specified in IS: 12075.

4.0 **CONSTRUCTIONAL FEATURES**

4.1 Indoor motors shall conform to degree of protection IP: 54 as per IS: 4691. Outdoor or semi-indoor motors shall conform to degree of protection IP: 55 as per IS: 4691and shall be of weather-proof construction. Outdoor motors shall be installed under a suitable canopy

4.2 Motors upto 160KW shall have Totally Enclosed Fan Cooled (TEFC) enclosures, the method of cooling conforming to IC-0141 or IC-0151 of IS: 6362.

Motors rated above 160 KW shall be Closed Air Circuit Air (CACA) cooled

4.3 Motors shall be designed with cooling fans suitable for both directions of rotation.

4.4. Motors shall not be provided with any electric or pneumatic operated external fan for cooling the motors.

4.5 Frames shall be designed to avoid collection of moisture and all enclosures shall be provided with facility for drainage at the lowest point.

4.6 In case Class 'F' insulation is provided for LV motors, temperature rise shall be limited to the limits applicable to Class 'B' insulation.
In case of continuous operation at extreme voltage limits the temperature limits specified in table-1 of IS:325 shall not exceed by more than 10°C.

4.7 **Terminals and Terminal Boxes**

4.7.1 Terminals, terminal leads, terminal boxes, windings tails and associated equipment shall be suitable for connection to a supply system having a short circuit level, specified in the Data Sheet-A.

Unless otherwise stated in Data Sheet-A, motors of rating 110 kW and above will be controlled by circuit breaker and below 110 kW by switch fuse-contactor. The terminal box of motors shall be designed for the fault current mentioned in data sheet "A".

4.7.2 unless otherwise specified or approved, phase terminal boxes of horizontal motors shall be positioned on the left hand side of the motor when viewed from the non-driving end.

4.7.3 Connections shall be such that when the supply leads R, Y & B are connected to motor terminals A B & C or U, V & W respectively, motor shall rotate in an anticlockwise direction when viewed from the non-driving end. Where such motors require clockwise rotation, the supply leads R, Y, B will be connected to motor terminals A, C, B or U W & V respectively.

4.7.4 Permanently attached diagram and instruction plate made preferably of stainless steel shall be mounted inside terminal box cover giving the connection diagram for the desired direction of rotation and reverse rotation.

4.7.5 Motor terminals and terminal leads shall be fully insulated with no bar live parts. Adequate space shall be available inside the terminal box so that no difficulty is encountered for terminating the cable specified in Data Sheet-A.

4.7.6 Degree of protection for terminal boxes shall be IP 55 as per IS 4691.

4.7.7 Separate terminal boxes shall be provided for space heaters.. If this is not possible in case of LV motors, the space heater terminals shall be adequately segregated from the main terminals in the main terminal box. Detachable gland plates with double compression brass glands shall be provided in terminal boxes.

4.7.8. Phase terminal boxes shall be suitable for 360 degree of rotation in steps of 90 degree for LV motors.

4.7.9 Cable glands and cable lugs as per cable sizes specified in Data Sheet-A shall be included. Cable lugs shall be of tinned Copper, crimping type.

4.8 Two separate earthing terminals suitable for connecting G.I. or MS strip grounding conductor of size given in Data Sheet-A shall be provided on opposite sides of motor frame. Each terminal box shall have a grounding terminal.

4.9 **General**

4.9.1 Motors provided for similar drives shall be interchangeable.

4.9.2 Suitable foundation bolts are to be supplied alongwith the motors.

4.9.3 Motors shall be provided with eye bolts, or other means to facilitate safe lifting if the weight is 20Kgs. and above.

4.9.4 Necessary fitments and accessories shall be provided on motors in accordance with the latest Indian Electricity rules 1956.

4.9.5 All motors rated above 30 kW shall be provided with space heaters to maintain the motor internal air temperature above the dew point. Unless otherwise specified, space heaters shall be suitable for a supply of 240V AC, single phase, 50 Hz.

4.9.6 Name plate with all particulars as per IS: 325 shall be provided

4.9.7 Unless otherwise specified, the colour of finish shall be grey to Shade No. 631 and 632 as per IS:5 for motors installed indoor and outdoor respectively. The paint shall be epoxy based and shall be suitable for withstanding specified site conditions.

5.0 INSPECTION AND TESTING

5.1 All materials, components and equipments covered under this specification shall be procured, manufactured, as per the BHEL standard quality plan No. PED-506-00-Q-006/0 and PED-506-00-Q-007/2 enclosed with this specification and which shall be complied.

5.2 LV motors of type-tested design shall be provided. Valid type test reports not more than 5 year shall be furnished. In the absence of these, type tests shall have to be conducted by manufacturer without any commercial implication to purchaser.

5.3 All motors shall be subjected to routine tests as per IS: 325 and as per BHEL standard quality plan.

5.4 Motors shall also be subjected to additional tests, if any, as mentioned in Data Sheet A.

6.0 DRAWINGS TO BE SUBMITTED AFTER AWARD OF CONTRACT

a) OGA drawing showing the position of terminal boxes, earthing connections etc.
b) Arrangement drawing of terminal boxes.
c) Characteristic curves:
(*To be given for motor above 55 kW unless otherwise specified in Data Sheet*).

i) Current vs. time at rated voltage and minimum starting voltage.
ii) Speed vs. time at rated voltage and minimum starting voltage.
iii) Torque vs. speed at rated voltage and minimum voltage.
For the motors with solid coupling the above curves i), ii), iii) to be furnished for the motors coupled with driven equipment. In case motor is coupled with mechanical equipment by fluid coupling, the above curves shall be furnished with and without coupling.
iv) Thermal withstand curve under hot and cold conditions at rated voltage and max. permissible voltage.

SECTION-C4

C&I SPECIFICATION

C&I SPECIFICATIONS

FOR

AIR CONDITIONING SYSTEM

FOR

2X500MW NNTPP (TG & SG PACKAGE)

Specific Technical Requirements (C&I):

1.0 The control of Air Conditioning System Plant shall be through PLC based control system having hot redundant Central Processing Unit. The control of Ventilation system shall also be through above PLC based system. The operation and control philosophy of Air Conditioning System and Ventilation system has been elaborated in separate section in the specification. The PLC shall be common for both units, and shall be located in AC Plant Room. One no. OWS with 21" TFT monitor per unit and one no. laptop with Engg. Softwares per PLC shall be provided by the bidder for operation & monitoring of the Air Conditioning System and Ventilation system. It shall be possible to use the same OWS as programming station. Bidder to provide one number A4 size color laser printers per unit. Bidder shall provide number of remote I/O panels as required for control of the system. Bidder shall include in his scope Remote I/O panels required for Air Washer Room in power house building and UAF in ESP control rooms for both units. The Remote I/O panel shall be suitable for working in Non-A/C environment. Local panel/posts for start/stop of AWU & UAF shall also be in bidder's scope. The Complete PLC based control system with OWS, Laptop, Remote I/Os, Printer, UPS (for PLC, OWS, Remote I/Os, Printer etc.), desk along with furniture for Air Conditioning System and Ventilation system shall be in Bidder's scope. PC for OWS shall be of workstation grade.

1.1 Bidder to consider I/Os for ventilation system in offered PLC. Same shall be finalized during detail engg.

1.2 Bidder to keep the provision for accepting fire signals from Fire Alarm & Protection System and the closure of relevant fire dampers in Air Conditioning and Ventilation System.

1.3 The communication between PLC and Main plant DCS shall be OPC compliant (Data Access 2.0) TCP/IP on Fibre Optic link. The communication link between PLC and Main plant DCS shall be redundant. The necessary hardware/software including LIU (Light Interface unit) at PLC end shall be in Bidder's scope. Repeaters if required for interfacing shall also be provided by the bidder. For communication between main plant DCS and PLC, the PLC end shall be considered as server and DCS shall be considered as client.

1.4 PLC control system shall be time synchronized with the Master clock system of the main plant to ensure uniform time indication throughout the Plant. The required provision (IRIG-B) shall be made by the bidder at the PLC end to achieve the same.

1.5 The software and hardware for offered PLC system shall be of latest version and shall be upgradable. Bidder to ensure the availability of spares and service support for the offered PLC system for minimum 10 years after guarantee period.

1.6 All electrical actuators shall be of non-integral starter type.

1.7 The make/model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict and repetition of clauses in the specification, the more stringent requirements among them are to be complied with.

1.8 The solenoid valves shall have limit switches for open/close feedback.

1.9 Interface of MCC, HT SWGR, field instruments, Actuators etc. with PLC based control system shall be as per Drive Control Philosophy attached in the specification.

1.10 All the instruments/drives shall be terminated on JBs/Panels in field. JBs/Panels shall be in Bidder's scope.

1.11 Soft link connectivity between microprocessor based panels (VAM/Chillers) & DCS is required for monitoring & is in bidder scope.

1.12 LPB station for start/stop & open/close shall be provided for testing & maintenance facility.

1.13 Scope of Instrumentation cables (Screened Control Cables), Fibre Optic cable & Control cables shall be as per Electrical Cable scope matrix in Electrical portion of specification.

1.14 UPS (Common) for PLC & OWS shall be in bidder’s scope with 2X100% configuration. UPS shall have 2X100%, Lead Acid Plante type battery bank with 30 min back up.

1.15 Bidder to provide Customer training for 1 week for 4 persons on PLC Hardware & Software.

1.16 Following documents to be furnished by the bidder along with the bid:

- PLC configuration diagram.
- Duly stamped and signed copy of Quality Plan.
- Requirement of electronic earthing, if any, for PLC based control system

1.17 Drawings/Documents and data to be furnished after award of the contract:

- Input/Output signal list.
- BOM of PLC.
- Control panel/control desk/charger panel/battery GA drawings.
- Power distribution scheme.
- PLC control room layout drawing.
- PLC and field instruments quality plan.
- PLC data sheet.
- Cable schedule and cable interconnection drawing.
- Instrument schedule.
- Instrument Data sheets.
- Plant schematic for monitoring & operation shall be available on OWS, bidder to further submit list of important signal along with applicable schematic for monitoring in DCS.
- Any other document decided during detailed engineering.

1.18 Industrial grade furniture required for placing OWS & printer shall be in bidder's scope. Industry standard revolving chairs with wheels and with provision for adjustments of height (hydraulically/gas lift) shall be provided for the operators in local control room area. Chair pedestal shall be made of 5mm thick MS plate covered with poly-propylene cladding. Arm-rests in one piece shall be of poly-urethane and twin wheel castor of glass filled nylon. The exact details shall be finalized & approved by owner/purchaser during detailed engineering.

All furniture shall be from reputed suppliers like Rittal / Godrej Pyrotech or equivalent as approved by owner/purchaser.

Sl.No	Description	Unit	Qty.	Remarks
1.18.1	Complete set of control valve each size and type with actuator and its control	%	5	
1.18.2	**Control valves internals**			
1.18.2.1	Valve stem with plug & seat ring each size and type	Nos	2	
1.18.2.2	Gasket of each type and Size	Nos	5	
1.18.2.3	Body seal gaskets of each size and type	Nos	5	
1.18.2.4	Cage of each size and type	Nos	1	
1.18.2.5	Gland packing each size and type	Sets	5	
1.18.2.6	Valve Trim of each size and type	Nos.	1	
1.19	Actuator internals			
1.19.1	Complete set of control valve each size and type with actuator and its control	%	5	
1.19.2	Diaphragm of each type and size	%	5	
1.19.3	Seal box "O" ring of each type and size	%	5	
1.19.4	Color "O" ring of each type and size	%	5	
1.19.5	Limit switch (complete instrument) of each model and type	%	5	
1.19.6	Solenoid valve (complete instrument) of each model and type	%	5	
1.19.7	Valve positioned (complete instrument) of each model and type	%	5	
1.19.8	Position transmitters (complete instrument) of each model and type	%	5	
1.19.9	Air set / regulator with gauge	%	5	
1.19.10	Air lock relay	%	5	
1.19.11	Air booster / accumulator	%	5	
1.20	**HVAC system**			
1.20.1	Humidistat	no	2	
1.20.2	Pr. Gauge of each type and range	%	5	
1.20.3	Temperature gauge of each type and range	%	5	
1.20.4	Level switches of each type and range	Nos	2	
1.20.5	Solenoid valves of each type and range	Nos	2	
1.20.6	Flow meter of each type and range	Nos	2	
1.20.7	Flow Switch of each type	Nos	2	
1.20.8	Thermostat of each type	No	2	
1.20.9	PLC and its cards (if applicable)	%	10	

PLC & its Cards means all types of cards/ modules of PLC including CPU, power supply modules, interface modules, converter modules, I/O modules, relays, MCBs, fuses, terminal blocks, converters etc.

Any other equipment not specifically mentioned for Turbo generator area but necessary for operation of the plant shall be finalized at the end of detail engineering.

LIST OF VENDOR DELIVERABLES FOR C&I FOR AC & VENTILATION SYSTEM (2 X 500 MW NNTPP- TG & SG PACKAGE)						
		DOCUMENT NUMBER PE-GL-400/402-145-I100			SHEET	1 of 1
Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CAT OF APPROVAL BHEL	FROM	USER	REMARKS
		INSTRUMENTATION				
1	PE-V9-400-553-I901	INSTRUMENT DATA SHEETS	A	VENDOR	C&I	
2	PE-V9-400-553-I902	INSTRUMENT SCHEDULE	I	VENDOR	C&I	
3	PE-V9-400-553-I903	INSTRUMENT HOOK UP	A	VENDOR	C&I	
4	PE-V9-400-553-I904	FIELD JB TERMINATIONS	I	VENDOR	C&I	
5	PE-V9-400-553-I905	QUALITY PLANS/CHECK LISTS (For all applicable instruments)	A	VENDOR	C&I	
		PLC PANEL				
1	PE-V9-400-553-I911	PLC DATASHEET	A	VENDOR	C&I	
2	PE-V9-400-553-I912	PLC CONFIGURATION DRAWING	A	VENDOR	C&I	
3	PE-V9-400-553-I913	PLC PANEL GA (INTERNAL & EXTERNAL)	A	VENDOR	C&I	
4	PE-V9-400-553-I914	CONTROL SCHEMES (BLOCK LOGIC)	A	VENDOR	C&I	
5	PE-V9-400-553-I915	PLC INPUT / OUTPUT SIGNAL LIST	I	VENDOR	C&I	
6	PE-V9-400-553-I916	UPS BATTERY CHARGER/ BATTERY DATASHEET & SLD	I	VENDOR	C&I	$$- Refer Notes Below
7	PE-V9-400-553-I917	UPS SIZING CALCULATIONS	I	VENDOR	C&I	
8	PE-V9-400-553-I918	BATTERY SIZING CALCULATIONS	I	VENDOR	C&I	
9	PE-V9-400-553-I919	CONTROL DESK LAYOUT / GA DRAWING	A	VENDOR	C&I	IF APPLICABLE
10	PE-V9-400-553-I920	PLC-OWS/PRINTER FURNITURE BOM	A	VENDOR	C&I	
11	PE-V9-400-553-I921	PLC CONTROL ROOM LAYOUT DRAWING	A	VENDOR	C&I	
12	PE-V9-400-553-I922	PLC CATALOGUE	I	VENDOR	C&I	
13	PE-V9-400-553-I923	PLC QUALITY PLAN & FAT PROCEDURE	A	VENDOR	C&I	
14	PE-V9-400-553-I924	LIST OF SIGNAL EXCHANGE WITH DCS (BOTH HARDWIRED & SERIAL INTERFACE IN BHEL FORMAT)	A	VENDOR	C&I	
15	PE-V9-400-553-I925	PROCESS GRAPHIC MANUSCRIPTS PLC	I	VENDOR	C&I	
16	PE-V9-400-553-I926	PROCESS GRAPHIC MANUSCRIPTS FOR DCS	I	VENDOR	C&I	
17	PE-V9-400-553-I927	CABLE SCHEDULE & INTERCONNECTION	I	VENDOR	C&I	
18	PE-V9-400-553-I928	ANNUNCIATION LIST	A	VENDOR	C&I	
19	PE-V9-400-553-I929	POWER DISTRIBUTION SCHEME	A	VENDOR	C&I	
20	PE-V9-400-553-I930	PANEL & ELECTRONIC EARTHING REQUIREMENT	I	VENDOR	C&I	
21	PE-V9-400-553-I931	PANEL HEAT DISSIPATION DATA	I	VENDOR	C&I	
22	PE-V9-400-553-I932	BILL OF MATERIAL INCLUDING MANDATORY SPARES	A	VENDOR	C&I	
23	PE-V9-400-553-I933	PLC O&M MANUAL	I	VENDOR	C&I	
24	PE-V9-400-553-I934	VIBRATION MONITORING SYSTEM GA/LAYOUT, DATASHEETS, WIRING DIAGRAM,BOQ,TRANSDUCER MOUNTING PAD DRAWING	A	VENDOR	C&I	IF APPLICABLE
	Notes:					
		$$ - Approval by BHEL if Vendor BBU Item Approval by Customer if Customer BBU Item				

FORM NO. PEM-6666-0

	SPECIFICATION FOR MOTORISED VALVE ACTUATOR	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		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	
	OFFER REFERENCE	
	* TAG NO. SERVICE	
	* DUTY	☐ ON / OFF ☐ INCHING
	* LINE SIZE (inlet/outlet): MATERIAL	
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ 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, DUST TIGHT, WEATHER PROOF, IP:67
	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 90% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. FOR REGULATING SERVICE - 150 STARTS/HR MINIMUM
HANDWHEEL	* REQUIRED	■ YES ☐ NO
	* ORIENTATION	☐ TOP MOUNTED ☐ 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	IE1 TYPE AS PER IS: 12615, SQUIRREL CAGE INDUCTION MOTOR SUITABLE FOR DOL STARTING.
	ACTUATOR APPLICABLE WIRING DIAGRAM	■ ENCLOSED (BIDDER TO CONFIRM) ■ DRG. NO. 4-V-MISC-90271 R11
	COLOUR SHADE	■ BLUE (RAL 5012), To be decided during detail engg.
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ■ EPOXY ☐ …….
	SHAFT RPM	BIDDER TO SPECIFY
	OLR SET VALUE	BIDDER TO SPECIFY
	@ STARTING / FULL LOAD CURRENT	600% OF FLC INCLUSIVE OF **I.S.** TOLERANCE
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC / DOL STARTER
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V
	@ ENCLOSURE CLASS OF MOTOR	■ IP 67 ☐ FLAME PROOF
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		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)
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	☐ REQUIRED ■ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	☐ CONTACTORS ☐ THYRISTORS	
	TYPE	☐ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐……	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	☐ REQUIRED	
	OPEN / CLOSE PB	☐ REQUIRED ☐ NOT REQUIRED	
	STOP PB	☐ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	☐ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	☐REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	☐ REQUIRED ☐ 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/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ☐ EITHER	
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	■1 No ☐2 Nos. / 2 Nos. (ADJ.) / ■1 No. ☐2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.:
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		SECTION
		REV. NO. / DATE:
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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 & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	
	SUPPLY	■ 24V DC ☐ ……	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING	FOR MOTORS WITH RATING >30 KW	
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@☐ IP 68 @☐……	
	@ EARTHING TERMINAL	8 SWG GI WIRE	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	☐ REQUIRED ■ NOT REQUIRED☐ ☐ 2 NOS. ☐ ----------	
CABLE GLANDS	@ POWER CABLE GLAND	SIZE:DDE	
	@ SPACE HEATER CABLE GLAND	SIZE:DDE	
	OTHER CONTROL CABLE GLANDS-1	☐ 1No. for BFV of CW PUMP(Cable size 2Px1.5mm2)	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE: 1no., 2.5 sq. mm	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

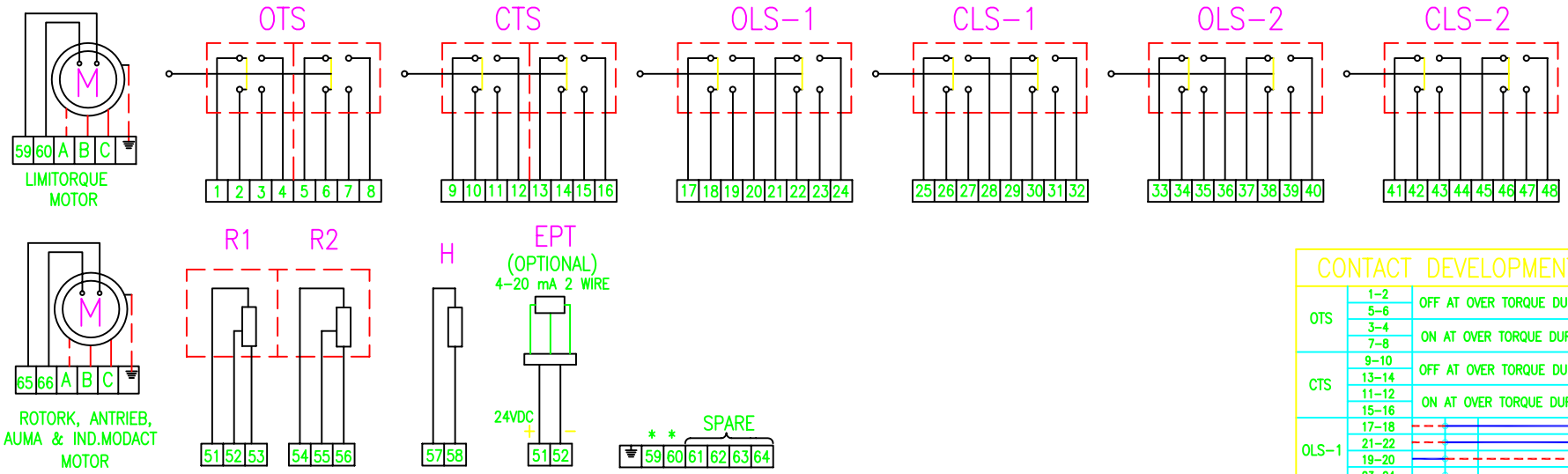
1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691, IS 12615 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL, WITH NICKEL COATING SHALL BE PROVIDED.
5. 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.
6. 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%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.

$$ TORQUE SWITCH & LIMIT SWITCH SHALL ACT INDEPENDENT OF EACH OTHER. TANDEM OPERATION IS NOT ACCEPTABLE.

