ii)	C.I Pipe / Ductile Iron	-	100
iii)	Rubber lined steel pipe	-	120
iv)	PVC / HDPE pipes	-	140

For calculating the pump head, at least 20% margin shall be taken over the pipe friction losses.

2.01.10 All piping system shall be capable of withstanding the maximum pressure and temperature in the corresponding line.

2.01.11 Fittings

(a) Fittings to be used with carbon steel pipes shall conform to IS:1239 Part-II (Heavy grade) for sizes up to 150 NB.

(b) For sizes 200 NB & above steel fittings shall conform to ASTM A 234 Gr. WPB. However for sizes above 350 NB fabricated fittings (meter bends etc) may be used. Forged elbows of long radius shall be used.

(c) For Galvanized pipe application all the fittings shall be galvanized as per IS:4736.

(e) Fittings to be used in other type of piping shall conform to relevant IS/BS ANSI Standards and in conformity with the parent pipe standard.

(f) Unless otherwise shown eccentric reducers shall be installed with straight side at the top of piping connection.

2.02.00 **Design of Piping Systems**

2.02.01 Steel pipe flanges shall be generally slip on flat face type. Weld neck flanges shall be used when flange follows immediately after a butt-welding or where it is required with respect to service conditions. When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

2.02.02 All the piping flanges and counter flanges & their drilling shall conform to ANSI B 16.5 of relevant pressure & temperature class. Flanges shall conform to ANSI B.16.5 class 150 (min.).

2.02.03 For easy handling & removal of equipments, valves etc. and for maintenance purpose, break up flanges for 65 NB and above sizes and suitable type of compression flexible coupling for flanged joints of 50 NB and below size shall be provided. The over ground piping wherever routed inside building, shall have a clear head room of minimum 2.1 meter from operating floor.

2.02.04 Pipes shall generally be routed above ground but where specifically indicated/specified the pipe may be laid in trenches or buried. Buried piping shall be generally installed so that the top of pipe is 1.0 metre below the ground level unless otherwise specifically mentioned. Full length of buried piping shall be provided with 100 mm thick sand bed.

2.02.05 Butt-welding edge preparation shall be done as per ANSI B 16.25.

2.02.06 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from BHEL.

2.02.07 Pipe coming under purview of IBR should meet its requirements and getting the IBR approval shall be under Vendors scope.

3.00.00 VALVES

3.01.00 Valves will be used to start/stop or control flow. Sample valves will be used in sample collection lines.

3.02.00 All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the relevant design standard. All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.

3.03.00 **GATE VALVES**

Sluice/gate valve shall conform to IS 14846 of rating PN 1.6 (min.). Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS:780. Flanges shall be designed as per ANSI B 16.5 Cl. 300 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type.

Sluice valves for sizes below 50 NB and below shall conforms to IS:778 Class-2/ANSI B16.34 straight, rising stem; without side screw.

3.03.01 Sluice valves shall be provided with the following accessories in addition to the standard items.

a) Hand wheel

b) Manual Gear reduction unit operator for valves 250 NB and above.

c) Draining arrangement wherever required.

d) Arrow indicating flow direction.

e) Position indicator.

3.03.02 Sluice Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

3.04.00 **BUTTERFLY VALVES**

Butterfly valves shall be of double flanged of low leakage rate confirming to AWWA-C-504 class 150 (min.) or BS:5155 PN 10 (min.)

3.04.01 The various components of butterfly valves shall be of the following

i)	Body	:	SS316
ii)	Disc.	:	SS316
iii)	Shaft	:	SS410
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber)
v)	Hand wheel	:	Cast iron or Malleable iron.

3.04.02 Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

3.04.03 All the butterfly valves shall be provided with Hand wheel or lever as per the requirements.

For larger sizes i.e. 150 NB and above hand wheel shall be provided. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate

positions.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 NB and above. Valve provided with motorized or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Hand wheel or Gear reduction unit or Motor actuator etc.) shall be designed as per relevant International Standard.

3.04.04 All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.300 (min.)

3.05.00 **BALL VALVES**

i)	Design Standard	:	BS:5351 Class 150 (min.)
ii)	Type	:	Welded/Flanged ends; Full bore: Split Body & Seat supported construction.
iii)	**Material of Construction**		
	Body	:	SS316
	Ball	:	SS316
	Seat ring	:	PTFE
	Stem	:	Stainless steel AISI 420
	Seats	:	Nitrile rubber; PTFE.
	Hand wheel	:	Cast iron or Malleable iron.

iv) Valves shall be designed to be directly operatable by a wrench / Hand lever.

v) Suitable stops shall be provided for both the fully open & close condition.

vi) All the valves shall be provided with an indicator for showing the position of the ball port.

3.06.00 **NON-RETURN VALVES (CHECK VALVES)**

3.06.01 Non return valves shall be of swing check (reflux) type or dual plate type.

3.06.02 The valves shall conform to the following specifications.

i)	Design Standard	:	IS:5312, BS:1868, BS:5153 API 594/ API 600 or Eqvt.
ii)	Type	:	Swing check or dual plate type and Flanged ends.
iii)	Material of Construction		

a)	Body & Cover	:	SS316
c)	Disc facing ring	:	SS316
d)	Body Seat ring	:	SS316
e)	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
f)	Bolts	:	Carbon Steel

3.06.03 Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.

4.00.00 **STRAINERS**

4.01.00 **Y-Type Strainer**

a) Y-Type strainer for water application shall be constructed of following materials :

i)	Body	:	SS316
ii)	Strainers	:	Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.

5.00.00 **General Requirements for Valves, Gates, Strainers**

- All the equipments shall be of proven design for the duty conditions and the contractor or manufacturer shall have sufficient experience in using the above equipments in water treatment application in the plants supplied earlier by them.
- In case BHEL desires, the experience list/feedback from the users shall be made available to BHEL for any or all the equipments during the detailed engineering phase.
- Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the contractor.
- Sizes of the valves shall be same as that of the interconnected pipe sizes.
- The various equipments shall be installed so that they are easily approachable for the operating and maintenance personnel. Generally Valves shall be located about 1.2 meter to 1.5 meter from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.
- However valves which are provided (in the burried pipe line) with a valves chamber shall have manual operator/Hand wheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.

GENERAL TECHNICAL REQUIREMENT FOR

PRESSURE & STORAGE VESSEL

1.00.00 GENERAL

The following principal pressure and atmospheric vessels for the system has been covered in this part of specification.

1. Air receiver
2. Oxygen receiver
3. Air driers
4. Oxygen generators
5. Portable water storage tank

1.01.00 Of these, the items specified from Sl No. 1 to 4 shall be designed as pressure vessels and the rest shall be designed as atmospheric vessels.

1.02.0 All other vessels, not specifically listed here, but required for the Bidder's system shall also meet the technical requirements of this specification.

1.03.0 Process requirements of these vessels shall be governed by the requirements of the Ozone generation plant, which will determine their design conditions. Following sections only indicate some of the minimum requirements which must be met, and the actual design of these vessels shall be better than these, if that is required from process considerations.

2.00.00 GENERAL DESIGN FEATURES

2.01.00 **Design**

2.01.01 Design of all pressure vessels shall conform to ASME Section VIII ed. 2010 or acceptable equivalent international standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 20% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps and compressors shall be based on the shut-off head of the pumps or compressors plus static head at pumps or compressors suction if any.

However minimum design pressure of each pressure vessel shall be at least 10 Kg/cm² (g).

2.01.02 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.

2.01.03 Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BSEN: 12285-2:2005.

2.01.04 Design temperature of all pressure vessels and storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.

2.01.05 In case, tank is subjected to vacuum; the same shall be taken care in designing the tank.

2.02.00 All vessels / tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end. Vessel ends shall be of dished design and constructed by forging, pressing or spinning process. Conical or flat ends shall not be accepted.
However the minimum thickness of the shell of all the pressure vessels shall not be less than 8mm and the minimum thickness of the dish of all the pressure vessels shall not be less than 10mm The stress relieving (if required) of all the pressure vessel shall be done as per code requirement.

2.03.00 All the atmospheric tanks shall have sufficient free board above the "Level High"/"Normal Level" as the case may be. The overflow level shall be kept at least 20 cm or 10% of vessel height which ever is more above the "Level High"/"Normal Level" for all the tanks except for the DM tanks for

which a minimum height of 300 mm shall be provided over the "High Level". Further, a minimum 200 mm free board shall be provided above the top of overflow level to the top of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.

2.04.00 Vessels coming under preview of IBR shall be designed accordingly.

2.05.00 Interior surfaces of all tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.

2.06.00 All welds on inner tank surface shall be free of voids, gaps craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding. Inside weld seams shall be ground flush and smooth applicable for corrosion resistant coating or lining.

2.07.00 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps, craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 5 mm minimum radius.

2.08.00 Weld splatter shall be removed.

2.09.00 All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.

2.10.00 The plates for cylindrical tanks shall be accurately formed in bending rolls to the diameters called for, and the completed shells be concentric and plump. Plates shall be cold-rolled by plate bending machine in a number of passes to true curvature and joined by welding.

2.11.00 Vessels seam shall be so positioned that they do not pass through vessel connections.

2.12.00 Operating platforms, ladders, supports and other structural works for each pressure vessel and atmospheric tanks to facilitate accessibility for operation and maintenance is also in bidder's scope.

3.00.00 APPURTENANCES

3.01.00 **Manholes**

3.01.01 All the pressure vessels and horizontal type storage tanks shall be provided with manhole of 500 mm diameter minimum size, preferably at the top head, complete with cover plate, lifting handle, davit cap, nuts, bolts, gaskets etc. to ensure leak tightness at the test pressure.

3.01.02 The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more. For the DM water storage tanks, manholes shall be provided as per IS:803.

3.01.03 All the vessels and tanks shall be normally provided with a six inch gasketed handhole located near the bottom of the straight side.

3.01.04 The required lining/coating for the inside surface of the manhole/handhole, nozzle and cover plate of the manhole/handhole shall be same as that of the respective vessel/tank.

3.02.00 **Lifting Lungs**

All vessels of diameter 1200mm or greater shall be provided with a minimum of 4 lifting lugs. Smaller vessels shall be provided with at least 2 lifting lugs.

3.03.00 **Vessels Supports**

Adequate supporting arrangements like straps, saddles, skirt rings, or legs of steel shall be provided to transfer all loads to the respective skid structures.

3.04.00 **Piping Connections**

The vessel connections for each pressure vessels and atmospheric tanks shall be conform to ANSI B 16.5 150 class. Flat face flanges shall be used throughout. Nozzle material shall be ASTMA-106. Grade B. schedule 80 pipe or IS 1239 heavy grade. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full-face gaskets.

5.00.00 SPECIFIC DETAILS

5.01.00 **AIR RECEIVER & OXYGEN RECEIVER**

- The air receivers & oxygen receivers will be vertical self-supporting cylindrical vessels with supporting legs for resting on their foundation.
- Air receiver & oxygen reveivers shall be provided with nozzles, air release vents, safety valve, pressure gauge, pressure transmitter, temperature gauge, minimum 500 mm dia. manhole for inspection.

6.00.00 CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure and storage vessels shall conform to the latest revisions of the following standards, in addition to other standards mentioned elsewhere in the tender document subject to any modification and requirement, as specified here in after.

a)	IS: 803	-	Code of practice for design, fabrication and erection of Vertical Mild Steel cylindrical welded oil storage tanks.
b)	IS: 816	-	Code of practice for use of metal arc welding for general construction in mild steel.
c)	IS: 817	-	Code of practice for training and testing of metal arc welders.
d)	IS: 822	-	Code of procedure for inspection of welds.
e)	IS:1363	-	Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia to 24 mm).
f)	IS:1367	-	Technical supply conditions for threaded fasteners.
g)	IS:2062	-	Hot rolled low, medium & high tensile structural steel.
h)	IS:2002	-	Steel plates for pressure vessels for intermediate and High temperature service including boilers.
i)	IS:2825	-	Code of unfired pressure vessels.
j)	IS:3133	-	Manhole and inspection opening for chemical equipment.
k)	IS:4049	-	Specification for formed ends for tanks and pressure vessels.
l)	IS:4682	-	Code of practice for lining of vessels and equipment for chemical processes Rubber Lining.
m)	BS:2594	-	Specification for carbon steel welded horizontal cylindrical storage tanks.
n)	ASME	-	Boiler and pressure vessel Section VIII code.

o) ASTM - American Society for Testing and Materials.

7.00.00 FABRICATION

7.01.00 The vessel ends for storage tanks of vertical type shall have dished bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Tori-spherical type designed.

7.02.00 The plates to be used for fabrication will have a minimum width of 1500 mm.

7.03.00 All the joints (circumferential / longitudinal) shall be continuous butt welded, inside and outside. Connection shall be flush with inner surface of tanks and welded continuously on both sides of shell. Sharp inside edges shall be rounded to a minimum 5 mm radius.

7.04.00 Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the engineers. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.

7.05.00 All pressure vessels and storage tanks shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

7.06.00 **Tank Connections**

7.06.01 All flanged connections should be supplied complete with matching counter flanges, nuts bolts and gasket materials. The flange design, (thickness and drilling etc.) shall match with the interconnected piping flanges.

7.06.02 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS:1367. However, internal fasteners if any, shall be of SS316.

7.06.04 Gaskets shall be of full face type.

7.07.00 **Vessels Supporting Lifting Lugs**

7.07.01 Adequate supporting arrangements like straps, saddles, skirt boards, pillars etc. shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.

7.07.02 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs.

7.07.03 Material of construction for these vessel supports, saddles, lugs shall conform to IS:2062 of tested quality.

7.08.00 **Special Accessories Storage Tanks**

7.08.01 All the pressure vessels and tanks shall be provided with drain connections along with drain valves of suitable size. Further all the atmospheric storage tanks shall be provided with over flow connection designed for the filling rate of the respective tank.

7.08.02 All the pressure and tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created in the tank during maximum filling/drain-off rate.

7.08.03 Various instrumentation and the fittings required for the same shall be supplied as elaborated in data sheets.

SECTION – D2

D2: GENERAL TECHNICAL REQUIREMENTS FOR ELECTRICAL

GENERAL TECHNICAL REQUIREMENTS FOR LV MOTORS

1.0 **A.C. MOTORS**

1.1 All HT motors shall be suitable for 11kV / 3.3kV, 3 phase, 50 Hz and LV motors shall be suitable for 415V, 3 Phase, 50 Hz power supply.

1.2 The motor rating shall be arrived at considering 15% margin over the duty point input or 10% over the maximum demand of the driven equipment, whichever is higher. Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding acceptable winding temperatures when supply voltage is 80% of the rated voltage for HT motors and 85% for LV motors. HT motors shall also be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 min. commencing from hot condition.

1.3 Motors shall be capable of developing the rated full load torque even if the supply voltage drops to 70% of the rated voltage. If such operation is envisaged for a period of one second, the pull out torque of the motor shall be atleast 205% of full load torque.