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

	PREPARED BY	CHECKED BY	APPROVED BY	VENDOR COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				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 TRAMSMITTER (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 SWITCHS IN ANTRIEB & LIMITORQUE

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

SETTING PROCEDURE OF POSITION LIMIT AND TORQUE SWITCH

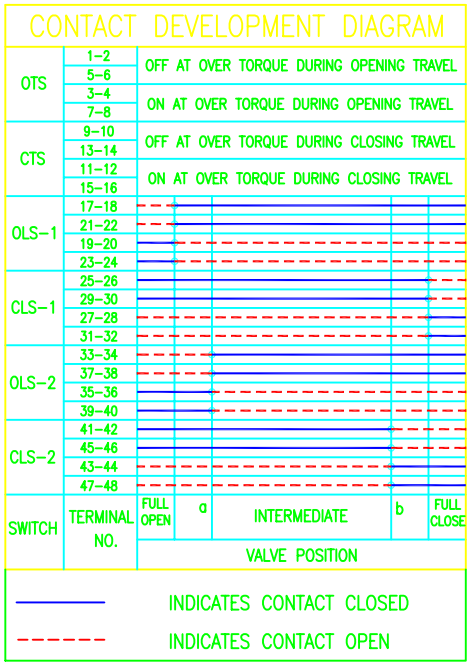
VALVES	OPEN		CLOSE	
	MAIN	BACK UP	MAIN	BACK UP
GATE VALVE OF 100 mm AND ABOVE IN 1500 CL AND ABOVE RATINGS	OLS	OTS	CLS	CTS
ALL OTHER GATE & GLOBE VALVES	OLS	OTS	CTS	@

@ – CLS NOT TO BE CONNECTED IN TRIP CIRCUIT

NOTE:

1. BYPASS OTS FOR INITIAL 5% OF TRAVEL (FOR GATE VALVES ONLY)
2. CONNECT THERMOSTAT WITHOUT FAIL IN THE STARTER CIRCUIT

CONTACT DEVELOPMENT DIAGRAM



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

REV	DATE	CHED	APPD	DESCRIPTION
11	09.09 2000			CONTACT DEV. FIG.ADDED.

BHARAT HEAVY ELECTRICALS LTD.
UNIT: HIGH PRESSURE BOILER PLANT.
TIRUCHIRAPALLI 620014.

365-139

DRAWN	N.P.ESWAR
CHECKED	K.ARUNACHALAM
APPROVED	P.LOGANATHAN
DATE	09.09.2000

TITLE

INTERNAL WIRING DIAGRAM
FOR
ELECTRICAL VALVE ACTUATORS (AC)
(DRAWN FOR INTERMEDIATE POSITION OF VALVES)

DRAWING No. 4-V-MISC-90271 REV 11

RETRACED WITH REVISION 11

9. FIELD INSTRUMENTS & FINAL CONTROL ELEMENTS

9.1 General Requirements

1. Measuring instruments/equipment and subsystems offered by the Contractor shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to owner's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, make/ numbers as approved by the owner during detailed engineering.
2. Every panel mounted instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
3. All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided.
4. The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors, switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapings where the pressure exceeds 40 kg/sq cm.
5. For protection purposes, transmitters can be considered in place of switches.

9.2 Pressure / Differential Pressure / Flow / Level Transmitter

Table 9.1

Specifications for Pressure / Differential Pressure / Flow / Level Transmitter

S.N	Features	Minimum Requirements
1	Type	Microprocessor based 2 wire type, HART protocol compatible
2	Sensor Type	Capacitive/ Piezo-electric
3	Output Signal	4-20 mA signals superimposed with HART signal.
4	Signal Processing Unit	Microprocessor based
5	Overpressure	150% of max. operating pressure. For vacuum service, the element shall have under – range protection to full vacuum
6	Turn-down Ratio	10:1 for vacuum / very low pressure applications. 100:1 for other applications.
7	Stability	± 0.1% of calibrated span for six months up to 70 Kg/cm² and ± 0.25% for range more than 70 Kg/cm²(g).
8	Span and Zero drift	± 0.015% per deg. C at max span & 0.11% per deg. C at min. span.
9	Enclosure Class	Weather proof as per IP 67 with corrosion resistance coating. For hazardous area explosion proof enclosure as described in NEC article 500
10	Zero & span adjustability	Continuous, tamper proof, remote as well as manual from instrument with zero suppression and elevation facility.
11	Local Indicator	To be provided
12	Display	Digital LCD Integral Display (minimum 5 digit) Engineering Unit
13	Process connection	½" NPT (F)
14	Electrical connection	½" NPT
15	MOC of Electrical Housing	Aluminum Alloy or better
16	Ambient Temperature	65 Deg. C
17	Operating Voltage	16 – 48 Volts DC
18	Load	600 Ohms (minimum) at 24 Volts DC
19	Accuracy	± 0.075% of span or better
20	Response Time	100 milli-second or better
21	Adjustment/ calibration/ maintenance	Centralised PC based system maintenance per clause.

1. All transmitters shall be equipped with all necessary accessories like valve manifolds, mounting bracket etc. Pulsation dampeners shall be used where the process media is unstable for measurement such as at the discharge of a pump. For absolute pressure transmitter, 2 valve manifold; for gauge / vacuum pressure transmitter, 3 valve manifold and

for DP / level / flow transmitter, 5 valve manifold shall be provided. In case if it becomes necessary to use a DP transmitter for pressure measurement then a 3 valve manifold shall be used in place of 2 valve manifold.

2. Pressure transmitter shall have easily accessible span, zero and time constant adjustments. A range suppression / elevation device shall be provided wherever required.

3. For pressure / differential pressure transmitter, proof pressure shall be 200% of maximum static process pressure.

4. All transmitter cases shall be dust – tight and rugged. Weather – proof and explosion – proof cases shall be used in outdoor and hazardous areas respectively. Protection clause shall be of IP 67 or better.

5. Transmitters for pressure / DP measurements of liquid and steam shall always be installed below the sampling point, preferably with the connection at the top.

6. Transmitters for pressure / DP measurements for gases and air shall always be installed above the sampling point, preferably with the connection at the bottom.

7. Transmitters with diaphragm seal system shall be considered when

   - The process temperature is outside of the normal operating ranges of the transmitter and cannot be brought into those limits with impulse piping or
   - The process is corrosive and would require frequent transmitter replacement or unusual materials of construction or
   - The process contains suspended solids or is viscous and may plug the impulse piping or
   - There is a need to make density or interface measurements or
   - The process medium may freeze or solidify in transmitter or impulse piping.

8. Diaphragm seal shall be either capillary type or direct mounted type depending upon the application. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application.

9. Differential pressure type level transmitters shall be used for range above 1219 mm, for services requiring purge or where liquid might boil in external portions.

10. Differential pressure type level transmitters for use on corrosive service shall generally be diaphragm wafer with extended filled capillary type. Flush or extended diaphragm type DP transmitter shall be considered for special application. Diaphragm material shall normally be stainless steel or any other special alloy.

11. Differential pressure type flow transmitters shall have in-built square-root extractors.

9.3 Temperature Transmitter

Table 9.2

Specifications for Temperature Transmitter

S.N	Features	Minimum Requirements
1	Type	2-Wire, Smart (HART)
2	Output Signal	4-20 mA signals superimposed with HART signal.
3	Signal Processing Unit	Microprocessor based
4	Accuracy	± 0.075 % of span or better
5	Local Indicator	To be provided
6	Display	Digital LCD Integral Display (minimum 5 digit) Engineering Unit
7	Input	Ohm input from Pt-100 RTD/ mV signal from thermocouples
8	Stability	± 0.1 % of reading or 0.1^0 C, whichever is greater, for 24 months for RTDs. ± 0.1 % of reading or 0.1 ^{0}C, whichever is greater, for 12 months for thermocouples
9	Output	4-20 mA DC, linear
10	Load	600 Ohms (minimum) at 24 Volts DC
11	Power Supply	24 VDC, 2- Wire Loop Power
12	MOC of Electrical Housing	Aluminum Alloy or better
13	Enclosure Class	Weather proof as per IP 67 with corrosion resistance coating. For hazardous area explosion proof enclosure as described in NEC article 500

1. The temperature transmitter of following types (2-wire Loop Powered temperature transmitter) compatible with thermocouples and RTDs shall be provided. Cold junction temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

   a. Single Input DIN-rail mounted Temperature Transmitter

   These shall be suitable for mounting on DIN-rails in Panels/JBs in air conditioned room. This temperature transmitter shall be the ones which are especially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

b. Dual-input Temperature Transmitter With Indicator

These shall be suitable for mounting on pipes/ supports. Indicator shall be provided with these transmitters. These transmitters shall have bump-less change over facility to second sensor in case first sensor fails .This changeover is to be alarmed. Protection class shall be IP67 minimum.

The exact applications for which this type of transmitter is to be provided shall be finalized during detailed engineering.

2. Transmitters shall be provided with following features:
   - Sensor drifts alarm for sensor failure prediction
   - Differential & average temperature measurement if required.
   - Automatic switch-over to back-up sensor on primary sensor failure.
   - Accepts any combination of two sensor types (RTDs, T/Cs, mV or ohms)
   - Ambient temperature compensation
   - Fault detection for electronics & sensors with fail-safe alarming.
   - Provision of built-in CJC
3. Transmitters to be used for RTD sensors shall be provided with RTD EMF correction features so that it shall detect and eliminate EMF errors which are the result of small voltage produced by RTD sensing elements.
4. The product and make shall be selected so that with one make of transmitter all applications with respect to measuring range, temperature sensor (resistance thermometer / thermocouple) and connection type (2/3/4) wire connection of resistance thermometers) shall be covered.
5. Transmitters shall be capable of communication with HART (Highway Addressable Remote Transducer) communicator. HART communicator shall be provided with transmitters for tuning / configuring / diagnosing / maintenance of the transmitters. It shall meet the intrinsic safety requirement if required depending upon the application.

All transmitters' cases shall be dust-tight and rugged. Weather-proof and explosion-proof cases shall be used in outer and hazardous areas respectively

9.4 Thermocouple

Table 9.3

Specifications for Thermocouple

S.N	Features	Minimum Requirements
1	Wire Gauge	16 AWG (for K type

S.N	Features		Minimum Requirements	
			24 AWG (for R type)	
2	Protective tube		O.D. 8 mm Material SS 316 seamless Filling – Compacted Magnesium Oxide (Purity above 99.4)	
3	Loading		Shall be spring loaded to ensure positive contact with the well. Prevention of rotation of the insert with respect to head and resultant twisting of leads shall be ensured.	
4	Accuracy		As per ANSI MC 96.1 / IEC 751 / IS-2054 / 2055, 1974.	
5	Characteristic		Linear with respect to temperature within +/- ½ per cent of top range value.	
6	Reference		For temperature vs. mV characteristics, following IS shall be applicable : Type K IS – 2054, 1974 Type R IS - 2055, 1974	
7	Head	Type	IP-65 universal screwed type (Explosion proof for NEC class-1, division-1 area)	
		Material	Die-cast aluminium or better material painted with black enamel paint.	
		Terminal Block	Brass screw type / silver plated on ceramic head.	
		Cable Connection	½ " NPT gland & grommet	
		Cover	Screwed cover with suitable gasket & SS Chain	
8	Instrument connection to Well		½" NPT	
9	Accessories		a)	Adjustable nipple-union-nipple {1/2" Sch. 80 X1/2" NPT (M)} with thermowell connection
			b)	Compression fittings/union
			c)	Flanges etc. (For flanged connection only)
			d)	SS 316 forged/barstock thermowell as per ASME PTC code. Process connection M33X2 (M)in general or 1½" Flanged for Flue gas/ Furnace

S.N	Features	Minimum Requirements	
			air etc. application

1. The following types of sensors shall be used for the different temperature ranges:
   - For measurement of temperatures of up to max. 1100 °C, rapid-responded sheathed thermocouples with insulated tip, 16 AWG wire, as Chromel-Alumel (NiCr-NiAl, ISA type K) measuring element, with admissible deviation of thermo voltage of half the values stated in IS-2054, 1974 or DIN 43710.
   - For measurement of temperature between 1100°C and 1300°C, 24 AWG, Platinum Rhodium (13%) – Platinum (ISA type R) measuring elements, with admissible deviation of thermo voltage of half the values stated in IS-2055, 1974 or DIN-43710.
2. All thermocouples shall be duplex type with tip grounded. Thermoelectric properties and accuracy shall be as per ANSI MC 96.1 / IS-2054 / 2055: 1974.
3. The design of thermocouple assemblies shall be such that replacement on line is possible.
4. Gas-tight ceramic sheaths partially reinforced with stainless steel sheath shall be used as protective tube for Pt Rh – Pt thermocouples. For other type of thermocouple stainless steel tubes shall be used as protective sheaths. For measuring temperature of high pressure process fluid, tapered protection sheath made from solid bar stock shall be used.
5. The time-constant of thermocouples shall suit the process requirement and shall be subject to approval of Owner / Consultant.
6. The thermocouples shall be supplied with factory tested and calibrated assemblies. The assemblies shall be complete with thermo well, sensing element, connection lead, duplex terminal block, extension nipple, compression fittings / unions /flanges etc. to meet all functional requirements as per Owner's / Consultant's approved drawings. The thermocouples equipped with thermo well shall be spring loaded for positive contact with the well.
7. The duplex terminal block shall be constructed with high temperature ceramic base with brass screw type terminals.
8. Thermocouple shall be suitable for steam, water or any other liquid application.
9. All thermocouples shall be terminated to the nearest junction boxes. The cold junction compensation shall be implemented within the measuring module level, no local/ field cold junction compensation box is allowed.

9.5 Resistance Temperature Detector (RTD)

Table 9.4

Specifications for RTD

S.N	Features	Minimum Requirements	
1	Type	3 / 4 wire , Pt-100 (100 ohm at 0 deg C) (as per DIN 43760)	
2	No. of Element	Duplex	
3	Housing/Head	IP-65/Diecast Aluminium. Plug in connectors are to be provided for external signal cable connection	
4	Sheathing of RTD	Metal sheathed , mineral insulated, ceramic packed	
5	Calibration and accuracy	As per DIN-43670 Class-A for RTD	
6	Stability	Zero & span drift within 0.1% of span for a 6 month period.	
7	Characteristic	Linear with respect to temp, within ±1/2percent of top range value	
8	Standard	As per DIN-43670 for RTD & ASME PTC-19.3 for Thermowell	
9	Accessories	a)	Adjustable Nipple-Union-Nipple with thermo well connection / plug in connectors
		b)	Compression fittings / unions
		c)	Flanges etc.
		d)	Thermowell as per requirement

1. RTDs shall be of duplex, platinum three / four wire type with a nominal resistance of 100 ohms at 0°C and conform to DIN 43760 / BS 1904.

   Stability of RTD over full range shall be better than 0.05 ohms and the repeatability figure shall be better than 0.02 ohms. Accuracy shall be of the order of 0.15% or better and response time shall be less than 20 seconds with thermo well.

2. The protective-sheath material shall be SS 316, seamless tubes using compacted magnesium oxide packing for insulation. The insulation resistance at 540°C shall not be less than 5 mega-ohms.

3. The time constant of the RTD shall suit the process requirements and shall be subject to approval of Owner / Consultant.

9.6 Thermowell for Temperature Elements

1. The design of the thermo well shall take into consideration the temperature, pressure, medium and fluid velocity specified in the process in accordance with ASME Standard PTC 19.3, 1974.

2. Thermo wells shall, in general, be of SS 316 and shall be drilled from bar stock except for air and flue gas services. However, selection of thermo well material shall be as per following guideline.

3. Welded type thermo wells with 38 mm O.D. for welding & ½" NPT internal threads shall be used for pressure above 100 kg / sq cm or temperature above 400 deg C. Socket weld type thermo well with 34 mm O.D. for welding & ½" NPT internal thread, shall be used for pressure between 40-100 kg/cm2 and temperature up to 400°C. Screwed type thermo wells with ½" NPT internal threads & M33X2 (M) outer threads shall be used for pressure below 40 kg/cm2 and temperature below 400°C. For pipes having probability of prolonged vibration, seal welding may be done all around after tightening the thermo well within the base.

4. Thermo well manufacturing drawing covering material specification, dimensional details, details of special treatment, finish etc. as well as test procedure shall be subject to Owner's / Consultant's approval. Material certificate shall have to be furnished for each thermo well.

5. Wherever any approval is necessary from any recognized body / authority during manufacturing of high pressure wells, the same shall have to be arranged by the Contractor.

6. The thermo well immersion depth (U) shall be sufficient to eliminate conduction error. A general rule which may be followed is to use an immersion length equalling a minimum of 10 times the diameter of the protective tube or well. In general, immersion length of thermo wells for different line sizes shall be as follows:

Table 9.5

Thermowell Immersion Length

S.N	Line Size	Immersion Length
1	From 4" to 6"	65 mm
2	From 8" & onwards	140 mm
3	Vessels	400 mm

9.7 Pressure Gauge/ Differential Pressure Gauge/Draft Gauge

Table 9.6

Specification for Pressure Gauge/ DP Gauge/ Draft Gauge

S.N	Feature	Minimum Requirement
1	Type	Bourdon / Bellows / Diaphragm
2	Sensing Element Material	AISI 316 SS
3	Movement Material	AISI 304 SS

S.N	Feature	Minimum Requirement
4	Case Material / Protection Class	SS / IP 65
5	Dial Size	150 mm For Special application 250 mm shall be used
6	Scale	Black lettering on white background in 270 °C arc
7	Range Selection	Normally operate at 75% of its maximum pressure range. Instruments measuring varying pressures shall operate in a band of 60% of its maximum pressure range.
8	Over range Protection	150% of maximum range by internal stop. External stop below zero.
9	Adjustment	External Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
10	Stop at Max. Reading	Shall be provided
11	Element Connection	Argon welding
12	Process Connection	½" NPT(M) bottom connection for local mounting, back connection for panel mounting
13	Accuracy	+/- 1.0 % of full scale or better
14	Operating Ambient Temperature	50 °C (Max. continuous)
15	Safety Feature	Neoprene Safety Diaphragm (Blowout disc) at the back
16	Window	Shatter-proof glass
17	Chemical Seal Unit	SS 316 Flange and Diaphragm, PTFE coated / block, Silicon Oil filling fluid
18	Accessories	Snubbers for pulsating fluid applications / 3-way gauge cock / 2-valve manifold / Pigtail / Siphon for steam service / Gauge Saver, if maximum or Design Pressure is very high than the Operating Pressure / Counter Flanges / Bolts, Nuts, Gaskets / SS Tag Plate

1. Directly connected pressure measuring instruments shall be diaphragm, bourdon or bellow type elements depending upon the services conditions. In general, diaphragm elements shall be used in the range of 0 to 1000 mm water column pressure, bellow type element for ranges of 0 to1 Kg/cm2 and bourdon type element for ranges greater than 1 Kg/cm2.
2. Primary element material shall be corrosion resistant to process fluid or diaphragm seals shall be provided for protection.
3. For draft measurement Teflon coated beryllium copper diaphragm shall be used.