1.4 Motors shall withstand for 1 second the voltage and torque stresses developed due to the vector difference between the motor residual voltage and the incoming supply voltage equal to 150% of the rated voltage during fast change over of buses.

1.5 Locked rotor current of the HT motors rated 1500 kW and below shall be limited to 600% inclusive of 20% tolerance of the full load current of the motors and motor rated above 1500 kW shall be limited to 450% (inclusive of 20% tolerance) of full load current of the motor. Locked rotor current of the LV motor shall not exceed 600% of full load current inclusive of 20% tolerance.

1.6 The locked rotor withstand time under hot condition at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater. Provision of speed switch shall be avoided to the extent possible.

1.7 The degree of protection for the motor enclosure shall be IP-55 and IP-54 for outdoor & indoor respectively and terminal boxes shall be provided with atleast IP-55. For single core cable termination, gland plates shall be of non-magnetic material. All motors located in hazardous area shall have flame proof design.

1.8 All HT motors shall be provided with vibration pads for mounting vibration detectors.

1.9 Motors rated 1000 kW and above shall be provided with differential protection. These motors shall be provided with star connected stator windings. The 3 nos. current transformers, one for each phase shall be mounted in a separate compartment in the neutral side terminal box. The three phases shall be connected to form the star point after they pass through the CTs. The CTs shall be of relay accuracy and the CT characteristics shall be compatible with the differential relay. The additional 3 nos. CTs of identical characteristics shall be provided in the 11kV / 3.3 kV switchgear panel. kWh meters shall be provided on all motor feeders.

1.10 The ring oiling system shall be adequate for starting and continuous operation of the motor for atleast one half hour without pressure oiling system in operation.

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1.11 For 11kV & 3.3kV motors, 6 nos. duplex/ 12 nos. simplex RTDs for winding shall be provided. Each bearing shall be provided with one no.PT-100 duplex type RTDs for temperature monitoring. These motors shall be designed to withstand atleast 5% harmonics in the supply voltage.

1.12 The maximum double amplitude vibrations for motors upto 1500 rpm shall be 25 microns and 15 microns upto 3000 rpm. For 415V motors, maximum double amplitude vibrations upto 1500 rpm shall be 40 microns and 15 microns upto 3000 rpm.

1.13 Maximum noise level measured at a distance of 1 metre from the outer surface of the motor shall not exceed 85 dB (A).

1.14 Cable boxes of all 11kV & 3.3kV motors shall be provided with quick disconnecting type terminal connectors to facilitate easy disconnection and removal of the motors without requiring unsealing or otherwise disturbing the external cable connections and leaving the phase segregated terminal box intact.

1.15 The insulation system for 11000V & 3300 V AC motors shall withstand the negative or positive 0.3 / 3.0 microsecond wave (2.7 pu rated peak line to earth operating voltage) switching surges originating from non-effectively earthed power system. All 11000V & 3300 V AC motors shall have BIL and withstand frequency voltage as per relevant standards.

1.16 If required by the system, variable frequency controller shall be provided for I.D.Fans.

2.0 DC MOTORS

2.1 DC motors shall be suitable for the DC system voltage available in the plant. Motor shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range of 85% to 110% of rated motor voltage. The field windings for the motors shall be continuosly rated without forced ventilation.

3.0 ACTUATOR MOTORS

3.1 The actuator motors shall be designed for short time duty (S2) in accordance with IEC 60034-1.

3.2 Hand wheel operation shall be provided in addition to motor drive.

3.3 The DC and AC actuator shall be provided with accessories viz., Torque limit switch, end of travel switch, adjustable limit switch, hand wheel motor, thermostat, integral starter, vaive position indicator, Manual-Auto lever with suitable locking arrangement, etc.. Complete actuator shall be tested at factory as per IS 9334.

3.4 Two normally open and two normally closed or two changeover potential free contacts corresponding to open and close positions of the valve shall be provided.

3.5 Degree of protection for actuator motor enclosure shall be IP-55 and IP-67 for indoor and outdoor respectively.

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4.0 **TESTS**

4.1 Tests on all types of motors shall be conducted as per relevant standard.

4.2 All type, routine & acceptance tests as per relevant IS shall be conducted on 11 kV & 3.3 kV motors. For LT motors, type test for each rating and frame size & make, and for all motors routine and acceptance tests shall be conducted as per relevant standards.

4.3 For 11000V and 3300V AC motors, in addition to all the tests specified above, polarisation index test shall be carried out as a routine test on each motor (the minimum value of polarisation index for all motors shall be 2 when determined according to IS : 7816).

4.4 Noise level measurement and vibration test as per standards shall be conducted on all motors.

4.5 Di-electric tests to establish the insulation withstand level of motors as indicated in Clause 1.15 shall be performed on a sample coil (identical to those to be used in the motor quoted for) for each type of motor. These tested sample coils shall not be used in the motors to be supplied.

4.6 All characteristic curves for the motors including hot and cold withstand characteristics, starting time vs current, current vs speed, speed vs torque at 110%, 100% and 90% of rated voltage, negative withstand characteristics, rotor voltage vs rotor current curves(for wound motors), Efficiency, power factor, slip, current Vs output curve etc., shall be furnished.

5.0 **TECHNICAL REQUIREMENTS**

The motors shall comply with the particulars indicated below and CONTRACTOR shall furnish the details in respective column given below (to be separately submitted for different type & rating of the motor).

SL. NO.	DESCRIPTION	UNIT	SPECIFICATION REQUIREMENT	CONTRACTOR
I	AC Motors			
1.0	Application/Designation		*	
2.0	Manufacturer		*	
3.0	Type of motors/ frame size		Squirrel cage except for cranes	
4.0	Rated			
	(a) Output	kW	*	
	(b) Speed	rpm	*	
	(c) Voltage	V	*	

	(d) No.of Phases / Frequency		*	
	(e) System neutral		*	
5.0				
5.1	Type of Duty (IS-325 or equivalent)		*	
5.2	Duty designation (IS-325 or equivalent)		*	
6.0	Supply Conditions			
	(a) Allowable variations in			
	(i) Voltage	%	± 10	
	(ii) Frequency	%	± 5	
	(iii) Combined	%	± 10	
	(b) Permissible unbalance in supply voltage	%	2	
7.0	Current		*	
	(a) Full load	Amps.	*	
	(b) Starting	% FL	*	
8.0	Method of starting		DOL	
8.1	Starting time	Sec		
	With rated Voltage			
	With min. Voltage			
	With Max. Voltage			
8.2	Safe stall time under hot/cold condition	Sec		
	With rated Voltage			
	With min. Voltage			
	With Max. Voltage			
9.0	Insulation			
9.1	Class of insulation		Class F with temperature rise limited to Class B	

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9.2	Temperature rise by winding resistance method	Deg. C	For LV motors (Temp. limited to 65°C), For HT motors (temp. rise limited to Class B)	
10.0	Type of cooling (IS : 6362)	Deg. C	TEFC for LV, TEFC / TETV/CACA for 11/3.3 KV motors.	
11.0	Degree of protection (IS:4691 or equivalent)		Refer Clause 1.7	
12.0	Suitable for outdoor operation	Yes / No	*	
13.0	Normal winding connection	Star / Delta	*	
14.0	Permissible No. of equally spread starts per hour under normal service conditions		*	
15.0	Efficiency (%)	%		
	Full load			
	75 % Load			
	50 % Load			
	25 % Load			
16.0	Power Factor			
	Full Load			
	75 % Load			
	50 % Load			
	25 % Load			
17.0	Torque			
	Starting			
	Maximum (Pullout)			
	Pull up			
18.0	Motor reactance (pu)			
	Subtransient			
	Transient			
	Steady state			
15.0	Fault level	kA/sec	*	

II	**DC MOTORS**			
16.0	Rated Voltage	V	220 V DC	
17.0	Class of Insulation	:	Class F with temperature rise limited to class B	
18.0	Temperature rise	:	--- do ------	
19.0	Method of starting	:	*	
Items under AC motors which are applicable for DC motors shall also be listed				

NOTE :

1.0 "*" Information shall be filled furnished by CONTRACTOR along with offer.

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GENERAL TECHNICAL REQUIREMENTS FOR CABLES

1.0 CABLES

1.1 H T Cables

MV system (11kV & 3.3kV system) cables shall be unearthed grade suitable for use in medium resistance earthed system, with stranded & compacted aluminium conductors, extruded semi-conducting compound screen, extruded XLPE insulated, Dry cured extruded semi-conducting compound with a layer of non-magnetic metallic tape for insulation screen, extruded PVC (Type ST – 2) FRLS inner sheath, Aluminium / galvanised steel round wire armoured, extruded PVC (Type ST – 2) FRLS outer sheathed, single / multicored conforming to IS 7098 (Part II) for constructional details and tests.

1.2 L T Power Cables

steam/siolas/gas cured

LV Power Cable shall be 1100 V grade, single / multicore, stranded aluminium conductor, XLPE insulated, ~~Dry cured~~ with PVC inner sheath, Type ST – 2 and outer sheath made of FRLS PVC, Type ST-2 compound. The armouring shall be of Aluminium / galvanised steel round wire. The cable used for DC system shall be of single core type. All other details shall be as applicable. Minimum conductor cross section of power cables shall be 4 sq.mm.

1.3 Control Cables

Control cables shall be 1100V grade, multicore, minimum 2.5 sq.mm cross section, stranded copper conductor having 7 strands, PVC insulated, inner PVC sheathed, galvanised steel wire armoured and outer sheath made of FRLS PVC compound. In situations where accuracy of measurement or voltage drop in control circuit, warrant, higher cross sections as required shall be used. 4 sq.mm copper conductor cables shall be used for CT circuits all other specifications remaining same.

1.4 Instrumentation Cables

Page 38, mem part 2 of 3, 1.1 KV

Instrumentation cables shall be with stranded high conductivity annealed, tinned copper, twisted pair (with min. 20 twists for meter) extruded PVC insulated with overall and / or individual screening, extruded PVC inner sheathed, extruded outer sheathed with FRLS PVC compound and aluminium/galvanised steel wire armoured complying to IEC60189 – Part I & II

The conductor size shall be minimum 0.5 sq.mm. Triplex cables similar to instrumentation cables can be used for RTDs.

1.5 Lighting Wires

1100V grade, single core, stranded, copper conductor, PVC insulated wires conforming to IS-694-1990 / IEC 60227 Part 1 to 5 (1979) / IEEE-719 (1981). Minimum cross section of copper wires shall be 2.5 sq. mm for lighting circuits and 4 sq. mm for receptacle circuits.

1.6 **Trailing Power and Control cables for Mobile Equipment.**

11kV / 3.3 kV (UE) and 1100V (E) grade power & control flexible trailing, annealed tinned copper conductor, EPR insulated, EPR inner sheathed, CSP outer sheathed and shall have conductor screen of rubber. Cables shall conform to IS requirements and any other applicable standards.

2.0 **CABLE PROPERTIES**

2.1 All power, control and Instrumentation cable will be with armour. MV cables will be with FRLS PVC inner and outer sheath and other type of cables are with FRLS PVC, Outer sheath.

All single core power cables will have wire armouring of aluminium, whereas multicore cables will have galvanised steel wire armouring.

2.2 The outer sheath of all cables shall be of extruded layer of suitable synthetic material compatible with specified ambient and operating temperature of the cables. The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack.

2.3 The inner and outer sheath of FRLS PVC compound shall meet the following performance requirements :

(a) The critical oxygen index value shall be minimum 29 when tested at 27± 2^{0}C as per ASTM-D-2863-77 and the temperature index will be minimum 250^{0}C at oxygen index value of 21 when tested as per ~~NES 715~~. ASTM-D-2863

(b) The maximum acid gas generation as determined by titration shall be less than 20% by weight when tested as per IEC-60754-1 (1994).

(c) The smoke generation under fire shall have maximum smoke density rating of 60% when tested as per ASTM-D-2843-7 (1988).

(d) The cables will pass the hydraulic stability and ultraviolet tests as per DIN 53387.

2.4 The finished cable shall pass the flammability test as per IEC-60322-1 (1993) and IEEE-60383. In addition, it shall also pass flammability test as per Class F3 of Swedish Standard SS-424-1475 (1978).

3.0 **DESIGN CRITERIA FOR CABLE SIZING**

3.1 **Power cables**

Power cable sizes shall be selected on the basis of current carrying capacity, short circuit rating, permissible voltage drop and standardization of cable sizes.

3.1.1 Power cables shall carry the full load current of the circuit continuously under site conditions considering the various derating factors like Thermal resistivity of soil, ambient air/ground temperature, grouping, method of laying, etc. The

design ambient air and ground temperatures shall be considered at 50° C & 30° C respectively.

3.1.2 Power cables shall withstand the fault current of the circuit for the duration not less than the maximum time taken by the primary protective system to isolate the fault. Fault clearing times for 11000V / 3300V motor feeders and transformer feeders having high-set instantaneous protection shall be 0.16 secs., whereas tie between two 415V switchgear and any two 11000V / 3300V switchgear shall be 0.5 secs., and for incomers and tie feeders 1.0 sec.

The short circuit withstand capacity of screen in case of HT cables shall be 300 amps for 2(two) seconds per core.

3.1.3 For 11000V / 3300V motors controlled by vacuum contactors with back-up HRC fuses, the minimum cross-section of cables shall be based on the cut-off current of the fuses and their fusing time.

3.1.4 For the cables to 415V motors and feeders protected by fuses, the cross section shall be chosen according to the cut-off current of the fuse and its fusing time.

3.1.5 Voltage dip at motor terminals during starting of motors will be limited to the following values :

(i) For coal mill motors – 10% of the rated voltage.
(ii) For all motors except BFP – 15% of the rated voltage.
(iii) For BFP motors – 20% of the rated voltage.
(iv) For LV motors – 15% of the rated voltage.

3.1.6 Voltage drop in feeder cables between the transformer & PCC and between PCC & MCC, for full load current, shall be limited to 2 %. Further, the Voltage drop in feeder cables between PCC/MCC to Motor terminals shall be limited to 3% during full load running condition.

3.1.7 For power supply to valve actuator motors, actuators of various isolating and regulating dampers and exhaust fans, 3 core 2.5 sq. mm stranded copper conductor cable may be used in view of ease of termination. These cables shall be in other respects similar to cables described in Clause 1.2 above.

3.2 **Control Cables**

3.2.1 Current transformers leads shall be checked for the lead burden vis-a-vis the current transformer VA capacity and 4 sq.mm cables shall be used for connection of CT to loads. In case 4 sq.mm conductor impose unacceptable high burden on CTs, higher cross section of conductor shall be used.

3.2.2 Voltage transformer leads shall be checked for voltage drop, which shall be limited to within 1% for all cases other than tariff metering. For tariff metering the voltage drop shall be limited to 0.2%. In case the voltage drop with 4 sq. mm Cu conductors exceed this value, higher conductor sizes shall be used.