4. Snubbers shall be floating pin type, externally mounted and externally adjustable. It shall be used for all pulsating services.
5. Diaphragm seals, filled type or mechanical type shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be the clean out type with flushing connection.
6. Over-range protection shall be provided to at least 150 % of range. For vacuum service, the element shall have under-range protection to full vacuum
7. Ranges of the gauges shall be so selected that the gauge normally operates in the middle third of the scale and conform to IS 3624 standard dials, wherever necessary.
8. The sensing elements for all gauges shall be properly aged and factory tested to remove all residual stresses and shall be SS 316 with forged socket and tip of the same material. Elements above 70 Kg/sq. cm range shall be bored instead of drawn.
9. For low pressure application where long elements are used, well supported protecting tube shall be installed to prevent mechanical damage and erosion of the elements.

9.8 Temperature Gauge

Table 9.7

Specification for Temperature Gauge

S.N	Feature	Minimum Requirement
1	Type	Mercury filled
2	Sensing Element material	Bourdon AISI 316 SS
3	Movement Materials	AISI 304 SS
4	Case Material/Protection class	SS / IP65
5	Capillary Armouring	SS Flexible
6	Capillary	SS 316 (5 mtr. Length for Local & 15 metre for panel Mounting)
7	Bulb/Stem Diameter	12 mm
8	Dial Size	150 mm
9	Window	Shatterproof glass
10	Scale	Black lettering on white background in 270 °C arc
11	Adjustment	Micrometer screw for zero adjustment. Internal micrometer screw for range adjustment.
12	Pointer	Externally Adjustable
13	Range Selection	Normal Process Temperature –

S.N	Feature	Minimum Requirement
		approximately two third of Temperature range.
14	Stop at Max. Reading	Shall be provided
15	Over range Protection	150% of FSD
16	Instrument Connection	Bottom connection for local mounting, back connection for panel mounting.
17	Process Connection	½" NPT with Thermowell
18	Performance :-	
a	Accuracy	+/-1.0% of full scale or better
b	Repeatability	Less than 0.5% of full range
c	Response Time	30 seconds (max.) with Thermowell and 15 seconds Bare.
19	Operating Ambient Temperature	50 °C (Max. continuous)
20	Accessories	Mounting brackets, Bolts, Nuts, Gaskets / SS Tag plate, SS Thermowell etc.

1. Temperature gauges shall be dial thermometers (liquid spring / steam pressure spring / metal expansion thermometer), either rigid stem or capillary tube depending upon application; if this is not possible for design reasons, industry type liquid – in – glass thermometers shall be used.
2. Case shall have back or bottom connection with adjustable gland to permit adjustment of thermometer into the thermo well.
3. Thermometer stem adjustable gland with union connection and bushing shall be suitable for ½ inch NPT connection.
4. Bi-metallic type dial thermometer, if used, shall be hermetically sealed, back or bottom connection type, with 150 mm dial.
5. The gauges shall be provided with automatic ambient temperature compensation.
6. Scale ranges shall be selected so that normal process temperature in middle two – third of full scale range

9.9 Level Gauge

Table 9.8

Specification for Level Gauge

S.N	Feature	Minimum Requirement
1	Sensing Element & material	Tempered toughened Borosilicate gauge glass steel Armored reflex or transparent type
2	Body Material	Forged carbon steel / 304 SS

S.N	Feature	Minimum Requirement
3	End Connection	Process connection as per ASME PTC and drain / vent 15 NB
4	Accuracy	+/- 2 % of complete range
5	Scale	Linear vertical
6	Range Selection	Cover 125 % of max. of scale
7	Over Range Test	Test pressure for the assembly shall be 1.5 to the Maximum design pressure at 38 degree C
8	Housing	CS / 304 SS leak - proof
9	Identification	Engraved with service legend or or laminated phenolic Name plate
10	Packing	PTFE Teflon
11	Illumination	220 V, 50 Hz, 25 / 40 Watts either with deflector or diffuser (for transparent type level gauge) / 220V , 50 Hz, 25 /40 Watts with red and green filter
12	Accessories	Gasket for all KEL – F shield for transparent type vent and drain valves of CS / SS as per requirement
13	Others	Anti – Frost extension for low temperature service. Heating / cooling arrangement

1. Level gauges shall be steel armoured reflex or transparent or bi –colour type, top and bottom connection as per pressure vessel standard of ASME PTC code and 15 mm NB (1/2 inch NPT) Drain and Vent connection.
2. Body material and cover material shall normally be forged carbon steel, 304 stainless steel or other superior material.
3. Reflex type gauges shall be used for clean and colorless liquids and transparent type for other liquids. For boiler and condensate services, treated water, the transparent type with KEL – F shields shall be used to avoid their attack on the glands.
4. The gauge glass must have a rating equal to or more than the vessel design pressure and temperature. The test pressure for the complete design gauge assembly shall be as per Owner's / Consultant's recommendation.
5. The maximum length of a single gauge glass shall not exceed 1400 mm. Where large range is required, multiple gauges of preferably equal lengths shall be used with 50 mm over – lapping in visibility.
6. The visibility shall cover the operating level range and the maximum and minimum ranges expected considering start – up conditions as well as alarm and shut down points. Internal heating shall be provided for

viscous liquids. Integral illuminators shall be used for transparent gauges, if necessary.

7. Stand – pipes shall be used for multi – gauge glass and level controller installation and on horizontal drum or exchanger with top and bottom connections to have visibility of the complete span. The stand pipe shall not be used with block valves.

8. Primary isolation valves shall be used In addition to the gauge glass valves unless otherwise specified. When the process fluid may create lugging or leakage problem, gauge valves may be omitted. For low temperature liquid having high vapour pressure at ambient temperature, isolation and gauge valves shall not be permissible. Safety valve shall be provided at the vent connection of the gauge glass where isolation is required.

9.10 Pressure/ Differential Pressure Switch

Table 9.9

Specification for Pressure/DP Switch

S.N	Feature	Minimum Requirement
1	Type	Piston for high pressure application Bellow/Diaphragm for low pressure application
2	Sensing Element material	AISI 316 SS
3	Wetted Parts material	AISI 316 SS
4	Case Material	Epoxy coated Die Cast Aluminium
5	Setter Scale	Black graduation on white linear scale. Graduation 0 – 100% with red pointer for set points.
6	Over range for Pressure / Vacuum Switch	150% of maximum pressure
7	Set Point	Adjustable throughout switch operating range.
8	Static Pressure for Differential Pressure Switch	Maximum Line Pressure or Static Pressure on either side without permanent deformation or loss of accuracy.
9	Adjustments	Internal – set point Differential adjustable feature
10	Process Connection	½" NPT(M) bottom connected
11	Switch Configuration	2 SPDT / 1 DPDT
12	Switch Rating	230 V, 5A AC / 220 V, 0.25 A DC/24 V, 2A DC
13	Switch Type	Snap acting, shock and vibration-proof
14	Cable Connection	½" ET conduit connections or compression gland
15	Enclosure Class	Weather proof as per IP 65 with corrosion resistance coating.

S.N	Feature	Minimum Requirement
16	Accuracy	1% of span up to 3Kg/cm2 0.5% of span for more than 3 Kg/cm2.
17	Repeatability	0.5% of span
18	Accessories	
a)		Snubbers for pulsating fluid application.
b)		Tag Number, service engraved in SS tag plate
c)		Teflon back-up sheath protection, as required.
d)		i) Remote diaphragm seal with SS 316 armored capillary for typical application. MOC of seal material shall be as per process fluid requirement. ii) Silver coated diaphragm for corrosive services like chlorinated water.
e)		Retention ring and screws for surface mounting.
f)		3-way Gauge Cock (SS 316) for PS / 5-Valve Manifold (SS 316) for DPS.
g)		Mounting bracket / Clamp for 2 '' pipe, bolt & nut.

1. The pressure switches shall have sensing elements made of copper alloy or stainless steel sealed diaphragm and piston actuated for high pressure service and bellows for low pressure / vacuum service.
2. Low differential pressure switches for low static pressure ranges shall be diaphragm type with snap action switch elements.
3. Low differential pressure switches for high static pressure shall be elbows and torque tube type and snap – action switch elements and metric scale dial indicators.
4. For corrosive, viscous process fluids diaphragm sealed with completely filled inert liquid shall be provided. Material of diaphragm and wetted parts shall be selected considering the nature of process fluid.
5. The sensing elements shall be properly aged and factory tested to remove all residual stresses. They shall be able to withstand at least 150 % the full scale pressure without any damage or permanent deformation.
6. Actuation set point, dead band shall be internally adjustable through out the range with tamper proof facilities.
7. Electrical connection for the switch devices shall be suitable for plug in type connection.
8. Process connection shall be ½ inch NPT. Process piping connections shall include necessary union, nut, nipple, tail pipe, isolation valve and test connection to permit servicing, testing, calibration and removal of the instrument device.

9. Instrument for steam & hot water service, shall be connected through siphon, of stainless steel or suitable material. Pulsation dampeners shall be provided for all pulsating fluids.

10. Pressure switches shall be tested as per BS – 6134.

9.11 Conductivity Type Level Switch

Table 9.10

Specification for Conductivity Type Level Switch

S.N	Feature	Minimum Requirement
1	Sensing elements	Conductivity type
2	Material	SS 316
3	Repeatability	± 0.5 % of full range or better
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
6	Probe length	As per requirement
7	Mounting	Flanged- on external cage
8	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
9	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
10	Enclosure	IP 65
11	Housing	Cast aluminum epoxy coated weather proof
12	Ambient Temperature	60*C (max.)
13	Electrical Connection	Plug-in type
14	Cable connection	½ " NPT with cable gland
15	Set point	Adjustable
16	Accessories	All mounting accessories

9.12 Capacitance Type Level Switch

Table 9.11

Specification for Capacitance Type Level Switch

S.N	Feature	Minimum Requirement
1	Type	Capacitance type
2	Probe	Rod or Suspended Electrode
3	Material	SS 316
4	Insulation	PTFE/PP/Kynar part/full as required

S.N	Feature	Minimum Requirement
5	Repeatability	± 0.5 % of full range or better
6	Accuracy	± 0.5 % of full scale or better
7	Working temperature	As per process requirement
8	Probe length	As per requirement
9	Probe Mounting	1½" Flanged
10	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
11	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
12	Enclosure	IP 65
13	Housing	Cast aluminum epoxy coated weather proof
14	Cable connection	½ " NPT with Cable gland
15	Ambient Temperature	60*C (max.)
16	Electrical Connection	Plug-in type
17	Accessories	Counter flange, Cable gland, Prefab cable etc.
18	Set point	Adjustable
19	Accessories	All mounting accessories

9.13 Float/Displacer Type Level Switch

Table 9.12

Specification for Float/Displacer Type Level Switch

S.N	Feature	Minimum Requirement
1	Type	Float/Displacer type
2	Float/Stem/Displacer Material	SS 316
3	Repeatability	± 0.5 % of full range or better
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
7	Process connection	As per requirement
8	Over-range proof	150% of max. design pressure
9	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact
10	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
11	Enclosure	IP 65
12	Hydro Test	Chamber – 100% at 1.5 times rated pressure or as per ANSI flange rating Float – 1.1 times of operating pressure
13	Electrical Connection	Plug-in socket
14	Accessories	All mounting accessories

1. Level Switch shall work on gland less magnetically coupled float or displacer operated mechanism having separate float chamber.
2. Float, stem and displacer shall be 316 stainless steel.
3. Level switch body, cage and process connections shall be designed to withstand the maximum pressure and temperature of the operating fluid.
4. A setting adjustment on the level set point of + / - 25 mm shall be provided. The adjustment shall be made externally to the switch.
5. The accuracy & repeatability of the switch shall be within +/- 0.5 % of full-scale range. On – Off differential shall be adjustable.
6. Process connections of the cage shall be 25 NB male plain nipples connected through socket / welded isolation valves of adequate rating.
7. Level switch connections shall also include 15 NB test and drain connections to permit servicing, testing, calibration of the instrument.
8. The switching elements shall be snap-acting, shock-proof and vibration-proof. All switches shall have two electrically isolated SPDT contacts with provision of external adjustment of set points and dead bands. The contact ratings shall be 5 amps at 240 V AC 50 Hz or 0.25 amps at 220 V DC.
9. Switch enclosures shall be cast aluminium, weather-proof, NEMA -4X type with cable entry through compression type cable glands / ¾ "NPT conduit connections. Switches located in hazardous areas shall have dust-ignition-proof enclosure as per NEC article 500 provisions.

9.14 Ultrasonic Level Transmitter

Table 9.13

Specification for Ultrasonic Transmitter

S.N	Feature	Minimum Requirement
1	Application	Level measurement in silos, sump water level etc.
2	Medium	Coarse, hard solid materials like ash etc. Materials may be slowly falling through the detection range.
3	Type	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic Transmitter
4	Principle	Time of flight
4	Sensor Material	Corrosion resistant material to suit individual application requirement.

S.N	Feature	Minimum Requirement	
5	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank / sumps obstructions such as pipes, heating coils or agitator blades. Also transmitters shall have adjustable damping circuitry.	
7	Range	Capable of covering the complete level span of tank/vessel taking care of blocking distance, frequency, attenuation due to surface, obstructions, vapours etc	
8	Output	4 – 20 mA DC with 600 ohms load with HART compatibility.	
9	Display	minimum 4 characters display with Integral keypad, access protected by user code.	
10	Diagnostics	Loss of echo alarm etc.	
11	Resolution	+/- 0.1 % of range or better	
12	Accuracy	+/- 2 mm or 0.2% of span	
13	Repeatability	3 mm or better	
14	Operating temperature	0 to 60^0 C	
15	Power supply	24 V DC + / - 10 %	
16	Mounting	Flanged connection at top of covers / side walls as per requirement.	
17	Accessories	a)	All weather canopies for protection from direct sunlight and direct rain.
		b)	For hazardous areas, explosion proof enclosure as per NEC article 500 shall be provided.
		c)	All mounting hardware and accessories required for erection and commissioning. Mounting fittings material shall be SS 316.

1. The power and frequency of transmission for the transmitter shall be selected to assure a sufficient signal / noise ratio.
2. The transmitter shall be designed with an electronic circuit having the features such as temperature compensation, rejection of unnecessary echoes and noises and adjusting 'zero' and 'span'. It shall consist of sensors, electronic unit and accessories.

9.15 Guided Wave Radar Type Level Transmitter

Table 9.14

Specification for Guided Wave Radar Type Transmitter

S.N	Feature	Minimum Requirement	
1	Application	Level measurement of vessel under vacuum or low pressure application	
3	Type	Guided wave radar	
4	Principle	TDR (Time domain reflectrometry)	
5	Probe Material	SS 316	
6	Accuracy	5 mm or better	
7	Resolution	+/- 0.1 % of range or better	
8	Signal Output	4 – 20 mA DC with 600 ohms load with HART compatibility	
9	Power Supply	24 V DC + / - 10 %	
10	Display	Integral	
11	Mounting	External cage type	
12	Transmitter housing Protection Class	IP-65 with corrosion resistance coating	
13	Accessories	a)	All weather canopies for protection from direct sunlight and direct rain.
		b)	For hazardous areas, explosion proof enclosure as per NEC article 500 shall be provided.
		c)	All mounting hardware and accessories required for erection and commissioning. Mounting fittings material shall be SS 316.

9.16 Flow Switch

Table 9.15

Specification for Flow Switch

S.N	Feature	Minimum Requirement
1	Type	Vane actuated/Differential bellow type
2	Vane/bellow Material	SS 316
3	Repeatability	± 0.5 % of full range or better

S.N	Feature	Minimum Requirement
4	Accuracy	± 0.5 % of full scale or better
5	Working temperature	As per process requirement
7	Process connection	As per requirement
8	Over-range proof	150% of max. design pressure
9	No. of contact	2 NO. + 2 NC, SPDT, snap action type dry contact, shock & vibration proof
10	Rating of contacts	5A, 240 V AC / 2A, 24 V DC / 0.25 A,220V DC
11	Enclosure	Cast Aluminium/IP 65
12	Cable connection	Compression type cable gland/ ½" NPT Conduit connection
13	Electrical Connection	Plug-in socket
14	Accessories	All mounting accessories

9.17 Rotameter

Table 9.16

Specification for Rotameter

S.N	Feature	Minimum Requirement
1	Type	Variable area Linear scale
2	Fluid media	Water/Oil
3	Float Material	SS 316
4	Accuracy	± 2 % of full scale or better
5	Working temperature	0 to 70*C
6	Process connection	As per requirement
7	Over-range proof	150% of max. design pressure
8	Enclosure	Transparent toughened glass/IP 65
9	Accessories	Flange, orifice in case of bypass Rotameter

Rotameter shall be used for low flow & low viscosity applications of liquid.

9.18 Sight Glass Indicator (Flow Glass)

Table 9.17

Specification for Flow Glass

S.N	Feature	Minimum Requirement
1	Application	Online observation of fluid flow in Pipeline
2	Type	Double window for pressurized pipe with rotary wheel for installation in horizontal or vertical pipeline. Full view for non-pressurized pipeline.

S.N	Feature	Minimum Requirement
3	Size	Double window up to 12" and 600 lbs rating. Full view up to 6" and 150 lbs rating.
3	Body Material	SS 316
4	Glass	Pyrex tempered glass
	Others	Rotor & wetted parts shall be bronze All accessories shall be SS316
5	Protection class	IP-65
6	Connection	Screwed up to 50 NB size Flanged ANSI 150 RF – above 50 NB size
7	Accessories	Name plates, mating flanges with gasket, bolts & nuts etc.

9.19 Flow Elements

a) Orifice Plate

Table 9.18 A

Specification for Orifice Plate

S.N	Feature	Minimum Requirement
1	Type	Concentric as per ASME PTC – 19.5 (Part III); ISA RP – 3.2, 960; BS – 1042; ISO 5167
2	Material	SS 316
3	Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe diameter above 300 mm.
3	Beta ratio	0.34 to 0.7
4	Tapping's	Flanged weld neck 3 pairs of tappings.
5	Material of Branch Pipe	Same as main pipe
6	Root Valve type	Globe
7	Root Valve material	SS 316
8	Root Valve size	1"
9	Accessories	Root valves, flanges, vent / drain hole (as required)

1. Contractor to provide Beta ratio calculation, Assembly drawings & flow vs DP curves.
2. Each orifice plate shall be provided with a handle on which the orifice diameter, pipe diameter and pressure tap distances are stamped. This information shall be so located that it can be read without removing the orifice plate from pipe line.
3. The standard primary element shall be thin plate, square-edge concentric orifice plate mounted between a pair of weld-neck type

orifice flanges with flange taps. The minimum pressure rating of flanges shall be 300 pounds ANSI. The material of the orifice plates shall be SS 316 in general. Orifice plates shall be not less than 3 mm thick for nominal pipe diameters up to and including 300 mm, and not less than 6 mm thick above 300 mm NB pipe.

4. Quadrant edge or quarter circle orifice plates shall be used for highly viscous liquids and for pipe Reynolds Number below 10,000. Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids up to Reynolds Number below 250. Vent and drain holes shall be provided wherever necessary.

5. Orifice diameter shall be selected, so that d/D ratio is between 0.20 to 0.70 for gas and steam and up to 0.75 for liquids.

6. Metering orifices shall not be installed in lines less than 1 ½" (40 mm) the lines shall be blown to the 1 ½ " (40 mm) size for the meter run, keeping the d/D ratio within limits.

7. Restriction orifices and integral orifice transmitters do not require upstream or down stream straight pipe runs.

8. The orifice plate shall be supplied and fitted in conformity with ISO. When the pipe diameter is larger than the value specified in ISO, the restriction ratio will be decided by extending the specific curve externally.

9. The length of straight pipe run required for metering accuracy shall be in conformity with ISO. When it is extremely difficult to comply with the standard, a minimum straight length of 10D (D = pipe inner diameter) on the upper stream and a minimum length of 5D on the down stream shall be considered.

10. All orifice plates shall be supplied with matching flanges of material and pressure rating not less than the rating of the associated pipe system.

11. For pipeline sizes of 500 mm and less, the orifice plates shall be an integral unit comprising of carrier ring assembly, tapping arrangement on both upstream as well down stream side. For line sizes more than 500 mm, the orifice plate shall be disc type. For disc type orifice plate, suitable corner tapping arrangement on both upstream as well as down stream side shall be provided. All tapping arrangements shall be complete with a piece of impulse pipe line and a shut – off valve suitable for specified line pressure.