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3.3 **Instrumentation Cables**

Instrumentation cables shall comply with the Electrical Properties suitable for the Digital and Analogue signals.

4.0 **CABLE TERMINATIONS**

4.1 All 11000V / 3300V termination kits shall be of heat shrinkable type and suitable for XLPE insulation and the same shall have been tested for a short circuit current as per relevant Standards

4.2 All 1100V termination for XLPE/PVC power cables and control cables shall be by crimping type tinned copper / aluminum lugs.

5.0 **CABLE JOINTS**

Cable joints shall be avoided to the extent possible. If joints are unavoidable due to circuit length, in excess of permissible maximum drum length, they shall be heat shrinkable type having a short circuit with stand capacity of 40kA for 0.5 sec. for 11kV / 3.3kV cables and 50kA for 0.5 sec. for 1100V grade cables.

6.0 **POWER RECEPTACLES**

3 phase, 4 pin, 63A power receptacles with switch shall be provided two in each floor of TG building, boiler platforms and one in each pump house. The receptacle shall be industrial heavy duty type and shall have suitable interlock facility for safety. The receptacle shall conform to IS 1293 and the switch to IS 4064.

7.0 **CABLE CARRIER SYSTEM**

7.1 The cable carrier system shall be designed considering the following :

(a) Facility for easy laying of cables.
(b) Access to maintenance.
(c) Neat and aesthetic appearance.
(d) Safety of equipment & personnel.
(e) Ground water seepage.

7.2 Cables shall be laid in prefabricated ladder/ Perforated type trays and in conduits. Direct burial of cable shall be avoided as far as possible. In case cables are buried, length of burial shall be limited to about 10 M and depth of burial shall be about 750 mm. Cable route markers shall be provided at every 15 m intervals and at bends. Also joint markers shall be provided at each joint.

7.3 Cable tunnels are not acceptable. Cables shall necessarily be run in overhead racks.

8.0 CABLE INSTALLATION AND ACCESSORIES

8.1 All material and accessories required for cable installation like cable trays, tray covers, support steel, etc., shall be hot dip galvanised and conduits/pipes shall also be hot dip galvanised.

The racks/trays, conduits/pipes, trenches required to route the cables to individual equipments shall be supplied and installed by the CONTRACTOR.

8.2 Separate trays shall be provided for HV Power/LV Power (AC&DC)/Control & Instrumentation cables.

9.0 CABLE TRAYS AND COVERS

9.1 Cable trays shall be of ladder / perforated type complete with all necessary coupler plates, elbows, tees, bends, reducers, stiffeners and other accessories. Cable trays of ladder and perforated types and the associated accessories such as coupler plates, tees, elbows, etc. shall be fabricated from 12 gauge (2.5 mm thick) mild steel sheets. cable tray covers shall be fabricated from 16 gauge (1.7 mm thick) MS sheets. All the sheet steel shall be hot dip galvanised as per relevant standards.

Cable trays shall be ladder type for power & control cables and perforated type for Instrumentation cables.

9.2 Cables of sizes 120 sq.mm and above shall be laid in single layer. Single core cables used for 3 phase AC power circuits shall be laid in Trefoil form.

10.0 FIRE-PROOF SEALING OF CABLE PENETRATION

Cables / cable tray openings in walls and floors or through pipe sleeves from one area to another or one elevation to another, between the units and within the same unit, shall be sealed by a fire-proof sealing system. The fireproof sealing system (FPSS) shall effectively prevent the spread of fire from the flaming to the non-flaming side, in the event of a fire. The FPSS shall conform to relevant standard in addition to the following requirements :

(a) FPSS shall have a fire rating of two hours.

(b) The FPSS shall be subjected to fire endurance test, hose stream test, temperature measurement of non-flaming side as per ASTM-E119. 'Standard method of fire tests of building construction and materials'.

(c) The FPSS will also conform to the incombustibility test carried out in accordance with IS:3144-1992.

(d) Under fire condition, the FPSS material shall not emit excessive smoke or any corrosive or toxic fumes.

11.0 FIRE BREAK

11.1 Firebreak shall be provided by applying a suitable fire-resistant coating on cables for the required length to meet the fire rating of thirty minutes.

11.2 Firebreak shall be provided at an interval of 15 metres in the straight portion of each of the cable tray above ground, at intervals of 30 metres in cable trenches and at 5M for all vertical trays. All cable inter section and tee offs shall be provided with firebreaks.

12.0 TESTS

All tests shall be carried out as per relevant standards and approved GTP/QAP.

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GENERAL TECHNICAL REQUIREMENTS FOR PANELS, CABINETS & MISCELLANEOUS ELECTRICAL EQUIPMENTS

1.0 CONTROL PANELS & CABINETS AND MISCELLANEOUS ELECTRICAL EQUIPMENT

1.1 Indoor control panels provided for control of miscellaneous systems in the plant viz., air conditioning, evaporative air cooling, fire protection system and outdoor control cabinets shall comply with the requirements outlined under clause 1.5 below.

1.2 All the meters provided on the panel shall be min. 96 sq.mm with an accuracy class of 0.5 unless otherwise specified. Tariff meters shall have an accuracy of 0.2. All meters shall be of digital type.

1.3 The facia annunciation windows if provided on the panel, shall conform to requirements outlined under instrumentation and control section.

1.4 The required 240V, 1 phase AC supply required for panel illumination, receptacle and for space heating of panel shall be derived in the control panel itself.

1.5 **Technical Requirements**

SL. NO.	DESCRIPTION	REQUIREMENTS
1	Location	Indoor/Outdoor depending location
2	Type of mounting	Wall/Floor
3	Cable entry	Top/bottom depending on layout
4	Paint Finish: Outside/Inside	To be decided later/ glossy white.
5	Supply voltage	415V 3 phase 3 wire
6	Control transformer	Required to derive 110V control supply
7	Space heater, lighting supply voltage	240V, 1 phase AC
8	Applicable standards	
9	Switchgear general requirements	IS 4237
10	Factory built assemblies of switchgear and control gear for voltages upto and including 1000V AC & 1200V DC	IS 8623

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11	Air break switches	IS 13947 pt 1 & 2
12	Miniature circuit breakers	IS 8828
11.5	HRC cartridge fuses	IS 9224
11.6	Contactors	IS 2959
11.7	Control switches/push buttons	IS 6875
11.8	Current transformers	IS 2705
11.9	Voltage transformers	IS 3156
11.10	Relays	IS 3231
11.11	Indicating instruments	IS 1248
11.12	Arrangement for bus bars, main connections and accessories	IS 375
11.13	Degree of Protection	IS 2127 / 3427
11.14	Climate proofing of electrical equipment	IS 3202
11.15	Code of practice for phosphating iron & steel	IS 6005
11.16	Wrought aluminium and aluminium alloys for electrical purposes	IS 5082

2.0 Following miscellaneous equipment shall be included in CONTRACTOR's scope.

2.1 Local push button stations.

2.2 Junction boxes (JBs)

2.3 Danger boards

2.4 Rubber mats

3.0 **LOCAL PUSH BUTTON STATIONS (LPB)**

3.1 Local push button station shall be provided for all the drive motors of the plant (415V motors and 11kV & 3.3kV motors) (start stop push buttons for all motors; only stop push button for emergency motors).

3.2 The degree of protection of LPBs shall be IP55 with canopy for outdoor and IP54 for indoor applications.

3.3 All PBs shall be push to actuate type and the stop PB shall be lockable in off position.

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3.4 All push buttons shall be provided with 2 nos. NO and 2 nos. NC contacts for various interlocking purposes. One contact of stop PB shall be directly wired to the switchgear module for direct tripping and another contact to control system.

4.0 **JUNCTION BOXES (JBs)**

4.1 Junction boxes as required for the power plant shall be supplied :

4.2 The JBs used in outdoor areas shall be weatherproof type. Sheet steel thickness of the JBs shall be minimum 2 mm. The sheet steel shall be hot dip galvanised.

4.3 Junction boxes/marshalling boxes (JBs/MBs) shall be provided to enable running large core cables from (JB/MB) to control panels, terminal cabinets, etc.

4.4 Clause deleted.

5.0 Danger boards shall be provided in line with the statutory requirements.

6.0 Rubber mats shall be provided to meet the safety and other statutory requirements.

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SECTION – D3

GENERAL TECHNICAL REQUIREMENTS FOR C&I

FORM NO. PEM-6666-0

BHEL	**SPECIFICATION FOR CONTROL & INSTRUMENTATION FOR AUX PACKAGES**	SPECIFICATION NO.:
		VOLUME
		SUB SECTION
		REV. NO. / DATE :
		SHEET / OF

GENERAL REQUIREMENT

1.0 Bidder shall provide complete and independent control & instrumentation system with all accessories, auxiliaries and associated equipments for the safe, efficient and reliable operation of auxiliary systems.

2.0 The quantity of instruments for auxiliary system shall be as per tender P &ID wherever provided of the respective system as a minimum, for bidding purpose. However, Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any price implication.

3.0 Measuring instruments/equipment and subsystems offered by the bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further all the instruments shall be of proven reliability, accuracy, and acceptable international standards and shall be subject to employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specification, ranges, makes/ numbers as approved by the employer' during detail engineering.

4.0 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifold 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 to suitably located junction boxes.

5.0 The customer specification attached as Specific Technical Requirement will supercede the Data sheets, if there is any mismatch.

GENERAL TECHNICAL REQUIREMENTS FOR LOCAL CONTROL PANEL

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL CONTROL PANEL**	SPECIFICATION NO.: PE-TS-999-145-I990 VOLUME SECTION REV. NO. 00 DATE: SHEET 1 OF 1

TAG No. …… Qty.....

Data Sheet A & B

			DATA SHEET-A FOR LOCAL PANEL (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	CONSTRUCTION		■ FOLDED ☐ WELDED (As per requirement)	
	ENCLOSURE SHEET THICKNESS	FRONT	■ 3.0 mm	
		OTHER	■ 3.0 mm	
		DOOR	■ 3.0 mm	
TECHNICAL	INPUT POWER SUPPLY		☐ 240V 50 Hz AC ☐ 220V DC ■ 415V 3 PHASE ☐	
	NO. OF FEEDERS		☐ ONE ■ TWO	
	CONTROL SUPPLY		☐ 110V AC ■ 220V AC ☐ 220V DC ☐ During detailed engg. (As per requirement)	
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		_____NOS. (AS REQUIRED)	
	PAINT TYPE		☐ EPOXY ENAMEL ■ EPOXY POWDER COATED	
	PANEL COLOUR (EXTERNAL)		■ LIGHT GREY (Shade 631 IS-5) (Project specific) ☐ OPALINE GREEN (Shade 275) ☐ During detailed engg.	
	FINISH		■ MATT ☐ GLOSSY ☐ SEMI GLOSSY	
	PANEL COLOUR (INTERNAL)		■ WHITE ☐ CREAM ☐ OFF WHITE	
	FINISH		☐ MATT ☐ GLOSSY ■ SEMI GLOSSY	
	CLASS OF PROTECTION		■ IP-65 ☐ IP-55	
	CONTROL HARDWARE		PLC BASED	
	FOUNDATION ARRANGEMENT		■ FOUNDATION BOLTS ☐ ANCHOR FASTENERS	
	WEIGHT OF PANEL (Kg.)			
	PANEL TYPE		☐ PRESSURISED ■ UNPRESSURISED As per Requirement	
	CABLE GLAND		☐ SINGLE COMPRESSION ■ DOUBLE COMPRESSION	
	AMMETER (TYPE OF INPUT)		☐ 1 Amp CT ☐ 4-20 mA	

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR LOCAL PANELS**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty.....

Data Sheet C

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

GENERAL	MANUFACTURER		
	CONSTRUCTION		
	ENCLOSURE SHEET THICKNESS	FRONT	
		OTHER	
		DOOR	
TECHNICAL	INPUT POWER SUPPLY		
	NO. OF FEEDERS		
	CONTROL SUPPLY		
	ALARM ANNUNCIATOR WINDOW (EXCLUDING SPARES)		
	PAINT TYPE		
	PANEL COLOUR (EXTERNAL)		
	FINISH		
	PANEL COLOUR (INTERNAL)		
	FINISH		
	CLASS OF PROTECTION		
	CONTROL HARDWARE		
	FOUNDATION ARRANGEMENT		
	WEIGHT OF PANEL (Kg.)		
	PANEL TYPE		
	CABLE GLAND		
	AAMETER (TYPE OF INPUT)		

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

	SPECIFICATION FOR LOCAL PANELS	SPECIFICATION NO.: PES – 145 – 054A	
		VOLUME II B	
		SECTION D	
		REV. NO. 02	DATE : 22-02-2008
		SHEET 1 OF 5	

1.0 SCOPE

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

2.0 CODES AND STANDARDS

2.1 All the equipments specified herein shall comply with the requirements of the latest issue of the relevant National and International standards.

2.2 As a minimum requirement, the following standards shall be complied with:

a)	IS-6005 : 1970	:	Code of practice for phosphating of iron and steel.
b)	IS-5 : 1978	:	Colours for ready mixed paints and enamels.
c)	IS-1248:1983	:	Direct Acting Indicating Instruments.
d)	IS-13947 (Part-III):1993	:	Rotary Cam Switches.
e)	IS-6875:1973	:	Auxiliary relays.
f)	IS-8828:1993	:	Circuit breaker for household and similar installations.
g)	IS-13947 (Part-I):1993	:	Low Voltage switchgear & control gear : Part-I (General Rules)
h)	NFPA-496:1974	:	Purged & Pressurised Enclosure for Electrical Equipment in Hazardous Locations.

3.0 TECHNICAL REQUIREMENTS

3.1 Panel Construction

3.1.1 The local panels shall house the secondary instruments, annunciation system, Single loop controller, Control switches / push buttons, indicating lamps, relays, timers and other devices required for operation and monitoring of the equipment locally.

3.1.2 The panels shall be of free standing type either welded construction on angle iron (minimum section of 50 x 50 x 4 mm) structure or folded construction by sheet metal formation depending upon the equipments to be mounted on it. The panels shall be robustly built and stiffners as necessary shall be provided.

3.1.3 The panel shall be suitably reinforced to ensure adequate support for all instruments mounted thereon. All welds on exposed panel surfaces shall be ground smooth.

3.1.4 The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.5 mm for load bearing sections (Mounted with instruments), 1.6 mm for doors and Not less than 2.0 mm for others
Panel Height: Not less than 2365 mm
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

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

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

3.1.7 The class of protection shall be in accordance with IP-42 unless otherwise specified in the data sheet – A (No. PES-145-54A-DS1-0).

3.1.8 All steel surfaces shall be cleaned by sand / pellet blasting, treated for pickling, degreasing and phosphating etc. by seven tank method. The panel shall have a high quality finish and appearance. The panel shall be painted with two coats of primer followed by two coats of epoxy / synthetic enamel based final paint of color shade and finish as given in data sheet-A (No. PES-145-54A-DS1-0). Minimum thickness of the paint shall be 85 microns for external paint and 70 microns for internal paint.