12. For steam applications, orifice plate shall be supplied with a pair of steam condensation chambers suitable for specified line pressure.

13. Data sheets, sizing calculation, fabrication & sheets for the elements shall be submitted for approval and finalization.

b) Flow Nozzle

Table 9.18 B

Specification for Flow Nozzle

S.N	Feature	Minimum Requirement
1	Type	Long Radius welded type ASME PTC 19.5 (Part III) or BS – 1042
2	Material	Same as Pipe material
3	Thickness	Suitable for intended application
3	Beta ratio	Around 0.7
4	Tapping's	D and D/2 (3 nos. tappings)
5	Material of Branch Pipe	Same as main pipe
6	Root Valve type	Globe
7	Root Valve material	SS 316
8	Root Valve size	1"
9	Accessories	Root Valves, Vent & Drain Hole

1. Contractor to provide Beta ratio calculation, Assembly drawings & flow vs DP curves.
2. The branch pipes for holding the flow nozzle shall also be furnished along with the flow nozzle. All nipples, welding adaptors and root valves shall also be in the scope of supply.
3. Flow nozzles in high pressure pipes shall be subject to a test according to DIN 50049, 3.1C, considering the technical guideline. The test of flow nozzles shall contain:
   - Check of drawings
   - X-ray testing of the circular bead or colour soaking or ultra-sonic testing
   - Test of sizes.
4. Flow nozzle shall be provided with a permanent mark indicating:
   - Measuring point number
   - Direction of flow
   - Plus and minus tapping
   - Material

   Moreover, the actual inside pipe diameter "D" and the diameter of the flow nozzle shall be stated on the identification plate.
5. The Contractor shall provide the following documents:
   - Design drawings of the flow nozzle
   - Calculation documents

- Fabrication, assembly and installation drawings
- Test reports.

6. For measurements of steam, balancing vessels shall be provided. Balancing vessels shall be used for flow measurement in steam system based on the differential pressure method to ensure a defined water column. The balance vessels shall be arranged on the same geodetic level. If this is not possible for design reasons, the level difference shall be taken into account during calibration

9.20 Hydrogen Analyzer

Table 9.19

Specification for Hydrogen Analyzer

S.N	Feature	Minimum Requirement
1	Accuracy	+/- 0.2 % of full scale
2	Linearity	+/- 1% of full scale
3	Response time	less than 5 seconds (Up to 90% of full scale)
4	Drift	+/- 0.005% per 2 Deg. Centigrade temp. change
5	Temperature compensation	Automatic
6	Sample filter	Ceramic 3.5 micron
7	Zero & Span Adjustment	Required
8	Ambient Temperature	60*C
9	Indication	Digital
10	Enclosure Type/Material	Weather & Dust proof IP-65 SS
11	Type of Electronics	Microprocessor based with self diagnostic facility
12	Calibration	Auto & manual
13	Output signals	Analog: 4-20 mA DC Binary: 2 NO + 2 NC for Alarms
14	Digital Signal transmission	RS-232 or RS-484 OR as per requirement to suit connection protocol of Plant DCS
15	Other requirement	HART Communication protocol compatibility & suitable for connection to Smart Transmitter Maintenance system. Purging System

9.21 Control Valves

A. Introduction

The control valves and accessories equipment furnished by the Contractor shall be designed, constructed and tested in accordance with the latest applicable requirements of code for pressure piping ANSI B

31.1, the ASME Boiler & Pressure Vessel code, Indian Boiler Regulation (IBR) & ISA or acceptable equal standards.

B. Control Valve Design & Sizing

1. The design of all valve bodies shall meet the specification requirements and shall conform to the requirements of ANSI for dimensions, material thickness and material specification for their respective pressure classes.

2. The valve sizing shall be suitable for obtaining maximum flow conditions with valve opening at approximately 80% of total valve stem travel and minimum flow conditions with valve stem travel not less than 10% of total valve travel. All the valves shall be capable of handling at least 120% of the required maximum flow. Further, the valve stem travel range from minimum flow condition to maximum flow condition shall not be less than 50% of the total valve stem travel. The sizing shall be in accordance with the latest edition of ISA Handbook on control valves. While deciding the size of valves, Contractor shall ensure that valves outlet velocity does not exceed 8 m / sec. for liquid services, 150 m/sec. for steam services and 50% of sonic velocity for flashing services. Contractor shall furnish the sizing calculations clearly indicating the outlet velocity achieved with the valve size selected by him as well as noise calculations, which will be subject to Consultant's / Owner's approval during detailed engineering.

3. Control valves for steam and water applications shall be designed to prevent cavitations, wire drawing, flashing on the downstream side of valve and downstream piping. Thus for cavitations / flashing service, only valve with anti-cavitations trim shall be provided. Detailed calculations to establish whether cavitations will occur or not for any given application shall be furnished.

4. Trim shall be multistage type having sufficient number of discrete pressure drop turns (stages) to ensure elimination of vibration, erosive – action, cavitations. Contractor shall identity the number of pressure drop turns in proposed equipment and shall also provide calculation demonstrating compliance to the trim exit velocity.

5. To prevent flow induced vibration and to protect the valve internals from foreign particles such as weld slag flow, direction shall be a flow to close (over the plug) configuration for liquid applications. To maximize noise attenuating benefits and to allow for constant fluid expansion, flow direction will be under the plug for steam and gas applications.

6. Control valves for applications for critical areas shall have permissible leakage rate as per leakage class V. All other control valves such as low and high range feed control valves etc shall have leakage rate as per leakage class IV.

7. The control valve induced noise shall be limited to 85 dBA at 1 meter from the valve surface under actual operating conditions. The noise

abatement shall be achieved by valve body and trim design and not by use of silencers.

8. The characteristic of the control valves shall be determined based on the application / service.

9. On supply air or electrical failure for pneumatic / electrical drive, the valve shall remain full closed, open or stay – put position as per process safety requirement.

C. Valve Construction

1. Proper selection of valve type and material of construction to meet operating requirement.

2. All valves shall be of globe body design and straightaway pattern with single or double port unless otherwise recommended by the manufacturer to be of angle body type. Rotary valve may alternatively be offered when pressure or pressure drops permit.

3. Valves with high lift cage guided plugs & quick charge trims shall be supplied.

4. Cast iron valves are not acceptable.

5. Bonnet joints for all control valves shall be of the flanged and bolted type for easy dis – assembly. Bonnet joints of internal threaded or union type will not be acceptable.

6. Plug shall be of one – piece construction either cast, forged or machined from solid bar stock. Plug shall be screwed and pinned to valve stems or shall be integral with the valve stems.

7. All valves connected to vacuum on downstream side shall be provided with packing suitable for vacuum applications (e.g. double vee type chevron packing).

8. Valve characteristic shall match with the process characteristics.

9. Extension bonnets shall be provided when the maximum temperature of flowing fluid is greater than 2800c.

10. Flanged valves shall be rated at not less than ANSI pressure class of 300 lbs.

11. Teflon shall be used for valve gland packing to suit process requirement.

12. The valve body shall be marked to show direction of flow.

D. Valve Materials

1. The control valve body material shall be

   - Carbon steel as per ASTM – A216 GR WCB for non – corrosive, non – flashing and non – cavitations services below 275 deg c temperature like Auxiliary Steam flow to Deaerator, CRH flow to Deaerator, Condensate flow to Deaerator etc.

- Alloy steel as per ASTM – A217 GR WC 9 for severe flashing / cavitations services like low load and full load feed water control, HP and LP heaters emergency drains, Deaerator overflow drain to Hotwell etc.
- Alloy steel as per ASTM A – 217 GR WC 6 for low flashing / cavitations services like HP heaters & LP heaters normal drain control, drain cooler normal level control, gland steam cooler minimum flow etc.
- 316 SS for condensate service below 300 deg C like condensate normal and emergency make – up controls etc.

2. The control valve trim material shall be
   - 17 – 4 PH SS for severe services listed under item D.1, 2nd point & 3rd point above
   - 316 SS for services listed at D.1, 4th point above and
   - 316 SS with stellite faced guide parts and bushings for remaining applications.
3. However, Contractor may offer valves with body and trim materials better than specified materials and in such cases Contractor shall furnish the comparison of properties including cavitations resistance, hardness, tensile strength, strain energy, corrosion resistance and erosion resistance etc. of the offered material vis – a – vis the specified material for Owner's / Consultant's consideration and approval.

E. End Preparation

1. Valve body ends shall be either butt welded / socket welded, flanged or screwed as finalized during detailed engineering and as per Owner's / Consultant's approval. The welded ends wherever required shall be butt welded type as per ANSI B 16.25 for control valves of sizes 65 mm and above. For valves sizes 50 mm and below welded ends shall be socket welded as per ANSI B 16.11. Flanged ends wherever required shall be of ANSI pressure – temperature class equal to or greater than that of the control valve body.

F. Valve Actuator

1. The regulating control valves shall be furnished with pneumatic actuators. The Contractor shall be responsible for proper selection and sizing of valve actuators in accordance with the pressure drop and maximum shut off pressure and leakage class requirements. The valve actuators shall be capable of operating at 60 *C continuously.
2. Valve actuators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance for stem force, at least 0.15 kg / cm^2 per linear millimeter of seating surface, shall be

provided in the selection of the actuator to ensure tight seating unless otherwise specified.

3. The travel time of the pneumatic actuators shall not exceed 10 seconds.
4. For quick opening / closing services (such as fuel oil shut – off valve), the actuator shall be pilot solenoid operated pneumatic drive; the rating of solenoid shall be 24 V DC.
5. Selection of actuator shall be such that it meets the requirements of thrust / torque, stroke length, angular movement, full scale travel time, repeatability & accurate positioning for successful operation of final control element.
6. All the actuators shall have also provision for manual operation during emergency / maintenance along with graduated local position indicator.

G. Control Valve Accessory Devices

All control valve accessories such as air locks, hand wheels / hand-jacks, limit switches, SMART positioners, diffusers, external volume chambers, reversible pilot for positioners, tubing and air sets, solenoid valves and junction boxes etc. shall be provided as per the requirements.

Table 9.20

Specification for E-to-P converter

S.N	Feature	Minimum Requirement
1	Air Supply	1.5 Kg/Sq. cm
2	Input Signal	4-20 mA DC
3	Output Signal	0.2 to 1.0 Kg/ Sq. cm
4	Linearity	0.5 % of span or better
5	Hysteresis	0.1 % of span or better
6	Ambient Temperature Effect (-20 to +60 *C)	<0.2 % of span per Degree centigrade
7	Mounting	Close to Actuator
8	Protection class	IP-65
9	Enclosure	Die cast Aluminium
10	Drift	+/- 2% of set point per hour

Table 9.21
Specification for Smart Positioners

S.N	Feature	Minimum Requirement
1	Input	4-20 mA DC
2	Power Supply	24 V DC Loop powered
3	Type of Electronics	Microprocessor based with self diagnostic

S.N	Feature	Minimum Requirement	
		facility & digital communication by means of HART Protocol	
4	Valve position sensing	Non-Contact type with 4-20 mA DC Output	
5	Enclosure Type/Material	Weather & Dust proof to IP-65/ Die cast Aluminium	
6	Ambient conditions	Suitable for - 30 to +80 *C temperature & 0-95% Humidity	
7	Operating Range	Suitable for Full range & Split Range operation	
8	Modes of operation	Suitable for Direct & reverse valve action	
9	Flow characteristics	Suitable for Linear & Equal percentage Characteristics	
10	Fail safe/Freeze feature	Required	
11	Air Capacity	Sufficient to handle the Valves Selected/Boosters to be supplied if required.	
12	Air supply pressure	To suite the Air Supply Pressure / Quality available	
13	Process Connection	1/4" NPT	
14	Characteristic Deviation	< =0.5% of span	
15	Ambient Temperature effect	< =0.01%/Deg C or better	
16	Configuration	Remote Calibration, Auto & Manual Calibration shall be possible	
17	Cable Entry	½" NPT, Side or Bottom Entry to avoid water ingress	
18	Accessories	a)	Display with push buttons for configuration and Display on the positioner itself (Password Protected / Hardware Lock).
		b)	For Supply & Output Pressure, Filter Regulator and other accessories shall be provided as on required basis for making system complete
		c)	Valves Mounting Assembly For Sliding Stem / Rotary / Single Acting / Double Acting on required basis

1. SMART positioner shall preferably be of the same make as the Control Valve, to ensure repeatability in Calibration, serviceability and proper maintenance of the Control System.
2. SMART positioner shall be a Double stage positioner. The first stage of the positioner shall be typically a flapper-nozzle that serves as a high-gain pre-amplifier. This sensitivity shall be maintained over a wide range of dynamic conditions. Second stage shall be a power amplifier that provides power to drive the actuator. Preferably this shall be a pneumatic relay. Spool Driven type SMART positioners are not preferred due to Higher Dead Band and Poor responsiveness. The SMART positioner shall have pressure sensors to measure the pneumatic outputs to the actuator.

3. The control algorithm for the positioner shall use feedback signal from the motion of the pneumatic relay beam instead of pressure feedback to minimize pneumatic related effects and for stable and smooth response of the control valve. The SMART positioner shall have user adjustable tuning sets to identify the optimum tuning for the total valve assembly. SMART Positioner with HART Communication facility shall communicate all the valve diagnostics to Plant DCS.

Table 9.22
Specification for Air Filter Regulator (AFR)

S.N	Feature	Minimum Requirement
1	Type	Constant Bleed type
2	Inlet Pressure	10 Kg/Sq. cm (maximum)
3	Output	Adjustable from 0-2 Kg/Sq. cm or 0-7 Kg/Sq. cm (Continuous) as required
4	Filter Element	5 microns
5	Filter Element Material	Phosphor Bronze
6	Bowl Material	Metallic
7	Drain	Automatic
8	Enclosure Protection class/ Material	IP-65/ Die cast Aluminium
9	Process connection	¼ " NPT
10	Accessories	All mounting accessories. 2" dial size Pressure gauge.

Table 9.23
Specification for Position Transmitter

S.N	Feature	Minimum Requirement
1	Power Supply	24 V DC Loop powered
2	Type	Non-Contact LVDT type
3	Output	4-20 mA DC/ Linear
4	Accuracy	+/- 1%
5	Enclosure Protection class/ Material	IP-65/ Die cast Aluminium
6	Cable Entry	½" NPT, Side or Bottom Entry to avoid water ingress.
7	Accessories	All mounting accessories

Table 9.24
Specification for Limit Switch (Non Contact Type)

S.N	Feature	Minimum Requirement
1	Type	Non-contact type inductive Proximity/Namur type
2	Sensing distance	10 mm minimum

S.N	Feature	Minimum Requirement
3	Hysteresis	Maximum 10% of sensing distance
4	Indicator	LED indication
5	Protection class	IP 67
6	Integral Cable	1 mtr.
7	Power supply	24 V DC/ 8 V DC
8	Mounting	Flush mounting with check nut
9	Other Feature	Explosion proof enclosures shall be provided wherever required by the application. Shock & Vibration proof.

H. Test & Examination

1. All valves shall be tested in accordance with the quality assurance programme agreed between the Owner / consultant and the Contractor which shall meet the requirement of IBR and other applicable codes.

2. The tests shall include but not but limited to the following:

   - Non-destructive test as per ANSI B – 16.34.
   - Hydrostatic shell test in accordance with ANSI B16.34 prior to seal leakage test.
   - Valve closure test and seal leakage test in accordance with ANSI B16.34 and as per the leakage class indicated under clause no. B.6.
   - Functional test: The fully assembled valves including actuators control devices and accessories shall be functionally tested to demonstrate times from open to close position.
   - All control valves shall be tested with the positioners for accuracy of positioning and reproducibility over the full range of travel.
   - CV Test : CV test shall be carried out as type test on each size, type and design of the valves as per AISA 75.02 standard and test report shall be furnished for Owner's / consultant's approval.
   - Magnetic particle inspection shall be performed on all machined surfaces of valves having ASA rating of 1500 lbs ASA or greater. All carbon steel valves with 1500 lbs ASA or greater shall receive 100% radio graphic examination in accordance with ASTM – E71.

3. Contractor shall submit test certificates for the tests mentioned in above paragraphs in accordance with ASME and ASTM requirements. In addition Contractor shall also submit for the above equipment, certificate of manufacture and test as required by the Indian Boiler Regulations. The certificate shall be in the prescribed forms III A & III C and shall be endorsed by an Inspection Authority recognized by the Indian Boiler Regulations.

I. General Requirements

1. Contractor shall furnish all the control valves as finalized during detailed engineering stage without any price repercussions whatsoever depending on the process requirements.
2. Following documents to be furnished by the Contractor after the award of contract.
   a. Final data sheet for all control valves.
   b. Detailed dimensional and cross-sectional drawing of control valves, indicating end to end dimensions, various clearances required, weight etc.
   c. Test certificate for the following :
      - Hydrostatic test for all control valves
      - Magnetic particle inspection for all control valves.
      - Radiographic examination of control valves.
      - Seal tightness test for control valves
      - Materials test certificate for control valves.

8. PROGRAMMABLE LOGIC CONTROLLER (PLC)

This section covers the minimum specification for the PLC for TG auxiliaries as specified in clause 7.9 & for the offsite packages such as Emergency DG System & HVAC system.

8.1 General Technical & Design Requirements

1. Programmable Logic Controller (PLC) shall be microprocessor-based system. The PLC shall be versatile, expandable, user friendly and latest state of art technology. The system shall be envisaged for the purpose of sequential operation, protection and interlock, data acquisition system, alarm functions, closed loop control and data archiving for fully automatic operation. Logic controller shall be provided with adequate and reliable protection safeguard for various equipments and to assist the operator for easy safe and efficient starting and stopping of various drives in the process. The system shall be designed by selecting high-grade components of proven quality and proper design of system electronics. The system shall be able to operate satisfactorily with reference to the specified environmental conditions as indicated in the specification.
2. The system shall be modular in construction and expandable in future by adding additional electronic modules, which shall be easily accessible for maintenance and repair. The modules shall preferably be Rack/Rail mounted. The types of modules shall be kept to minimum possible in order to have interchangeability and spares inventory.
3. The system shall have extensive self-diagnostic hardware and software features for easy and fast maintenance of the PLC. Safety barriers shall be provided for intrinsically safe input / output circuits.
4. The PLC shall have very high noise immunity in order to ensure safe and reliable operation when subjected to electrical radio frequency interference and electromagnetic disturbances expected in a power plant.
5. The system shall be programmed as per the logic requirements required for the functioning of the systems and equipment. Contractor shall prepare their own logic / ladder diagrams depending upon the capability of the programmable logic controller offered by them.
6. Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.
7. On-line replacement of any module shall be possible in such a way that the removal and addition of the module shall be possible without de-energizing the system or causing any interruption in the system while replacing a faulty module except for the inputs /outputs which are being handled by that module. However, in case of triple modular

redundant or dual PLC configurations, there shall not be any process upset while replacement.

8. PLC shall be provided with 20% hard wired installed spares and 20% I/O channels.
9. The system shall be capable of handling the long-term storage of data for 15 days and retrieval.
10. The system shall be provided with programming and diagnostic facility. Each PLC shall be provided with one no. Laptop of latest configuration with programming software & communication cable.

8.2 PLC System Configuration

PLC shall consist of following sub systems:

8.2.1 Input/Output Sub system

1. I/O subsystem shall be suitable for accepting discrete inputs, BCD inputs and analog inputs. The I/O modules shall be mounted in the I/O racks.
2. Each I/O shall be electrically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 500 V DC.
3. Each module shall have LED for each digital I/O channel to indicate the status of each input / output. Redundancy in I/O level shall be maintained as per the process requirement.
4. PLC inputs shall be provided with potential free dry contacts. All the inputs shall be double ended i.e., two wires per input and not common return for all inputs. The contact interrogation voltage for input contacts shall be 24V DC minimum. Each input channel shall be protected by separate fuse.
5. Output contacts from the PLC shall be potential free dry contacts. Each output shall be short-circuit proof and protected by fuse.
6. Visual indication of fuse blown must be provided for each input and output channel and should be alarmed
7. There shall be at least 20% spare capacity available on input & output modules, over and above the system requirement.
8. All input/output cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching of power supply.
9. The Contractor shall provide the following monitoring features:
   - Power supply monitoring.

- Contact bounce filtering.
- Optical isolation between input and output signals with the internal circuits.
- In case of power supply failure or hardware fault, the critical outputs shall be automatically switched to the fail-safe mode. The fail-safe mode shall be intimated to the successful Contractor during detailed engineering.

10. Further, keying-in of individual wire connectors shall be provided to ensure that only the correct card is plugged on the I/O module. It shall be possible to remove I/O module without disconnecting wiring from field inputs or outputs.

8.2.2 Processor Sub system

1. The processor sub system shall include CPU, memory, power supply, communication interface etc.
2. Dedicated PLC's shall be envisaged for each Auxiliary system. The processor shall have capability to implement all the control functions required. The processor shall have sufficient memory for storage of the program instructions as applicable to the logic requirements. CPU shall be of 32/64 bit or upgraded version of microprocessor.
3. Memory shall be non-volatile, preferably EEPROM type. However, in case volatile memory is provided, battery back up shall be provided for a minimum of three months to keep the stored program intact. A battery drain indication shall be provided at least one week before the battery gets drained. Memory shall be provided with adequate capacity with 40% spare capacity under worst loading condition.
4. The healthiness of processor hardware and software shall be continuously monitored by watchdog timer.
5. PLC's shall be provided as a minimum with dual redundant processor subsystem including CPU, memory and power supply. Redundancy shall be provided such that, in case of failure of the main processor, the standby processor shall take over automatically and vice - versa. The changeover shall be bumpless and shall not result any process or system upset.
6. In case of failure of complete processor system i.e., both processors, outputs shall take fail safe state automatically.
7. The scan time of programmable controller shall be of the order of 100 milliseconds or better. Scan time of PLC is defined as the cycle time taken by the system to read input, process input executing logic and update control output for all the logics configured within the system. Other activities like diagnostic routines, output / dump of data to

peripherals, or any other activity which consume processor time shall also be accounted while computing scan time.

8.2.3 Communication Sub system

1. The communication subsystem shall provide reliable and high speed data transfer between the processor subsystem, I/O subsystem, PLC console and other devices connected to the system.
2. Redundancy in communication subsystem shall be provided, such that on the failure of the active device, communication link or bus, the redundant device communication link or bus shall take-over automatically without interrupting the system operation. The communication bus shall be of coaxial / Fibre optic type.
3. Information about the failed device shall be displayed locally as well as on the PLC console. It shall be possible to manually switch-over the communication from main bus device to redundant bus device without interrupting the PLC functions.
4. The offered PLC shall have provisions of communication interface facility with Plant DCS system in order to make the entire system operational from CCR. Bi-directional, Redundant OPC links shall be provided in the PLC for the connectivity with the Plant DCS. All the required redundant Fibre Optic Cable Interface Modules on PLC side are included in the Contractor's scope.
5. Following are also in the scope of supply & work of the Contractor:
   - Cables required for interfacing with Plant DCS.
   - Implementation of Tags and establishing the Link.
   - Any other software/hardware required.

8.3 System Power Supply

1. For PLC system, redundant 24 V DC power supply shall be provided by the Contractor. The required power supply cable shall be provided by Contractor from the UPS DCDB & ACDB as explained in clause 6.2.14 for TG integral control system
2. For separately mounted I/O racks, separate power supplies shall be provided. Power supply module shall be of ample capacity to supply all modules. In addition 20% spare capacity for future shall be provided. All the drives shall be switched ON/OFF through 24V DC coupling relays to be provided in HT/LT SWGR panels. The exact power supply scheme shall be as approved by Owner during detailed Engineering stage.
3. For the Operator Stations and Engineering Station the power supply shall be from the 220 V, AC, UPS system.

8.4 PLC Console

1. PLC Console or operating panel/display panel shall be provided as operator Interface station for control and monitoring of the plant. This shall be done through dynamic mimic displays and control displays.
2. PLC console shall also be used for program storage, display, fault diagnostic and alarm monitoring. It shall be possible to modify, add or delete the application program on-line without affecting the outputs. It should be possible to modify or create new displays from PLC Console.
3. Isolation shall be provided between programming terminal and related subsystems, if there is any possibility of high voltage from TFT being transmitted to other subsystems.
4. The offered PLC system shall have provision to shift the Operator Station/Engineering Station to the CCR in future with third party interactive communication facility.

8.5 Displays

The system shall be capable of reading the status of equipments, acquiring the analog signals, displaying the status in the form of mimic diagram, video trend, bar graph, periodic display, alarm display, alarm overview display, logs such as hourly/shift/daily logs, alarm logs etc.

Displays include plant mimic diagrams, which shall include the complete auxiliary plant system indicating each major components of the system and the operating status of individual equipment and devices

8.6 Alarms

1. The system shall display history of alarms in chronological order of occurrence on the Operator Station TFT. At least three (3) levels of alarm priority shall be available which shall be displayed in different color. It should be possible to display and print alarms. System shall have all alarm related functional keys like acknowledge, reset etc. Other design features like set point / dead band adjustment, alarm priority, manual and automatic inhibition based on predefined logic etc. shall be provided, which shall be as finalized during detail engineering.
2. The alarm display shall be built bottom up with the most recent alarm at the top of the list. When a point returns to normal, the associated alarm line shall change color suitably and on acknowledgement, the line shall be blanked out.
3. The alarms below the blank lines shall move upward to fill the empty lines. If the capacity of the OWS display page is exceeded, alarm

history shall be stored in memory to accept the over- flow. This alarm history shall be displayed upon operator demand. The format and details of alarm displays shall be finalized during detail engineering.

4. When a point goes into an alarm state and appears on the alarm screen, the time of alarm will flash until acknowledged by the operator. Acknowledgement by the operator will cause the time to stop flashing. All alarm initiations and return to normal, shall be logged on a printer.

8.7 System Software

1. Complete licensed software for PLC based system including the communication software system shall be supplied and implemented to meet completely the specification requirements.
2. Application software shall be built based on approved logic diagram, graphics etc and shall include controls, graphics, logs, trends, historization, report generation etc.
3. The system software shall include all programs for the PLC and PLC console which are required to perform all the PLC functions including communication and self-diagnostics.
4. Diagnostic software shall have the capability to provide information about the failed module / system either in the form of a system configuration display or provide information in the form of a statement.
5. The Contractor shall provide software license for all the software provided for the project. The software's shall not be machine specific. All software licenses shall be valid for the continuous service life of the plant and equipment.
6. Password security shall be provided in order to ensure security level to the plant operation.

8.8 Peripherals

1. All peripherals shall conform to the minimum requirements indicated in the specification, the exact make and model number shall be as approved by the Owner/consultant during detailed engineering stage.
2. VDU/ TFT shall be multi-sync, 21" colour monitor with intelligent terminal and key board. TFT shall be provided with graphic and mimic capabilities with minimum 64 distinct colors. The graphic resolution shall be 600x 1280 dots minimum with 0.25 mm dot pixel and refresh rate shall be 85 Hz or better.
3. Suitable optical filter for minimum secondary glare shall be provided.
4. The color laser printer shall be automatic duplex printing type suitable for printing A4 size paper. Printing speed shall be minimum 6 ppm for

color and 24 ppm for black and white. The printer shall be heavy-duty type with minimum 50,000 pages/month printing capability, 600 dpi resolution, 128 MB memory and 3000 sheet input capability.

8.9 Inspection & Testing

The Contractor shall furnish the complete FAT procedure to Owner/consultant for approval during detail engineering and shall inform Owner the schedule of FAT to enable Owner/Consultant to witness the same. The following tests shall be performed as a minimum:

1. System pre-test: This shall be of physical check of all modules, racks, cabinets etc.
2. System power-up test: This shall test functionally all hardware and software.
3. Functional testing which shall include the following as a minimum

   - Complete system configuration function check and loading.
   - Demonstration of all PLC system functions.
   - 100% checking of logics configured in the PLC.
   - Checking of scan time.
   - Checking of all PLC console functions and operation in association with peripherals.
   - System redundancy checks including correct changeover of the back up unit in case of failure of main unit and vice versa.
   - System diagnostic checking for all subsystems, including checking of the testing software for I/O modules signal conditioning modules, CPU, Memory etc.
   - Checking of output status on processor failure.
   - Simulation of power failure and system restart.
   - Auto boot up of system configuration and program after power restoration.

The PLC system shall be tested at site after installation and commissioning with all inputs and output connected. All the tests conducted during FAT shall be carried out during site testing.

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BHEL	**DATA SHEET FOR PLC SYSTEM**	SPECIFICATION NO.:	
		VOLUME	
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Data Sheet No.: **PES-145-36-DS2-0**

Data Sheet A & B

		DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)	DATA SHEET – B (TO BE FILLED BY BIDDER)
GENERAL	PROJECT	2X500 MW NNTPP (TG & SG PACKAGE)	
	SERVICE	AC & VENTILATION SYSTEM	
	QUANTITY	☐ UNITISED ■ COMMON	
	LOCATION	■ INDOOR ☐ OUTDOOR ■ AC ☐ NON-AC	
PLC EQUIPMENT	MAKE / MODEL NO.	BIDDER TO INDICATE	
	PROCESSOR	REDUNDANT WITH HOT STANDBY	
	DATA BUS (HMI)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	DATA BUS (I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	DATA BUS (REMOTE I/O - CPU)	☐ COPPER WIRE ☐ FIBRE OPTIC	
	FIELD CONTACTS INTERROGATION VOLTAGE	■ 24 V DC ☐ 48 V DC ☐ 110 V AC	
	LOCATION OF COUPLING RELAYS	■ MCC ☐ PLC PANEL	
	DESKTOP OWS QUANTITY	■ ONE/UNIT ☐ TWO ☐ _____ ☐ DESKTOP VERSION ☐ SERVER VERSION ■ WORK STATION VERSION REQUIREMENT OF OWS IN CCR ☐ YES ■ NO QUANTITY_____	
	DESKTOP MONITOR TYPE	☐ 19" ■ 21" TFT MONITOR ☐ GIU ☐ OTHERS	
	PRINTER	INKJET ☐ A3___NOS ☐ A4___NOS LASER B/W ☐ A3___NOS ☐ A4___NOS COLOR INKJET ☐ A3___NOS ☐ A4___NOS COLOR LASER ☐ A3___NOS ■ A4 ONE/UNIT	
	LAPTOP QUANTITY	ONE/PLC	
	PROGRAMMING / CONFIGURATION FACILITY	A) ☐ HAND HELD ■ LAPTOP B) ENGINEERING SOFTWARE ☐ ONE OWS ■ ALL OWS INCLUDING LAPTOP ☐ _____	
	SAFETY STANDARD	☐ SIL-3 ☐ SIL-2 ■ NIL	
	COMPUTER FURNITURE	■ YES ☐ NO INDUSTRIAL GRADE ■ YES ☐ NO	
SPARE LIST	SPARE LIST	☐ START UP & COMMISSIONING ■ MANDATORY SPARE ☐ RECOMMENDED	
	SPARE LIST ATTACHED	■ YES ☐ NO	
REDUNDANCY	CPU	■ YES ☐ NO	
	POWER SUPPLY	■ YES ☐ NO	
	COMMUNICATION	■ YES ☐ NO	
	I/O CARD	■ YES , AS PER PROCESS REQUIREMENT (TO BE DECIDED DURING DETAIL ENGG.)	
	OTHER ELECTRONICS	☐ YES ■ NO	

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	DATA SHEET FOR PLC SYSTEM	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 2

Data Sheet No.: **PES-145-36-DS2-0**

Data Sheet A & B

		DATA SHEET-A FOR PLC SYSTEM (TO BE FILLED BY PURCHASER)	DATA SHEET – B (TO BE FILLED BY BIDDER)
No. of CHANNELS PER CARD	ANALOG INPUT	☐ 8 NOs ■ 16 NOs	
	ANALOG OUTPUT	☐ 8 NOs ■ 16 NOs	
	BINARY INPUT	☐ 16 NOs ■ 32 NOs	
	BINARY OUTPUT	☐ 16 NOs ■ 32 NOs	
	RTD**	4 NOs	
	THERMOCOUPLE**	8 NOs	
	ELECTRONIC CARD ISOLATION	☐ GALVANIC ■ OPTICAL ☐ OTHER	
PANEL	QUANTITY	BIDDER TO INDICATE	
	CLASS OF PROTECTION (Refer Location of PLC)	IP 42	
	REMOTE I/O PANEL	■ YES ☐ NO AC REQUIREMENT ☐ YES ■ NO	
	COLOUR	TO BE DECIDED DURING DETAIL ENGG.	
	BACK-UP DESK	☐ YES ■ NO	
	MIMIC	☐ YES ■ NO IF YES,THEN ☐ PANEL MOUNTED GUI ☐ ACRYLIC	
	CONTROL HARDWARE	■ PB ■ INDICATORS ■ FACIAS (AS APPLICABLE/REQUIRED)	
	CONFORMAL COATING	☐ YES ■ NO	
COMMUNICATION WITH OTHER SYSTEM	HARDWIRED	■ YES (LIMITED)	
	PURPOSE	☐ CONTROL ■ MONITORING	
	MEDIUM	☐ UTP ■ FIBRE OPTIC ☐ OTHERS	
	TIME SYNCRONIZATION SIGNAL FORMAT	☐ PULSE ☐ RS-485 ■ IRIG-B ☐ NTP	
	SOFTLINK	☐ MODBUS ■ OPC IF MODBUS THEN ☐ RS-485 ☐ ETHERNET	
	SERIAL LINK	COMMUNICATION PORT TYPE _____	
POWER SUPPLY INPUT FEEDER	PLC PANEL	BIDDER TO INDICATE LOAD DATA	
	REMOTE I/O PANEL	BIDDER TO INDICATE LOAD DATA	
POWER SUPPLY	SOURCE	■ UPS(INDUSTRIAL GRADE) ☐ 24V DC CHARGER	
	BATTERY TYPE	☐ Ni-Cd ■ LEAD ACID ☐ OTHERS	
	BACK-UP TIME	■ 30 MINS ☐ 60 MINS ☐ OTHERS	
	BATTERY CONFIGURATION	☐ 1X100% ■ 2X100% ☐ 2X50%	
CUSTOMER TRAINING	TRAINING	■ REQUIRED ☐ NOT REQUIRED	
	NO OF DAYS & PERSON	7 DAYS & 4 PERSONS	
	LOCATION	TO BE DECIDED DURING DETAIL ENGG.	

**SHALL NOT BE APPLICABLE IF TEMPERATURE TRANSMITTERS ARE ENVISAGED.

Checklist for Serial Communication between maxDNA Systems and Foreign Device :BHEL

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Modle No.& Make of Device		
2	Communications Link Options	☐ Multidrop ☐ Peer to Peer ☐ N/w topology attached	
3	Protocol Mode (Device is a)	☐ Master ☐ Slave ☐ Master/Slave	
4	Protocol	☐ RTU ☐ ASCII ☐ Other ----------	
5	Master	☐ System maxDNA ☐ Other ----------	
6	Dist.bet.maxDNA System & Device*	☐ ---------- Feet ☐ ---------- Meters	

B Electrical Spcific :

1	Interface Type	☐ RS232 ☐ RS422 ☐ RS485	
2	Wiring at Device end	☐ 2 Wire ☐ 4 Wire	
3	Transmission Channel	☐ Half Duplex ☐ Full Duplex	
4	Baud Rates (bps)	☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200	
5	Databits	☐ 8 ☐ 7	
6	Stopbits	☐ 1 ☐ 2	
7	Parity	☐ None ☐ Odd ☐ Even	
8	H/w & Software Handshake	☐ Yes ☐ No	
9	Response Timeout time (Sec)	☐ ---------- ☐ Configurable timeout	
10	Data Formats Supported	☐ Boolean ☐ Real ☐ Char ☐ Sn.Int ☐ UnSn.Int	
11	Transmission mode	☐ Asynchronous ☐ Synchronous	

C Application Specific : *

1	Primary Function*	☐ Data Acquisition ☐ Data Acquisition & Control			
		☐ Download parameter sets			
2	Analog Points to read	--------Nos.	☐ Details attached	☐ Details not attached	
3	Analog Points to write	--------Nos.	☐ Details attached	☐ Details not attached	
4	Digital Points to read	--------Nos.	☐ Details attached	☐ Details not attached	
5	Digital Points to write	--------Nos.	☐ Details attached	☐ Details not attached	
6	Memory / Flag Points to read	--------Nos.	☐ Details attached	☐ Details not attached	
7	Memory / Flag Points to write	--------Nos.	☐ Details attached	☐ Details not attached	

D Hardware Specific :

1	Cable type	☐ Boolean cable	☐ Twisted pair cable	
2	Cable Details Enclosed	☐ Yes ☐ No		
3	Any specific Converter required	☐ Yes ☐ No	☐ Details enclosed	

E Device Documents :

1	Manufacturer's Documents*	☐ Tech., Spec.	☐ Operating Manual	

***Notes:**

A6 To identify converter requirement and cable length.

C The sr.no.1 to 7 are reqd.to be furnished for interface impl. :such as Tagname,Description,point type, modbus(Register) address,EU,range & device (dlave) address

C1 What is the primary purpose of the communications link?

E1 Reqd. Contents : This document must provide an overview of the device including its intended use(a general technical,communication & electrical details)

Format for vendor to furnish signal
Exchange list between DCS-PLC

Tag Name	Tag Description	Modbus address	Point type	Range	Alarm Setpoint	Alarm priority	History reqd	Function code	

PEM :: C&I

STANDARD QUALITY PLAN FOR PROGRAMMABLE LOGIC CONTROLLER

QUALITY PLAN NO.:	**PE-QP-999-145-I036___**
VOLUME	IIB
SECTION	D
REV. NO.	01 DATE: 24.08.2007
SHEET	1 OF 8

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	**Materials /Components**											
1.1	Panels & Control Desks	Physical Inspection for Dimensions, Painting, Cutouts, Lifting / Locking Arrangements, Components, Drawing Pocket, Mounting accessories, Plinth & AV Pads, Cable Gland Plates, Hardwares, Hinges, Louvers & Filters, Fans & Panel Lamps	MA	Visual	100%	Contract specifications, Approved GA Drawings, BOQ	As per ref documents. No physical damage.	BHEL Quality Inspection Report.	3/2	2	1	
1.2	Power Supply/Packs, Battery & Battery charger, Transformer, UPS.	Physical Inspection Physical Damages Dimensions Mounting Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per reference documents, Test Report	BHEL Quality Inspection Report.	3/2	2	1	
1.3	Indicating Lamp, Annunciator, Meters, Transducers, Signal Converters, Instruments, Single Loop Controllers	Physical Verification Physical Damages Dimensions Accessories	MA	Visual	100%	Contract specifications, BOQ.	As per ref documents No physical damage. Test/ Calibration report.	BHEL Quality Inspection Report	3/2	2	1	
1.4	PLC processors, I/O modules, Power Supply modules, Communication modules, Mounting Racks, Ethernet	Physical Inspection • Identification Labels • Physical Damages • Quantity • Spare Capacity	MA	Visual	100%	Product Catalogue, Data sheets, Approved Configuration diagram, BOQ	As per ref documents. Test Certificates	BHEL Quality Inspection Report.	3/2	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 2 - Vendor 3 - Sub-vendor

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	
1.5	CPU, Monitor, Keyboard, Mouse, CD Drives, Printers, OS, System Software, Engineering software in the form of Licensed CD.	Physical Inspection Identification Labels, Tech. Specification Physical Damages Accessories Installation arrangements for Computers & Printers	MA	Visual	100%	Contract specifications, Product Catalogue, Approved GA / Configuration drawing, BOQ.	As per reference documents.	BHEL Quality Inspection Report.	3/2	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; 2 - Vendor; 3 - Sub-vendor

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	**Assembly**											
2.1	Functional Test for HMI/OWS devices such as Monitors, Keyboards, Mouse, Printers etc.	Operation	MA	Functional	100%	Approved Configuration Diagram & BOQ and FAT	Correct Operation of interconnected Devices of HMI system.	BHEL Quality Inspection Report.	2	1	1	
2.2	Hardware Functional Verification.	Physical arrangement, Wiring check & labeling, Continuity Checking, IR & HV test	MA	Visual/ Electrical	100%	Approved GA Drawing, Panel Wiring Diagram, IR & HV as per relevant International standard	Test Certification	BHEL Quality Inspection Report.	2	2	1	
2.3	Powering Up	Healthiness of all the modules/equipment, associated with Powering of PLC system	MA	Visual /Electrical	100%	Approved power supply scheme	All equipment to be healthy on power ON	BHEL Quality Inspection Report.	2	1	1	
2.4	Burn in test for PLC modules	Healthiness of PLC modules on Continuous Energisation, Temperature maintenance	MA	Visual/ Electrical	100%	FAT Procedure	Test certification as per FAT	BHEL Quality Inspection Report.	2	2	1	

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

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1 - BHEL 2 - Vendor 3 - Sub-vendor

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	
3.0	**Factory Acceptance Test (FAT)**											
3.1	Input Output Functional Verification	I/O configuration, I/O operation	MA	Visual/ Eletrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.2	Processor Verification	Processor configuration, Powering up, standby operation (as applicable) and Loading	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.3	Power Supply Module Verification	Redundancy Operation	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.4	Communication System Verification	Redundancy operation of Communication System, Measurement of Response Time, Communication with third party system	MA	Electrical	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.5	Diagnostic Verification	Self Diagnostic features of PLC system	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.6	Control Panel/Desk Verification	Operation of PLC driven annunciation system, Mosaic, Push buttons & selector switches, Indicating lamps	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality Inspection Report.	2	1	1	
3.7	Software Verification	(i) Control Logics (ii) Engineering Features (iii) HMI Features	MA	Visual	100%	FAT Procedure	AS per FAT	BHEL Quality 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

FACTORY ACCEPTANCE TEST (FAT) PROCEDURE

This document covers procedure to conduct/witness PLC system functional tests in order to demonstrate conformity to purchase specifications and related engineering documents. The test shall be conducted at the system suppliers works. The system supplier shall conduct all functional tests before commencing FAT and test results shall be made available during FAT. Vendor must furnish following relevant drawings, duly approved by BHEL Engineering, for reference during FAT.

a) Technical Specification of PLC.

b) PLC System Configuration

c) General Assembly Drawings.

d) Panel Wiring Diagrams.

e) Bill of Quantity for PLC System.

f) Logic Diagram.

g) HMI Schematics.

h) Input / Output List.