3.1.9 The cable glands of the required size and type as given in data sheet-A (No. PES-145-54A-DS1-0) shall be supplied alongwith the Panel.

3.1.10 All operable and indicating devices shall be mounted on the front of the panel while aux. Relays / timers MCBs etc. required for realization of control logics shall be mounted on a mounting plate inside the panel. Auxiliary relays and timers etc. shall be grouped according to the control function.

No operable or indicating devices shall be mounted below 750 mm and above 1800 mm (w.r.t. finished ground level). The devices shall be located in such a way so as to ensure easy access for operation / maintenance.

3.1.11 Single / dual control power supply feeders of voltage class as specified in data sheet-A (No. PES-145-54A-DS1-0) shall be provided by the purchaser. In case redundant power supply feeders are provided then auto changeover unit shall be mounted on the panel are in the panel supplier's scope. Where DC control power supply is specified an additional 240V, 50 Hz AC supply feeder for powering of space heater and lighting shall be provided by the purchaser. Suitable arrangement shall be provided inside the panel to receive and terminate the power supply feeder(s). For this purpose MCBs of suitable current rating shall be provided by the vendor. A supervisory relay along with a pilot lamp to indicate control supply 'ON' shall be provided on the panel. Any other power supply required for the operation of the devices mounted in the panel shall be arranged by the vendor.

3.1.12 The internal wiring shall be carried out with 1100 volt grade PVC insulated copper multi strand wire / flexible of 1.5mm2 size. AC & DC wires shall be kept separate from each other. Separate coloured wires to be used for AC and DC circuits. All wires shall be properly numbered and identified with ferrules as per the Control scheme / wiring diagram. Wires shall be routed and run through PVC troughs.

3.1.13 Terminal blocks shall be clip on type, 1100 volts grade. Separate terminal blocks shall be used for AC & DC circuits. The terminals shall be suitable for terminating 0.5 mm2 to 2.5mm2 external cables. The terminal for ammeters shall be provided with removable links for shorting CTs. Each terminal strip shall be provided with identification strip. The terminal shall not be mounted below 250 mm height from finished floor. The panel shall have ten (10) percent spare terminal.

3.1.14 The interior of each panel shall be suitably illuminated through fluorescent lamps operable on 240V 50 Hz AC power supply through panel door switch. A 15 Amp. 3-pin Power receptacle shall be provided.

3.1.15 Suitable space heaters operable on 240 Volts 50 Hz AC power system shall be provided at the panel bottom. These shall be designed to maintain the panel temperature five (5) deg. C above the ambient temperature during maintenance shutdown. Suitable isolating and control devices comprising of MCB, thermostat etc. shall be provided for the space heater.

3.1.16 The panel shall be provided with a copper earth bus of 25 x 6 mm size running throughout the width of the panel. It shall be terminated internally with 10 mm bolts at extreme ends for connection to; main station earth. The panel mounted equipments / devices shall be connected to earth bus through green coloured PVC insulated stranded copper conductor of 2.5 mm2 size.

3.1.17 Local Panel shall be provided with main name plate of 150 mm x 40 mm size having inscription of 20 mm height. The individual devices on the panels shall be as provided with separate name plate with inscription of 3 mm height. The instrument / devices shall be provided with stick on label plates inside the panel. The material of the main and individual labels shall be three (3) ply 3 mm thick Traffolyte Sheet / 2 mm Anodised Aluminium Plate. The inscription shall be with white letters on black background on traffolyte sheet. The labels shall be fixed by self tapping non-rusting screws.

3.2 Hazardous Area Panel Requirement

3.2.1 The Local Panel located in hazardous area shall be pressurized as per NFPA-496 requirements to render it non-hazardous. Alarms shall be provided for local and remote annunciation when pressurisation falls below 2.5 mm of water column. Protection shall be of type Z of NFPA-496. It shall not be possible to switch ON the power of purged section unless it is purged as per the recommendation of NFPA-496. Vendor must provide a protective device on the panel to protect the panel from over pressurisation.

3.2.2 Vendor shall supply pressurisation kit consisting of valves, restriction orifices, dual filter regulation, pressure gauges, pressure switches, rotameter etc. Pressurisation kit shall be surface mounting on a metal board and located outside the local panel. Pressurisation kit shall further consist of solenoid valve flow switch, timer blow off safety device etc., so as to make purging fully automatic. However final start shall be manual. Panel protection against over pressure to be provided as per NFPA-496.

3.2.3 Pressurised local control panel pressurization kit assembly design shall provide minimum leakage flow through the Local Control Panel. Panel venting shall be as per NFPA-496.

3.2.4 All components in the local panel like indicating instruments, push buttons switches, lamps etc., which are required to be energized without panel pressurization or before completion of purge cycle shall be explosion proof as per NEMA-7 & suitable for area classification.

3.2.5 All push buttons etc. requiring frequent operation during machine running shall have good positive sealing. Weatherproof housing or cover to be provided wherever necessary. Vendor shall provide pressurisation bypass switch outside explosion proof enclosure of pressurized panel with lamp indication. This shall be used only during maintenance. All hinges, screws, other non-painted metallic parts shall be of stainless steel material.

3.2.6 Provision to switch off manually all types of power shall be provided in the panel. In addition, it shall also be possible to switch off power circuits / components which are powered from motor control centre or control room manually in case of pressurization failure. All such cables from MCC and main control room shall be terminated in explosion proof boxes (NEMA-7).

3.3 Control & Monitoring devices

3.3.1 Instruments like Indicators, recorders, single loop controllers etc. as applicable and specified elsewhere for the plant / equipment shall be supplied and mounted on the panel.

3.3.2 Alarm Annunciator System

It shall be solid state discrete facia type having a sequence of ISA-S18.1A or as specified, opaque facia windows of 70 mm x 50 mm size, having two (2) lamps per window, and hooter of 10W, and provision for repeat group alarm at remote. The annunciator shall be provided with ten (10) percent spare windows or minimum two (2) windows along with electronics.

3.3.3 Relays

The relays shall be electromagnetic type suitable for specified control supply. Its contact configuration and rating shall be suitable for the specified control function. However minimum contact rating shall be 5 Amp AC & 2 Amp DC as applicable. There shall be ten (10) percent spare contacts.

3.3.4 Timers

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

3.3.5 Control / Selector Switches

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

3.3.6 Push Buttons / Indicating Lights

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

RED	Motor OFF / Valve CLOSE	YELLOW	Alarm acknowledge.
GREEN	Motor ON / Valve OPEN	BLACK	Lamp test

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

GREEN	Motor OFF / Valve CLOSED condition	AMBER	Motor tripped condition.
RED	Motor ON / Valve OPEN condition	WHITE	Normal / healthy condition

3.3.7 Ammeters

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

3.3.8 Miniature Circuit Breaker (MCB)

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

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

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

4.0 TESTING AND INSPECTION

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

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

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

4.3.1 Routine Tests

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

4.3.2 Type Tests

1. Enclosure Class Test

5.0 SPARES AND CONSUMABLES

5.1 Commissioning Spares and consumables

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

5.2. Mandatory Spares

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

5.3. Recommended Spares

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

6.0 DRAWINGS AND DOCUMENTS

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

1. Data Sheet no. PES-145-54A-DS1-0
2. General Arrangement Drawing.
3. Catalogue and technical information for instruments and devices.
4. Quality Plan.