Further the vendor shall furnish applicable product specification, datasheets, catalogues, test-certificates, and internal inspection records to enable FAT. Vendor shall also submit, to the inspecting agency, his standard test procedure, for clauses given below; where vendor's standard practice has been referred.

APPLICABLE TEST PROCEDURE:

1. Input/Output Functional Verification.

Check for correctness of addressing of racks, slots and I/O modules as per applicable PLC configuration diagram. Appropriate signal generators shall be used to simulate Inputs and outputs to check operation and SCAN time. Check online replacement of cards, processors, power supply etc.

2. Processor Verification

PLC Configuration drawing to be referred for ascertaining

i) Redundancy

ii) Type (Hot or Cold)

Both the processors are to be checked for healthiness in case of redundant configuration as per vendor's standard practice. In case of hot redundancy, switchover of control from primary processor to standby processor shall be demonstrated for uninterrupted control and data processing as per vendor's standard practice. Switchover shall be witnessed, by manual power off or resetting the Primary CPU or simulating failure of primary processor. Checking should be by witnessing the lighting up of Processor's LEDs as per manufacturer's product standard.
Vendor shall demonstrate, as per Vendor's standard practice, adequate Loading (Spare Capacity) of Processors, as mentioned in contract specs. This shall be done, by simulating worst load operation of fully integrated PLC system.

3. Power Supply Module Verification

Check if PSM is in redundant mode as per specification. Check the healthiness of power supply from both the modules' lamp indication/measurement. Simulate failure of one PSM and verify that standby PSM has taken over without any interruption.

4. Communication System Verification

Communication system has to be in line with approved PLC Configuration Diagram. Verify that both the communication buses are intact and connected. Communication between PLC processors, I/O rack, OWS etc. is to be checked through simulation of input data. Simulate the bus failure by disconnection of working bus. Check that the communication continues without interruption or loss of data.

Following response times are to be demonstrated as per vendor's standard practice for conformance to contract specifications:

1. Screen update time
2. I/O scan time
3. SOE resolution time
4. Data transfer time with third party system using Communication Protocol as per Contract specification and as per quantum of data as per approved signal exchange list.

5. Diagnostic Verification

Product Catalogue/Literature shall be referred for checking of all diagnostic features. Hardware failure to be simulated by removing an I/O

6. Control Panel /Desk Verification

i) PLC driven annunciation system should be checked by alarm signal simulation.

ii) Push Button and selector switch operation should be checked by verification of corresponding change of status of Data Base point.

iii) Indicating lamp / MIMIC should be checked by corresponding Data Base point simulation.

7. Software Verification

i). Control Logics:– Software switches, lamps and Analog sources shall be used for simulation of field conditions .Control logics shall be checked for its correct functionality as per approved logic schemes

ii). Engineering features:-
a) Online changing of parameters, set points.
b) Online modification in Control Logic Diagrams.
c) Online configuration of Graphics, Trends, Logs, HSR.

iii). HMI features:-
Check for configuration & operation of Graphics, Trends, Logs, HSR and Alarms, in the form of Displays and Printouts, by simulation of Inputs as per approved documents.

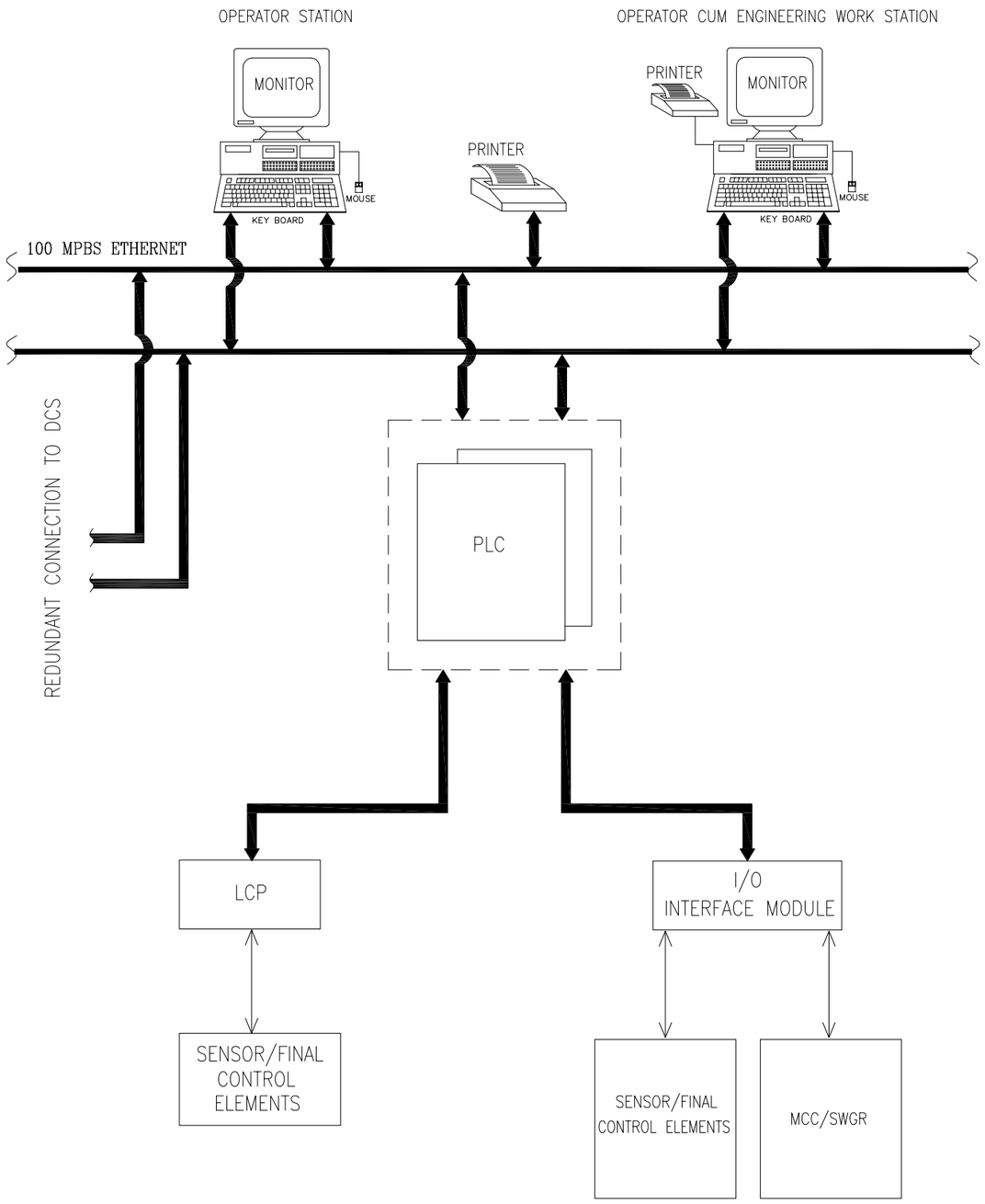
8. Burn in Elevated Temperature test

Electronic equipments shall be subjected to Burn in elevated temperature test as per the procedure detailed below:

a) (i) PLC modules are kept at 50 Deg c under continuous energized condition for 48 hours.

ii) 48 hours test period shall be divided into 4 equal time segment of 12 hours duration each. For every 12 hours duration segment, after lapse of first 11 hours 110% of nominal voltage shall be applied to the panel under test for a period of 30 minutes followed by application of 90% of nominal voltage for the next 30 minutes.

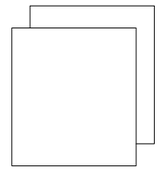
b) Assembled Panels with complete wiring shall be kept under continuous energized condition for 120 hours at ambient temperature. Temperature rise in panels should be below 10 Deg C above ambient.



NOTES:–

1. PLC SYSTEM SHALL BE PROVIDED WITH DUAL REDUNDANT POWER SUPPLY, CPU & COMMUNICATION.
2. PLC SYSTEM SHALL BE INTERFACED WITH DCS FOR MONITORING FROM CCR THROUGH REDUNDANT OPC LINK BY FIBER OPTIC CABLE.

ABBREVIATION:–



DUAL REDUNDANT

DCS	DISTRIBUTED CONTROL SYSTEM
I/O	INPUT/ OUTPUT
PLC	PROGRAMMABLE LOGIC CONTROLLER
MCC	MOTOR CONTROL CENTER
SWGR	SWITCHGEAR

FOR REFERENCE ONLY

REV. No.	DATE	DEM	DEC	DEE	DEI	DESCRIPTION
		CHECKED				
02	25.06.11				AJV	
01	27.05.11				AJV	
00	06.05.11				AJV	

NEYVELI LIGNITE CORPORATION LTD, NEYVELI, TAMILNADU

LAHMEYER INTERNATIONAL INDIA

LAHMEYER INTERNATIONAL (INDIA) PVT. LTD.
CONSULTING ENGINEERS, GURGAON, INDIA

CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	PS	06–MAY–11
DESIGNED BY	SM	06–MAY–11
CHECKED BY	AJV	06–MAY–11
APPROVED BY	UJR	06–MAY–11
SHEET SIZE	A3	
SCALE	NTS	

PROJECT : 2 X 500 MW NEYVELI NEW THERMAL POWER STATION

DRAWING TITLE : TYPICAL PLC BASED CONTROL SYSTEM CONFIGURATION BLOCK DIAGRAM

DRAWING NO : LII–GEOE11019–G–00172–325 | REV. 02 | SHEET 1 OF 1

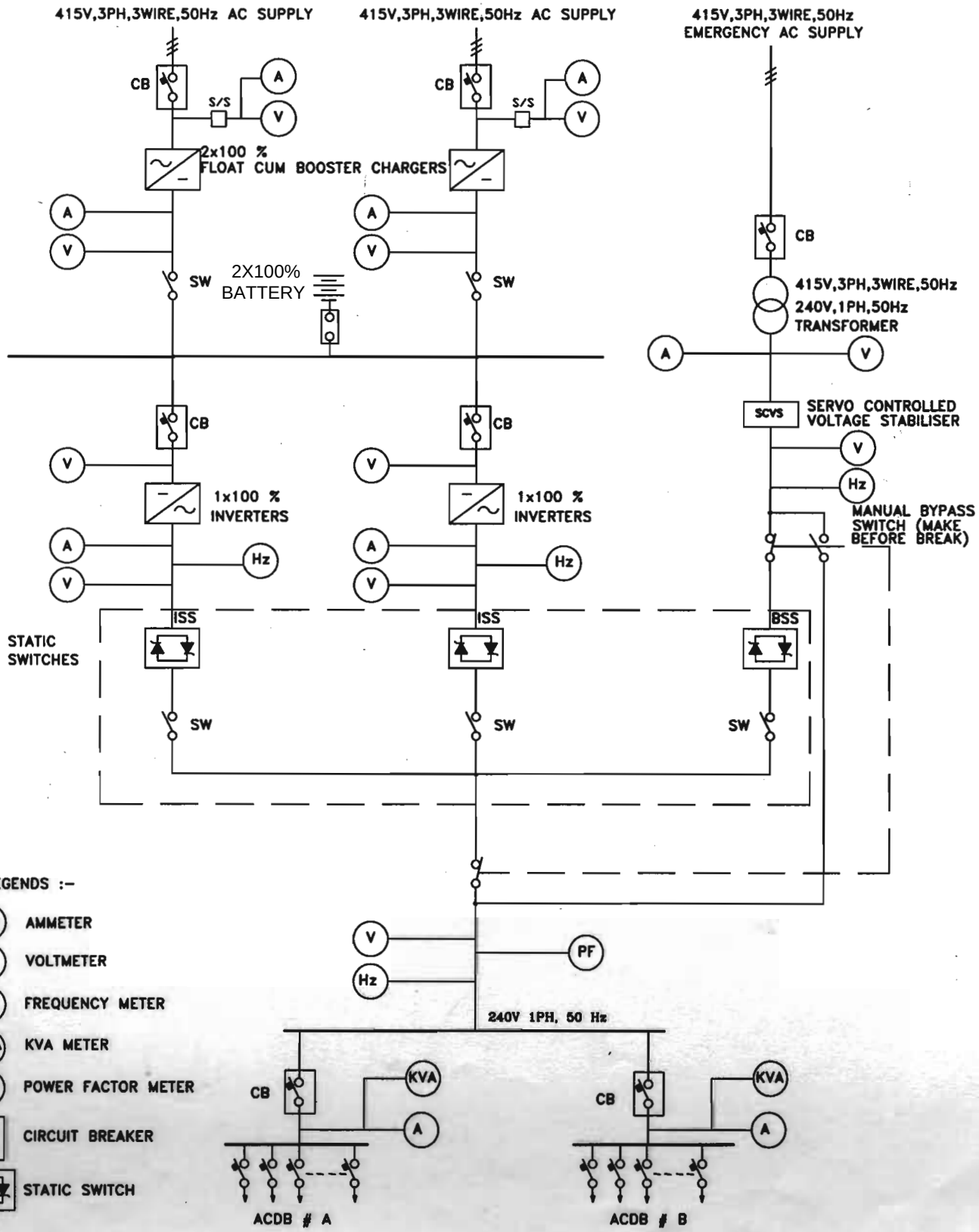
FORM NO. PEM - 6666-0

BHEL

TITLE :-

UPS SCHEME

SPECIFICATION NO. PE-SS-999-145-I035	
VOLUME II B	
SECTION D	
REV. NO. 00	DATE
SHT 11 OF 11	



NOTE:-
1. MIMIC PANEL SHALL BE PROVIDED.
2. TRANSDUCERS FOR VARIOUS METERS SHALL BE PROVIDED FOR GIVING 4-20mA ISOLATED SIGNALS FOR DAS.
3. FEEDERS IN ACDB SHALL BE PROVIDED WITH MCB's ON PHASE AND LINKS ON NEUTRAL.

G:\CI\COMMON\STANDARD\GENUSE\SPEC\UPSSCH

TECHNICAL SPECIFICATION
FOR
UNINTERRUPTED POWER SUPPPLY

1 SCOPE OF WORK

Scope of Supply

The scope of supply will include Uninterruptible Power Supply (UPS) System: Two (2) Sets (One set for each unit). Each set having minimum capacity of 2X100 kVA with 2X 100% Battery of 500 Ah.

a) Each UPS System set will comprise the following :

i)	100% Static inverter banks	:	2
ii)	100% Static switches	:	2
iii)	Manual bypass switch/breaker	:	3
iv)	100% UPS System battery banks	:	2
v)	100% Float-cum-boost charger	:	2
vi)	Static Voltage Regulator (SVR) with step down transformer and back up source static switch	:	1
vii)	UPS A.C. Power Distribution Board with MCCB	:	1
viii)	DC Breaker	:	2
ix)	Input/output MCCB	:	5

b)

c) All inter-connecting cables including those required for inter-connection within UPS equipment as mentioned a) above.

d) Mandatory Spare parts.

e) List of recommended spare parts for three (3) years satisfactory and trouble- free operation of the equipment for Purchaser's consideration.

f) All relevant drawings, data and instruction manuals.

Note: 40% cushion to be kept for Boiler area. Also, in the UPS DB, 40% feeders will be kept for Boiler area.

2 GENERAL REQUIREMENTS

2.1 Codes and Standards

a) All equipment and materials will be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) except where modified and/or supplemented by this specification. In case Indian Standards are not available for any equipment, Standards issued by IEC/BS/VDE/IEEE/NEMA or equivalent will be applicable.

b) Equipment and materials conforming to any other standard which ensures equal or better quality may be accepted. In such case, copies of the English version of the standard adopted will be submitted .

c) The electrical installation will meet the requirements of Indian Electricity Rules as amended up to date and relevant IS Codes of Practice. In addition, other rules or regulations applicable to the work will be followed. In case of any discrepancy, the more restrictive rule will be binding.

2.2 Annexures

2.2.1 All annexures appended to this specification will form part of this specification and supplement the requirements specified herein.

2.2.2 This specification will be read and construed in conjunction with the drawings and annexures to determine the scope of work and terminal points.

2.3 Completeness of supply

2.3.1 It is not the intent to specify completely herein all details of the equipment. Nevertheless, the equipment will be complete and operative in all aspects and will conform to the highest standard of engineering, design and workmanship.

2.3.2 Any material or accessory which may not have been specifically mentioned but which is necessary or usual for satisfactory and trouble free operation and maintenance of the equipment will be furnished.

2.3.3 The contractor will supply all brand new equipment and accessories as specified herein.

2.4 Guaranteed Performance

2.4.1 The proposal data sheets given in another volume of this package specification will be filled in without any ambiguity by typing in appropriate place on each page.

2.5 Drawing Approval

2.5.1 Before starting manufacture of any equipment, the contractor will have to take approval of relevant drawings and data from Owner/Consultant in writing.

2.5.2 Any manufacture done prior to the approval of drawings/data will be rectified in accordance with the approved drawings/data by the contractor at his own cost and the equipment will be supplied within the stipulated period.

2.6 Design Criteria

2.6.1 Design Basis

a) UPS System provides a regulated and uninterrupted single phase A.C. power, within specified tolerances, to critical station loads during normal and emergency operation.

b) The UPS system excluding its battery will be installed indoors in A.C. environment.

c) UPS system will be compatible for satisfactory and well-coordinated operation with other related equipment as well as with input and output systems.

d) Energizing or de-energizing any portion of the system serviced by the UPS will not cause output changes which will affect the operation or integrity of the remaining portions of the system in any way.

e) The equipment will be self-protecting against all A.C. and D.C. transients, voltage surges, and steady state abnormal voltages and currents.

f) The circuit protection will be coordinated with UPS short circuit capacity and protective device characteristics so that a fault on any circuit will result in minimum loss of function.

g) All non-interrupting components of UPS system will be capable of withstanding the prevailing short circuit current without damage.

h) All circuit interrupting components will be capable of withstanding and interrupting the prevailing short circuit currents without damage.

i) For continuous operation at specified ratings, temperature rise of the various components of UPS system will be limited to the permissible values stipulated in the relevant standards and/or this specification.

For selecting Battery capacity following data to be considered :

Maximum temperature	:	50 °C
Minimum temperature	:	8 °C
Battery backup time	:	30 minutes
Design margin	:	15%
Ageing compensation factor	:	1
Reference standard for Battery Sizing calculation	:	As per IEEE 446 Standard

k) UPS will have automatic on line battery health checking. It will have connectivity with the plant DCS status monitoring.

l) The chargers, inverters, static switches, regulating transformers and voltage stabilizers should be arranged in such a way that any equipment will be fully isolated for maintenance without affecting in any way the operation of other panels/ components.

m) In the A.C. Distribution Board, the contractor will provide 10% or minimum one (1) no. spare feeder of each size and type of the outgoing feeders.

n) The UPS system supplied will have provision to transfer UPS parameter/data to DCS (Including SG & TG Integral Control System).

Necessary data transfer software & hardware will be incorporated in the system for this.

2.6.2 System Concept

a) 3 nos. independent A.C. power sources are available to the UPS system. The system is so designed that its load will be served without interruption as long as one of the above power sources is available within specified limit of voltage and/or frequency.

The UPS will consist of two physically separate sets of equipment streams consisting of the following:

i) Two sets of converters to convert incoming 415V, 3 Ph, 50 Hz A.C. power to suitable D.C.

ii) Two sets of suitable Battery Bank to get charged by the above referred converter and to feed the inverter described below.

iii) Two sets of inverters to take D.C. input from above referred converter- Battery assembly output and to produce high quality 240V, 1Ph 50 Hz A.C. output power.

iv) Two sets of static switches, synchronizing circuit to parallel the above-mentioned Inverter output and bypass stabilized power stream.

v) One set of standby bypass stream consisting of suitable transformers, Static voltage regulator etc. to produce regulated 240V, 1 Ph. 50 Hz A.C. power from the 415V, 3 Ph. 50 Hz A.C. input from Station supply.

vi) One UPS A.C. power distribution board with suitable no. of outgoing feeders.

Two sets of equipment streams as mentioned above will constitute the UPS system.

One set of synchronizing equipment and high performance static switch will parallel the above two streams and common output will be taken to loads which can accept only single non-redundant power input source.

The system will ensure highest system availability around 99%.

b) Each of the two UPS streams will be of 100% capacity and will normally work, each sharing 50% load. On failure of any stream, its load gets automatically transferred to the other inverter through static transfer switch.

c) If one UPS stream is out of service for any reason then the second UPS stream will be working with 100% UPS load.

d) Inside each stream on failure of its converter/battery/inverter assembly the standby A.C. source will back up to supply the 100% UPS load automatically through static transfer switch.

2.6.3 Layout Criteria

a) The UPS system will be located indoor in Power House operating floor.

The inverter, static switches, chargers and distribution panels will be located in the UPS room. The batteries will be located in a separate battery room as shown in enclosed machine location plans.

The charger, inverters, static switches, regulating transformers & voltage stabilizers should be arranged in such a way that any equipment can be fully isolated for maintenance without affecting in any way the operation of other panels/components.

The equipment of the two UPS streams will be physically isolated with reasonable space between two installations.

b) Battery room ventilation will be under the scope of the Contractor.

c) Sufficient clear space will be provided for comfortable attending and removal of individual cells.

d) Sufficient clear space will be kept in the battery room to accommodate a battery of identical capacity in future.

e) Battery room will be acid proof type.

3 SPECIFIC REQUIREMENTS

3.1 Static Inverter

a) The static inverters will be static type consisting of IGBT PWM type inverter, static filters, integrated control modules including necessary oscillators, voltage regulators, current limiting and surge suppression.

b) The inverter equipment will include all necessary circuitry and devices to conform requirements like voltage regulation, soft start, transient recovery, protection, automatic synchronisation, wave shaping etc. as specified herein.

c) Upon transfer of full load, the inverter output voltage will not drop below 80% of nominal voltage during the first half cycle after transfer and 90% of nominal voltage in the next half cycle. The recovery to within ± 2% of voltage will be in less than 50 milli-seconds.

d) On occurrence of a fault in branch circuit, the inverter will be capable of clearing the highest rated branch circuit fuse in 4 milli-seconds or less.

e) The inverter will be protected against overload, short circuit, 100% loss of load, as well as excursions, loss or restoration of D.C. input voltage and synchronising voltage. The overload capacity will be 125% for 10 mins., 150% for 60 secs. and 300% for 4 msecs.

f) The D.C. input current will never exceed twice the full load current except for a short circuit within the inverter.

g) For any value of the load and load power factor drawn by the equipment served, the inverter will not impose on D.C. source any voltage oscillations in excess of 5 volts (RMS total all frequencies) or any current oscillations in excess of 3 percent (RMS total all frequencies) of the D.C. current at full load.

h) The inverter will be self protecting against A.C. and D.C. Transients, voltage surges and steady state abnormal voltage and currents likely to be encountered in the plant.

i) Under voltage(u/v), Over voltage(o/v) and earth fault protections will be provided for UPS (either separate relays or achieved electronically)

3.2 Automatic Synchronisation

a) Inverter equipment will include stable solid state oscillator devices designed to automatically maintain the inverter output in phase and in synchronism with the stand-by A.C. source.

b) Facility will be provided for automatic transfer to internal oscillator operation when the stand-by source frequency is beyond specified limits and the frequency will be automatically controlled within 50 Hz plus or minus 0.5 Hz when the inverter operates in this mode.

c) Retransfer to stand-by A.C. source for synchronisation will be automatic after the stand-by source frequency is restored to permissible limits and remains within this limit for an adjustable time delay period (up to 5 seconds).

d) Provision will be made for stepless adjustment of synch- disconnect frequency range from 50 Hz ± 0.5 Hz to 50 Hz ± 2 Hz.

e) Automatic adjustment of phase relationship between inverter output and stand-by A.C. source will be gradual at a controlled slow rate, which will not exceed one hertz per second.

3.3 Static Transfer Switch

a) The static transfer switch will be solid-state type using SCR for automatic/manual transfer of load from "inverter" to "stand-by" source and vice-versa.

b) Stand-by source can be either of the inverter or A.C. source depending on whether both the inverters are supplying 50% load each or one of the inverter is carrying 100% load.

c) The transfer time including sensing will be less than 4 m.secs. Further the transition will be make- before-break in both directions.

d) The capacity of static transfer switch will be equal to the continuous full-load capacity of the inverter. The switch will be provided with protective devices in both normal and alternate power source.

e) Static transfer switch will be furnished with contact to alarm failure of the alternate source or opening of any fuse protecting the static switch.

f) Static transfer switch will include all necessary circuitry and devices to meet the functional requirements of transfer initiation, transfer inhibit and re-transfer back to normal as detailed below :

g) Transfer Initiation

i) The transfer of static switch from normal 'Inverter' position to 'stand-by' position will be initiated by one of the following causes.

- Inverter failure and UPS system trouble.
- Inverter output voltage failure.
- Manual push button operation.

ii) The UPS bus will be monitored by two voltage detectors. One fast acting circuit will be used for detecting a complete and instantaneous voltage loss while the other slower acting averaging circuit with adjustable trip level will be employed to detect voltage deviation beyond selected limits. Both voltage detector circuits will automatically initiate operation of transfer switch.

iii) The static switch will automatic transfer the load from inverter to stand-by source when the maximum I2t capability of the inverter is reached and when the inverter output drops below 90%.

h) Transfer Inhibit

Automatic or manual transfer from inverter to stand-by A.C. source vice versa will be inhibited when the inverter frequency is not synchronised to the alternate source.

i) Retransfer to Normal

i) The return to inverter mode will be manual in all cases.

ii) Manual transfer will be initiated by push button actuation.

3.4 Manual By-pass Switch

a) Manual by-pass switch is used to isolate any static transfer switch for maintenance or repair without interruption to the UPS load.

b) The switch has also the facility of by-passing both the static transfer switches during start-up at the option of the operator.

c) Switch contact will be make-before-break type.

d) The switch will have current rating equal to the full load inverter current and necessary short time load carrying and interrupting capacity to meet the requirement of UPS system.

e) Breakers may be used instead of By-pass switch maintaining the same philosophy of operation.

3.5 Battery

a) General

i) The battery will be stationary Lead Acid 'Plante' type and will be suitable for operating satisfactorily in humid and corrosive atmosphere.

ii) The equipment will comply with the requirement of latest revision of following standards:

IS:1652 : Specification for Stationary cells and Batteries, Lead Acid type with plante +ve plates.

BS:6290 : Specification for Stationary cells and Batteries, Lead Acid type with plante +ve plates

Specification of battery will be as given in Section 7 (Battery & battery charger)

3.6 Float-cum-Boost Charger

3.6.1 Specification of Float cum booster charger will be as given in Section 7 (Battery & battery charger)

3.7 Step-down transformer and Static voltage regulator (SVR)

a) A three phase to single phase transformer along with associated voltage stabilizer will be furnished with the UPS system.

b) The transformer and SVR hall be sized for 100 per cent UPS load and will coordinate with the largest branch circuit protection device for feeder short circuit current without sacrificing voltage regulation.

c) The SVR will employ silicon solid state circuitry. It will maintain the specified output voltage within +/- 1.5% through out the load variation from 0 to 100% with maximum input voltage variation of +/- 10%. The make and rating will be subject to Purchaser's approval.

3.8 A.C. Distribution Boards

a) The DB will have one section with MCCB as incomer and will have bus healthy lamps, volt meter and ammeters. Outgoing feeders to the loads will be protected by semiconductor fuses with fuse monitoring devices, MCCBs and feeder 'ON' LED indication with glass fuse. Each load will be fed by two independent feeders terminated into a change over switch at the load point. The gland plate of the distribution board will be non-magnetic type having thickness 3mm.

Interposing relays / transducers /potential free contacts required for DCS (Including SG & TG Integral Control System) system will be mounted on the UPS distribution board.

b) The distribution boards will be fixed type, of modular design in freestanding gasketted sheet steel enclosure conforming to IP-54. Sheet steel thickness will be 2 mm minimum.

c) Each module will be housed in a separate compartment complete with individual front access door. Working height will be limited to 1800 mm from floor level.

d) A full height vertical cable alley will be provided in each panel to facilitate module wiring. The alley will be liberally sized and will have removable cover at the front. Removable back covers will be provided at the back of the panels.

e) Switches will be double pole, air break, heavy duty type, capable of safely making and breaking the full load current of associate circuit.

f) Switch handle will have position indicator and provision of padlocking in ON & OFF positions. Further it will be interlocked with access door for safety.

g) Fuses will be HRC, preferably link type, design to permit easy & safe replacement. 20% spare feeders will be provided in the DB. Visible indication will be provided for indication of fuse.

h) Provision will be made for giving 2 feeders to NTA 1 and four (4) feeders to NTA 3, besides own requirements.

3.9 UPS Cabinets/Enclosures

a) The UPS system components will be housed in a sheet steel freestanding IP-31 enclosure with all access from the front. Sheet steel thickness will be 2 mm minimum.

b) The enclosure will consist of vertical cabinets housing modules in rack type sub-assemblies, connected mechanically and electrically to form a rigid, self-supporting, metal enclosed structure.

c) The modular units will be mounted in pull out and/or swing trays. Each module will be capable of being easily removed to provide for the ready inspection of major solid-state devices.

d) Vertical wiring trough will be provided for the entire height of the UPS cabinet. Cable entry will be from bottom only.

e) Adequate ventilating louvers and screens will be provided. The top of the panel will be protected by a suitable drip cover to prevent entrance of falling liquid and foreign material.

f) If the equipment supplied requires forced air cooling, the cooling system furnished will meet the following requirement :

i) Two (2) nos. 100% cooling fans will be provided for each vertical panel.

ii) Completely independent duplicate protection, control and wiring systems will be provided for the cooling fans for redundancy.

iii) The cooling fans will be powered from the output of the associated inverter. Normally one fan will be running while the other is on stand-by.

iv) Each cooling fan will be equipped with an airflow switch having an alarm contact that closes upon failure of airflow.

3.10 Alarms

a) Solid state audio-visual annunciation system will be provided for inverters, static transfer switch, battery, battery charger.

b) Alarm facia will be provided on each charger and inverter panel, complete with proper actuating devices, circuitry and legends.

c) The arrangement will be such that on occurrence of a fault the corresponding window will light up and stays lighted until the fault is cleared and reset button pressed.

d) Each time a window lights up a master relay will get energized to provide group alarm signals for remote DCS alarm system.

e) The requirements of indication/metering/alarms are given in the annexure -B

f) Alarm contacts will be rated 0.5 A at 220 V DC and 5A at 240 V A.C.

g) Electrically independent, potential free alarm contacts for each of the points mentioned in Annexure-B will be wired up to the terminal block for Purchaser's use.

DCS Interface

Suitable soft link to be provided for interfacing with DCS for monitoring and control.

3.11 Lamp / Space Heaters / Receptacles

a) The panels will be provided with :

i) Internal illumination lamp with door switch.

ii) Space heater with thermostat control.

iii) 3-pin 6A receptacle with plug.

b) Lamp, heater and receptacle circuits will have individual switch fuse units.

3.12 Wiring / Cabling

a) The panels will be completely wired up. All wiring will be done with flexible, 1100V grade, PVC insulated wires with stranded 2.5 Sq.mm copper conductors and routed through wiring troughs. Each wire will be ferruled by plastic tube with indelible ink print at both end having terminal block No., terminal number as per approved wiring diagram.

b) Panels will have removable 3mm. gland plate for cable entry. All incoming/outgoing cables will be terminated in suitable terminal block.

c) Control terminal blocks will be box-clamp type, minimum 10 Sq.mm. 20% spare terminals will be furnished.

3.13 Nameplate

a) Engraved nameplates will be provided for each panel and for each equipment/device mounted on it.

b) The material will be anodised aluminium / lamicoid, 3 mm thick, with white letters on black background.

c) Nameplates will be held by self-tapping screws. The size of nameplates will be approximately 20 mm x 75 mm for equipment and 40 mm x 150 mm for panels.

d) Nameplates for panels will be provided both on the front and rear.

e) Control and meter selection switches will have integral nameplates. Nameplates for all other devices will be located below the respective devices.

f) Instruments and devices mounted on the face of the panels will also be identified on the rear with the instrument/device number. The number may be painted on or adjacent to the instrument or device case.

g) Caution notice on suitable metal plate will be affixed at the back of each panel.

3.14 Grounding

a) Normal 3-phase A.C power supply will be grounded at the source. For grounding other than this, isolation transformer will be furnished with the U.P.S.

b) The inverter D.C. input and A.C. output will be electrically isolated from each other and from cabinet ground.

c) Panels will have fully rated ground bus with two ground terminals, one at each end.

d) Each terminal will comprise two-bolt drilling M10 G.I. bolts and nuts to receive Purchaser's ground connection of 50 x 6 mm G.S. flat.

e) Separate electronic grounding will be provided for each UPS system.

3.15 Tropical protection

a) All equipment accessories and wiring will have fungus protection, involving special treatment of insulation and metal against fungus insects and corrosion.

b) Screens of corrosion resistant material will be furnished on all ventilating louvers to prevent the entrance of insects.

3.16 Painting

a) The panels will be finished in light grey shade (shade 631 of IS-5) with two coats of synthetic enamel paint. The panels will have a matt finish to prevent any glare from surface due to illumination.

4 TESTS

All equipment and components thereof will be subject to shop tests as per relevant IEC/BIS Standards. The tests will include, but will not be limited to :

4.1 Tests on Battery

4.1.1 Tests on battery will be as indicated in Section 7 (Battery & battery charger)

4.2 Tests on battery charger

4.2.1 Tests on battery charger will be as indicated in Section 7 (Battery & battery charger)

4.3 Tests on UPS System

a) Type & routine test for various components.

b) Burning test on PCBS - Assembled PCBS will be tested at 70 Deg.C for 72 hours in loaded condition.

c) Rapid temperature cycling test at 70 Deg.C and 0 Deg.C for 30 minutes at each temperature - 5 such cycles.

d) Functional tests to demonstrate compliance with all specified requirements and published. Specifications such as frequency, regulation, voltage regulation, current limiting, fuse clearing capability of inverters, demonstration of phase and frequency control of inverter for synchronisation with range of adjustments transfer and retransfer of static switches under influence of under voltage and over current, tests on chargers, batteries and other system component to confirm compliance with specification.

4.4 TYPE TEST

4.4.1 Type test certificates of any equipment will be furnished, if so desired by the Purchaser. Otherwise, the equipment will have to be type tested, free of charge, to prove the design.

5 DRAWINGS, DATA & MANUALS

5.1 Drawings, data & manuals to be submitted.

5.1.1 Technical data sheet (in the specification format)

5.1.2 UPS panels, Battery Charger and Battery layout drawing with dimensions.

5.1.3 General Arrangement drawing of UPS panels.

5.1.4 Bill of Material.

5.1.5 Schematic drawing of UPS circuits.

5.1.6 Battery cell voltage characteristics and data for different discharge rates.

5.1.7 Technical leaflets on :

a) UPS System
b) Battery
c) Battery charger
d) Inverter
e) Static Switch
f) Manual bypass Switch

5.1.8 Duty cycle diagram and battery sizing calculation in the format of IEEE Standard.

5.1.9 Sizing calculation of UPS system, charger main equipment, viz. SCRs, rectifier transformers etc.

5.1.10 Type test certificates for similar equipment.

5.2 To be submitted after Award of Contract

5.2.1 Manufacturer's Quality approval plan & technical data sheet

5.2.2 Dimensional UPS, battery layout diagram in plan & section.

5.2.3 Connection details of take-off terminals.

5.2.4 Dimensional general arrangement drawings of UPS, battery charger, battery clearly showing device dispositions, cable entry, space requirement, etc.

5.2.5 Sectional views of UPS System panels.

5.2.6 Panel foundation plan and loading.

5.2.7 UPS system schematics and wiring diagrams.

5.2.8 Test reports

5.2.9 Detailed bill of materials.

5.2.10 Any other relevant drawing or data necessary for satisfactory installation, operation, and maintenance.

5.2.11 Cable schedule & Inter-connection charts.

5.2.12 Instruction manuals of UPS system

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

5.3 The contractor may note that the drawings, data and manuals listed above are minimum requirement only. Contractor will ensure that all other necessary write-ups, curves and information required to fully describe the equipment are submitted .

6 SPECIAL TOOLS AND TACKLE

6.1 The contractor will quote any special tools and tackles needed for his equipment or stated herein.

7 RATINGS & REQUIREMENTS

7.1 STATIC INVERTER

7.1.1 Application : UPS System for control system, DCS and other essential loads

7.1.2 Type : static IGBT PWM type

7.1.3 Duty : Continuous

7.1.4 Enclosure : Sheet steel, IP31

7.1.5 Cooling : Natural convection or forced cooling using redundant fans.

7.1.6 Ambient temperature : 50 Deg.C maximum, 8 Deg. C minimum

7.1.7 Inverter capacity (min) : 100 KVA

7.1.8 Overload capacity : 300% for 4 m secs.
150% for 60 secs
125% for 10 mins
110% for continuous

7.1.9 Voltage

a) Inverter input, Battery output : To be decided by the contractor

b) Nominal output : 240 V, 50 Hz, 1-phase

7.1.10 Voltage Regulation :

a) Steady state (0-100% load at all input voltages and all power factors) : ± 1.5%

b) Transient voltage (On application or removal of 100% load) : ± 10%

c) Time to recover from transient to normal voltage : 50 milliseconds.

7.1.11 Wave form :

a)	Nominal frequency	:	50 Hz
b)	Frequency range for all conditions of input supplies, loads and temperature occurring simultaneous or in any combination (automatically controlled)	:	± 0.05 Hz.
c)	Synchronisation limits (for maintenance of synchronism between inverter and standby A.C source)	:	49 Hz to 51 Hz (factory set)
d)	Field adjustment range for (c) above	:	50 ± 0.05 Hz to 50 ± 2 Hz
e)	Total Harmonic Content	:	5% maximum at rated load
f)	Harmonic content for any single harmonic	:	3% maximum

7.1.12 Rated output current at rated output voltage with current limit not operating

a) Current : 200%

b) Duration : 100 milliseconds.

7.1.13 Efficiency at full load: 90% or better. (Watt output/watt input)

7.1.14 SCR derating from peak voltage and peak rating : 50%

7.1.15 Short time rating : 1 second for short circuit at inverter output terminals

7.2 STATIC SWITCH

7.2.1 Type : Solid-state, SCR

7.2.2 Duty : Continuous

7.2.3 Enclosure : Sheet Steel, IP31

7.2.4 Cooling : Natural convection or forced cooling--using redundant fans

7.2.5 Ambient Temperature : 50 Deg.C

7.2.6 Capacity

a) Continuous : Equal to full load capacity of the inverter.

b) Overload : 300% for 4 m secs.
150% for 60 secs
125% for 10 mins
110% for continuous

c) Peak : 1000% of continuous rating for 5 cycle.

7.2.7 Normal Voltage : 240V, 50 Hz, 1-phase.

7.2.8 Transient Voltage Tolerance : 340V peak above the nominal line voltage.

7.2.9 Transfer Time : less than 4 m secs.

7.2.10 Short time rating : Short circuit rating of the inverter for 1 second and 150% of Full load current for 2 minutes.

7.3 MANUAL BY-PASS SWITCH/BREAKER

7.3.1 Type : Maintained, make before break.

7.3.2 Voltage : 600V

7.3.3 Rated Current : To meet the requirement as specified in clause no.:

7.3.4 Short time rating : Short circuit rating of the inverter for 1 second and 150% of Full load current for 2 minutes.

7.4 BATTERY

7.4.1 Application : UPS Battery

7.4.2 Ambient Temperature :

a) Maximum : 50 Deg.C

b) Minimum : 8 Deg.C.

7.4.3 Type : Lead acid 'Plante' type

7.4.4 Nos. of Cells per Battery : Min 180

7.4.5 Battery nominal voltage : 360 V above

7.4.6 Battery capacity in AH at 27 °C for 5 hr. discharge and end cell voltage of 1.1 Volt/Cell : Contractor to compute considering 100% UPS load for 30 minutes. For 10 hrs. discharge end cell voltage will be 1.85v/cell for Lead Acid type.

7.4.7 Method of working

a) Float charge (Normal) : 2.18 Volt / Cell

b) Boost charge : 2.75 Volts/Cell (After complete discharge)

7.4.8 Mounting : Wooden racks

7.4.9 Connection : Cables

7.4.10 Battery Size (AH Capacity) : 500 AH (Minimum)

7.5 BATTERY CHARGER

7.5.1 Charger : Float + Float-cum-Boost

7.5.2 Type : Solid-state, full wave, fully controlled. 3 Phase Bridge.

7.5.3 Duty : Continuous

7.5.4 Enclosure : Sheet Steel, IP31

7.5.5 Cooling : Natural convection or forced cooling using redundant fans.

7.5.6 Ambient Temperature : 50 Deg.C

7.5.7 A.C. input :

a) Supply : 415V, 3-phase ,50 Hz, 3 wire

b) Voltage variation : ±10%

c) Frequency variation : ± 5%

d) Combined volt frequency variation : 10% (absolute sum)

e) Short-circuit level : 50 KA

f) System earthing : Unearthed

7.5.8 D.C. output : 100% UPS load plus restoring fully discharged battery to full charge condition in 8 hours.

7.5.9 Blocking Diode, Peak inverse voltage : 800 V (minimum)

7.5.10 Performance Requirement

a) The output voltage of the charger will be regulated within ± 1% of the set value for any load variation from 0 to 100% and A.C input voltage and frequency variation as indicated above in 5.07.00

b) The ripple content in charger D.C. output will be limited to less than ± 1% with battery and less than ± 2% without battery.

7.6 DISTRIBUTION BOARDS

7.6.1 Type : Fixed, Modular.

7.6.2 Enclosure : Sheet Steel, IP54

7.6.3 Mounting : Free standing (can be attended from both front & back)

ANNEXURE -1

THE ALARM POINTS TO BE PROVIDED ON UPS

SL. NO.	UPS ALARMS
1.0	AC SUPPLY FAILURE
2.0	DC VOLTAGE LOW
3.0	DC VOLTAGE HIGH
4.0	DC SYSTEM GROUND
5.0	CHARGER OVERLOAD
6.0	SCR FUSE BLOWN
7.0	FILTER FUSE BLOWN
8.0	DC OUTPUT FUSE BLOWN
9.0	FLOAT BUS OVER / UNDER VOLTAGE
10.0	BOOST BUS OVER VOLTAGE
11.0	BOOST OVER CURRENT FOR EACH CHARGER
12.0	FAILURE OF TYRISTOR / DIODES FOR EACH CHARGER
13.0	FAILURE OF BLOCKING DIODES
14.0	OUTPUT MCCB OPEN FOR EACH CHARGER
15.0	BATTERY MCCB OPEN
16.0	BATTERY CHARGING/DISCHARGING
	LED LAMPS INDICATIONS IN FCBC CUBICLE
1.0	FLOAT CUM BOOST CHARGER
2.0	MAINS AC AVAILABLE
3.0	DC OUTPUT AVAILABLE
4.0	CHARGER IN FLOAT MODE
5.0	CHARGER IN BOOST MODE
6.0	CHARGER TRIPPED ON FAULT
7.0	SELECTED FOR RESERVE OPERATION

INDICATING METERS
ALL INDICATING METERS WILL BE 96x96 mm SWITCHBOARD TYPE, WITH 250 DEG., ANTIGLARE GLASS, ±2% ACCURACY WITH ZERO ADJUSTER ON THE FRONT.

ANNEXURE -2

SET OF ACCESSORIES TO BE PROVIDED FOR EACH BATTERY BANK

SL. NO.	ACCESSORIES/DEVICES	QUANTITY (Nos.)
1.0	HYDROMETER	2 NOS.
2.0	SET OF HYDROMETER SYRINGES SUITABLE FOR THE VENT HOLES IN DIFFERENT CELLS	2 NOS.
3.0	THERMOMETER FOR MEASURING ELECTROLYTE TEMPERATURE	5 NOS.
4.0	SPECIFIC GRAVITY CORRECTION CHARTS	2 NOS.
5.0	WALL MOUNTING TYPE HOLDER FOR HYDROMETER AND THERMOMETER	2 NOS.
6.0	CELL TESTING VOLTMETER (3-0-3 V)	2 NOS.
7.0	ALKALI MIXING JAR	1 NO.
8.0	ACID MIXING JAR	1 NO.
9.0	RUBBER APRON	2 NOS.
10.0	PAIR OF RUBBER GLOVES	2 NOS.
11.0	SET OF SPANNERS	2 NOS.
12.0	"NO SMOKING" NOTICE	2 NOS.
13.0	GOGGLES (INDUSTRIAL)	2 NOS.
14.0	INSTRUCTION CARD	10 NOS.

IN ADDITION TO THE ABOVE, ONE (1) NO. MINIMUM AND MAXIMUM TEMPERATURE INDICATOR WILL BE SUPPLIED.

5. DESIGN CRITERIA

This section covers the general design criteria to be adopted in designing the Control & Instrumentation system for the TG Package.

5.1 General Requirements

5.1.1 Ambient Conditions

Instruments, devices and equipment for location in outdoor / indoor / air-conditioned areas shall be designed to suit the environmental conditions indicated below and shall be suitable for continuous operation in the operating environment of a Lignite fired Power plant and also during periods of air conditioning failure without any loss of function, or departure from the specification requirements covered under this specification.

Table 5.1

Protection Class Requirement

Ambient Temperature (outside temperature)	Pressure	Relative Humidity	Atmosphere	Required Protection class of panels /cabinets /desks to be provided by Contractor
Outdoor Location				
55 *C max	Atmosphere	100%Max	Air (dirty)	IP 65
4 *C min	Atmosphere	5% Min	Air (dirty)	IP 65
Indoor Location				
55 *C max	Atmosphere	95% Max	Air	IP 54^^
4 *C min.	Atmosphere	5% Min	Air	IP 5^^
Air-conditioned Area				
24 +/- 2 *C normal	Atmosphere	95% Max	Air	IP 42
50 *C Max. ^	Atmosphere	5 % Min	Air	IP 42

^ During Air Conditioning failure
^^ For non-ventilated enclosures. For Ventilated enclosures, protection class shall be IP 42.
1. For hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.
2. For PCs, OWS, EWS, Servers, Printers and other peripherals, maximum temperature limit shall be 35 *C. For LVS the same shall be 25 *C & for UPS the same shall be 40 *C

12. SYSTEM CABINETS, PANELS & JUNCTION BOX

12.1 General Requirements

1. All control panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads and accessories as per IS:5039-1969 as required for completeness of the system.
2. All panels & cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire. The Cabinets shall be designed for front & back access to components, terminals and wiring
3. The cabinets shall be provided with bottom glanding plate which shall be removable from inside and shall be provided with sufficient no. of knockouts. The details of knockouts shall be provided during detail engineering. All knockouts shall be provided with pluggable grommets.
4. The cabinets shall be of max. 2200mm height including base channel. The base channel shall be of 100 ISMC. All cabinets shall be of same height. Construction shall be modular. Contractor shall give the overall dimensions of each system and non-system cabinets in the format as per Schedule- 13 of this volume.
5. System & non-system cabinets shall have "look alike" appearance.
6. All electronic system cabinets shall be designed for 50 deg C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10 deg. C above ambient temperature under all operating conditions. Necessary louvers, fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.
7. Panels, cabinets enclosures wiring shall be arranged to enable the removal of modules/instruments and devices without unduly disturbing them.
8. All panels, cabinets, enclosures interiors shall be illuminated with rapid start fluorescent strip fixtures with door actuated switches. Door switch terminals shall be shrouded. All illuminated lights shall be provided with isolation switch in addition to door switch for maintenance & switching Off when not required. Illumination light shall be provided on both front & back sides if both sides are provided with equipments/instruments/terminal blocks requiring maintenance.

9. Sufficient number of power receptacles with disconnect switches shall be installed within panels, enclosure and racks.
10. The local instrument enclosures/racks shall be provided locally for mounting of electronic transmitters and switches, etc.
11. All panels, cabinets shall be properly grounded. The grounding scheme shall be as approved by the owner.
12. Exterior steel surface shall be sand blasted, ground smooth, filed, primed, sanded and smooth enamel painted to give a good finish subject to minimum paint thickness of 65-75 microns for sheet thickness of 3 mm and 50 microns for sheet thickness of 2mm. Minimum 2 coats of primer and two sprays of final finish colour shall be applied to all surfaces.
13. The colour of the panel's interior shall be brilliant white in the panel interior. External colour of the panels will be as RAL 7032 for LIE/ LIR and RAL 7035 for control room system cabinets.
14. All panels, enclosures, system cabinets, marshalling cabinets shall be provided with a minimum of 20% spare terminations and system cabinets shall be provided with spare space for 20% additional modules fully wired with connectors etc. in excess of the total requirement of the system design when the cabinets are delivered. The spare space capacity shall be distributed evenly throughout the cabinets.

12.2 System Cabinets

Table 12.1
Specifications for System Cabinets

S.N	Features	Minimum Requirements
1	Application	For housing Signal conditioning cards, input/output cards, processor cards, power supply units etc.
2	Location	Indoor
3	Type	Free standing Vertical type
4	Protection class	IP-42
5	Material & Thickness	CRCA steel/3mm
6	Doors	Double door with neoprene gasket, Lockable,
7	Cable entry	Bottom with fire proof compound thickness 50 mm for sealing
8	Anti vibration pad	Required, 15mm
9	Painting	Interior- Brilliant White Exterior- RAL 7035
10	Cabinet Dimension	To be decided during detail engineering
11	Grounding	M6 earthing stud shall be provided
12	Ventilation	Fans & louvers with brass mesh

S.N	Features	Minimum Requirements
		required
13	Lighting	rapid start fluorescent strip fixtures with door actuated switches required
14	Lifting arrangement	Removable lifting eyebolts shall be provided

1. The racks in system cabinets shall have provision along with plug in sockets/back plane to house accommodate the spare slots/modules as specified elsewhere.
2. The system cabinets, racks in system cabinets, slots in the racks & the terminals shall have identification numbers. A stainless steel metal tag (plate) shall be fixed to the inside of the door & the layout of the racks, slots & details of the card type/service shall be inscribed on this metal tag.
3. Each cabinet shall be provided with one each 3 pin receptacles for 230 V, 1P, 50 Hz and receptacles for 24V DC.
4. One of the doors shall be provided with folder to keep the relevant engineering document of the cabinet.
5. All cabinets shall have common key for locks.
6. Door shall have concealed type of hinges with 120 degree swing.
7. Door latches shall be of the three-point type to ensure tight closing.
8. Separate Power & shield earthing bus shall be provided at the front & rear side of the cabinets. The earthing bus shall be isolated from panel body by suitable insulation material.

12.3 Marshalling Cabinets

Table 12.2
Specifications for Marshalling Cabinets

S.N	Features	Minimum Requirements
1	Application	For termination of all cables originating from field.
2	Location	Indoor
3	Type	Free standing Vertical type
4	Protection class	IP-44
5	Material & Thickness	CRCA steel/ min. 2mm for panel sides & 3mm for gland plates
6	Doors	Double door with neoprene gasket, Lockable,
7	Cable entry	Bottom with fire proof compound thickness 50 mm for sealing
8	Terminal Blocks	Rail mounted cage-clamp fused type

S.N	Features	Minimum Requirements
		with LED indication suitable for conductor size up to 2.5 mm^2 & fused type with LED indication for power supply (24 VDC, 230 V AC, 110 V AC etc.) for instruments & equipments.
9	Anti vibration pad	Required, 15mm
10	Painting	Interior- Brilliant White Exterior- RAL 7035
11	Cabinet Dimension	To be decided during detail engineering
12	Grounding	M6 earthing stud shall be provided
13	Ventilation	Fans & louvers with brass mesh required
14	Lighting	rapid start fluorescent strip fixtures with door actuated switches required
15	Lifting arrangement	Removable lifting eyebolts shall be provided

1. Separate Marshalling cabinets for the system shall be supplied for terminating all cables originating from the field and for distributing the signals to different functional panels and cubicles.
2. The terminal blocks shall be cage clamp type. Fused terminal blocks hinged at one end to facilitate easy isolation shall be provided wherever necessary. All cabinets shall be provided with spare terminals for the spare inputs/outputs as specified else where in the specification. The type of terminals for terminations from cabinets/panels shall match with the pre fabricated cables and pins supplied.
3. The terminals for field cables shall be arranged in a logical order of equipment/system wise and shall be worked out by Contractor, subject to approval by Owner / Consultant.
4. The marshalling cabinets, the terminal blocks, the terminals and the electronic hardware if any, shall have identification numbers.
5. Each cabinet shall be provided with one each 3 pin receptacles for 230 V, 1P, 50 Hz and receptacles for 24V DC.
6. One of the doors shall be provided with folder to keep the relevant engineering document of the cabinet.
7. All cabinets shall have common key for locks.
8. Door shall have concealed type of hinges with 120 degree swing.
9. Door latches shall be of the three-point type to ensure tight closing.
10. Separate Power & shield earthing bus shall be provided at the front & rear side of the cabinets. The earthing bus shall be isolated from panel body by suitable insulation material

12.4 Local Instrument Enclosure & Racks

1. Transmitters and switches, devices, etc. mounted in the field shall be suitably grouped together and mounted in local instruments enclosures in case of open areas of the plant and in local instrument racks in case of covered areas. These local instrument enclosures and racks shall be furnished as per the actual requirements finalised during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalised during detailed engineering stage subject to the owner's approval.
2. The local instrument enclosures shall be constructed of 2 mm sheet plate and shall be of modular construction with one or more modules and two end assemblies bolted together to form an enclosure. Vibration dampeners shall be installed for supporting each enclosure. The internal layout shall be such that the impulse piping/ blow down lines are accessible from back doors of the enclosure and the transmitters etc. are accessible from front side for easy maintenance. Gaskets shall be used between all mating sections to achieve protection class of IP-65.
3. The local instrument racks shall be free standing type constructed of suitable 3 mm thick channel frame of steel and shall be provided with a canopy to protect the equipment mounted in racks from falling objects, water etc. The canopy shall not be less than 3 mm thick steel, and extended beyond the ends of the rack. Bulk heads, especially designed to provide isolation from process line vibration shall be provided. Exact fabrication details shall be as finalized during detailed engineering stage. The junction box for racks also shall conform to IP 65 protection class.
4. Provision for continuous purging arrangement is to be made for all air and flue gas applications.
5. Each transmitter enclosure housing instruments i.e. for air and flue gas applications, requiring purge air for continuous air purging shall be provided with common purge air header, redundant air filter regulators of sufficient capacity, required pressure gauges, valves, fittings, SS tubing and individual purge meters for each purge line etc. as required.
6. As soon as the panel's fabrication is over, Owner shall inspect the panels and further work on the panels, namely assembly, wiring and assembly of components shall be carried out only after the inspection.
7. The junction box of Local Instrument Enclosure & Racks shall be provided with hinged type door, latch for locking & gland plates for cable entry. All terminals in junction box shall be of rail mounted cage clamp type suitable for conductor size up to 2.5 Sq. mm.

12.5 Local Junction Box

Table 12.3

Specifications for Junction Box

S.N	Features	Minimum Requirements
1	No. of Ways	32 (2X16) with 20% spares terminals
2	Material & Thickness	3 mm thick Stainless steel
3	Protection class	IP-65 for outdoor/ IP 55 for Indoor
4	Cable entry	Bottom
5	Mounting	Suitable for Wall/column/structures mounting
6	Terminal Blocks	Rail mounted cage-clamp type suitable for conductor size up to 2.5 mm^2
7	Grounding	M6 earthing stud shall be provided
8	Gland plate	Removable type
9	Door	Single Lockable door with gasket, able to open sideways, turn able hinge based, latch type lock without handle with common key.
10	Accessories	Tag plate, clamps, fixtures, bolts (SS), nuts (SS), Gasket (Neoprene), cable glands (SS), Lugs (Brass), Fire proof compound for sealing.

1. All JB's for outdoor application shall be provided with individual canopies to prevent ingress of water.
2. All JB' shall have provision to add 10% additional TB's.
3. The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams.
4. Separate Terminal blocks shall be used for Analog & Digital Signals & also for signals with different voltage levels.
5. The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
6. Separate shield bus shall be provided with screw connection for terminating cable shields.
7. All spare cable entries shall be provided with plugs.
8. All wires in JB shall be neatly dressed & ferruled.
9. Double deck type terminal block shall not be used.

Table 12.4
Specifications for Cable Glands

S.N	Features	Minimum Requirements
1	Type	Double compression
2	Entry Thread	½" NPT
3	Material	Brass
4	Finish	Cadmium Plated
5	Protection	IP-54 or better
6	Accessories	Neoprene gasket, Locknut, Reducer etc.

10. PROCESS CONNECTION PIPING

The Contractor shall provide, install and test all required material for completeness of impulse piping system, sample piping system and air piping system as per the requirements of this clause on as required basis for the connection of instruments and control equipment to the process and make the system complete . However, the Contractor shall furnish during detailed engineering all relevant drawings, material and technical specifications of various items service wise for Owner's/Consultant's approval.

Control and instrument piping & connections shall generally be designed in accordance with the following criteria and these criteria shall be closely co-ordinated with Mechanical Piping Contractor / Erector to fulfill the Mechanical Design Criteria also. This is a guideline for Piping design & selection. OEM standard proven practice in these regard are also acceptable if it is complying with applicable international standard & specifications as described in this section.

1. Pressure connections and piping up to the root valves for all pressure indicators, pressure switches, pressure transmitters, etc., shall be as indicated for miscellaneous piping.
2. Temperature indicators, temperature controllers, temperature switches, temperature detectors, and test well connections shall be as follows:
   - Main steam -- 40 mm NPT.
   - Extraction steam -- 40 mm NPT.
   - Boiler feed water -- 32 mm NPT.
   - Reheat steam -- 40 mm NPT.
   - Duct temperatures -- 25 mm NPT.
   - All others -- 19 mm NPT.
3. Flow transmitter connections and piping up to the root valves shall be 25 mm for all piping except orifice flanges, where 15 mm piping and valves shall be used.
4. Level switch connections and piping up to root valves shall be 25mm.
5. Level controllers and level transmitters of the displacement type shall have connections and piping up to root valves of 50 mm.
6. Level controllers and level transmitters of the differential pressure type shall have connections and piping up to root valves of 25 mm.
7. Instrument columns at tanks and pressure vessels shall generally be 65 mm minimum.

A. Design Pressure and Temperature

Instrument primary piping design pressure and temperature shall be selected consistent with the requirements discussed in Mechanical Design Criteria of this specification, for the process pipe to which the instrument primary piping is connected. The following general criteria shall also apply:

Instrument primary piping for steam and other systems shall be designed for 1-½ times the maximum sustained process pressure and temperature (plus 20°C).

B. Sizes of Instrument Primary Piping

Instrument primary piping shall not be smaller than the connection at the process pipe root valve and/or the following (metric sizes are nominal):-

1. 20 mm for pressure measurement piping with a design pressure equal to or less than 42.0 bar and a design temperature equal to or less than 400°C.
2. 25 mm for pressure measurement piping with a design pressure greater than 42.0 bars or a design temperature greater than 400°C.
3. Flow and level measurement by differential pressure shall also use primary piping conforming to the above requirements; however, flange tap connections may be of 13 mm size.
4. Float actuated level switch devices shall be supported on connecting piping not smaller than 25 mm.
5. Level controllers and transmitters of the displacement float type shall be supported on connecting piping not smaller than 50 mm.
6. Instrument columns for float actuated level switches and displacement float devices shall be piping of not less than 65 mm.
7. Primary piping internal diameter shall not be less than 8 mm between the process connection and instrument blow down valve.

C. Materials for Instrument Primary Piping

Material for instrument primary piping connecting to the root valve shall preferably be the same as that used in the process system to which it is connected. Higher strength materials may be substituted in the interest of standardization; however, welding procedures at the point of joining the instrument primary piping to the process piping must be appropriate to the combination of materials involved. Copper may be used only for compressed air services that use copper process piping.