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

1. Data Shee No. PES-145-54A-DS2-0
2. GA Drawing indicating layout of instruments, construction details, foundation details, cable gland plate alongwith cable glands and all details mentioned in this specification.
3. Control Schematic Diagram along with grouping of different terminals for various functions.
4. Catalogue and technical information for instruments and devices with selected options clearly marked.
5. O&M Manuals.
6. "As Built" Drawing.
7. CDs.

7.0 MARKING AND PACKING

7.1 Panel with all instruments / devices mounted on it shall be suitably packed & protected for the entire period of despatch, storage and erection against impact, abrasion, corrossion, incidental damage due to vermin, sunlight, high temperature, rain moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in Transit and storage in open.

8.0 APPLICABLE DATA SHEET FORMS

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

- Data sheet A&B for Local Panels : Data sheet no. PES-145-54A-DS1-0
- Data sheet C for Local Panels : Data sheet no. PES-145-54A-DS2-0

GENERAL TECHNICAL REQUIREMENTS FOR INSTRUMENTS

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR TEMPERATURE ELEMENT (WITH THERMOWELL)** Refer Specific Technical Requirement for details	SPECIFICATION NO.: VOLUME SECTION REV. NO. / DATE: SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-03A-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR TEMPERATURE ELEMENT (WITH THERMOWELL) (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER			
	MODEL NUMBER			
TECHNICAL	ELEMENT TYPE	☐ RTD (3 WIRE) ☐ T / C		
	T / C GROUNDED	☐ YES ☐ NO		
	ELEMENT THICKNESS (AWG)			
	LIMIT OF ERROR	Accuracy +- 0.5 % of SPAN		
	INSULATION RESISTANCE	MORE THAN 5M OHM AT 100V DC		
	TIME CONSTANT			
	MOUNTING THREAD SIZE	Process connection M33 X 2 thread or 150 RF Flanged		
	CONDUIT THREAD SIZE			
	EXTENSION WIRE TYPE			
	THERMOWELL	☐ YES ☐ NO		
	THERMOWELL LENGTH			
	LINE SIZE			
	PRESSURE RATING			
	TEMPERATURE RATING			
	FLUID MEDIUM			
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR TEMPERATURE TRANSMITTER**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-03A-DS1-0**

Data Sheet C

DATA SHEET-C FOR TEMPERATURE ELEMENT (WITH THERMOWELL)
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	ELEMENT TYPE	
	T / C GROUNDED	
	ELEMENT THICKNESS (AWG)	
	LIMIT OF ERROR	
	INSULATION RESISTANCE	
	TIME CONSTANT	
	MOUNTING THREAD SIZE	
	CONDUIT THREAD SIZE	
	EXTENSION WIRE TYPE	
	THERMOWELL	
	THERMOWELL LENGTH	
	LINE SIZE	
	PRESSURE RATING	
	TEMPERATURE RATING	
	FLUID MEDIUM	

NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

BHEL	**SPECIFICATION FOR TEMPERATURE ELEMENT FOR AUX PACKAGE**	SPECIFICATION NO.: PES – 145 – 003A	
		VOLUME II B	
		SECTION D	
		REV. NO. 01	DATE : 27.07.94
		SHEET 1 OF 3	

1.0 TECHNICAL REQUIREMENTS

1.1 General

i) The temperature sensor elements shall be duplex type either thermocouple (T/C) or resistance temperature detector (RTD). Unless otherwise specified, the type of sensors for different applications shall be as follows:

ii) Nickel Chromium Nickel T/C medium temp. range (250°C to 600°C)

iii) Platinum-Rhodium Platinum High temp. range (600°C and above). Type S/R/B.

iv) Platinum RTD Low temperature & high accuracy (-50°C to 250°C).

1.2 Process Parameters

The instrument shall be suitable for a Process Parameters given in the instrument data sheet.

1.3 Thermocouple Wire Size

The thermocouple wire size for a given temperature application shall be as per table - 3.1A of ASME PTC 19.3 - 1974.

1.4 Sensor Grounding

As per instrument data sheet.

1.5 Sensor Protective Sheath & Wire Insulation

The sensor protective sheath shall be 8mm OD 316 SS seamless tube using compacted magnesium oxide packing/porcelain for insulation.

1.6 Sensor Characteristics

Thermocouple calibration characteristics i.e. temperature vs. milli volt or resistance shall be as per the applicable Indian Standards (IS-2054 for thermocouple 'K' type, IS-2055 for Pt.Rd.Pt.), RTD type of sensor calibration i.e. temperature vs. resistance shall be as per applicable Indian Standard (IS-2848).

1.7 Sensor Accuracy Limits

T/C sensor limiting accuracy shall be as per table 3.2A of ASME PTC 19.3 - 1974. RTD sensor accuracy shall be as per table 9.1 of ASME PTC - 19.3 - 74.

1.8 Insulation Resistance

Insulation resistance of RTD leads w.r.t. body shall be more than 5 mega ohms at 100V DC.

1.9 End Connection

The sensor assemblies shall have screwed M33 x 2 end connection. Specific design requirements of pressure, temperature and end connection type for a given application are indicated in the instrument data sheet.

1.10 Terminal Head

The terminal head cover shall be screwed type design having gasket with small flexible chain attached between fixed portion and head cover.

1.10.1 Terminal Head Enclosure

The terminal head enclosure shall be dust, weather proof and water proof as per NEMA-4 classification unless specified otherwise.

1.10.2 Terminals

The terminal head shall have provision of screwed terminal of 1.5 mm2 size for external connection. The terminals shall be suitably marked '+ve' & '-ve' for thermocouple and 'Lo', 'Hi' and "C' for three wire RTD.

1.11 Cable Entry

Cable gland complete with neoprene gromet suitable for PVC cable with maximum diameter of 17.5mm shall be provided for cable entry. The actual size of cable shall be indicated during the contract stage. Separate cable entry and cable glands shall be provided for both the elements.

1.12 Thermowell and its material

Temperature element shall be supplied along with the thermowell. The thermowell shall be of tungstion carbide for mill air temperature and for rest of the applications of AISI 316SS shall be machined out of solid bar stock and designed to suit the process conditions. For detail of the thermowell, see enclosed drawing.

1.12.1 Internal Construction

Sensor assemblies shall preferably be metal sheathed with spring load on to the thermowell tip for better response. The sheathed sensor assembly shall be replaceable (in-situ) type without removal of thermowell.

1.12.2 Compensating cable should be used for connecting elements to secondary Instruments/Device unless there is specific requirement for cold junction compensation. Field mounted cold junction compensation box as per NEMA-4 shall be provided for all thermocouples. The CJC box shall have automatic temperature control at reference junction temperature of 60°C. Each CJC box shall be provided with duplex RTD for remote monitoring.

2.0 TESTING

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

2.2 The vendor shall conduct following tests as a minimum requirement and shall furnish test certificate thereof, for BHEL's approval before despatch of the same.

2.2.1 Physical dimension of the sensor assemblies as per approved drawing.

2.2.2 Electrical characterstic of sensor such as continuity of the thermocouple wires, and insulation resistance of the RTD leads w.r.t. body.

2.2.3 Temperature vs. Resistance/milli volt for the sensor assemblies shall be tested with reference to standard resistance thermometer by comparison method. This test may be carried out once for the T/C or RTD sensor wires for each batch production.

2.2.4 Each type of high pressure thermowell assembly with thread and connection shall be tested against hydrostatic test pressure of one & a half times the maximum working pressure for any leakage. However dimensional checks and thread confirmity with gauges shall be checked for each sensor assembly.

3.0 APPLICABLE DATA SHEET FORMS

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

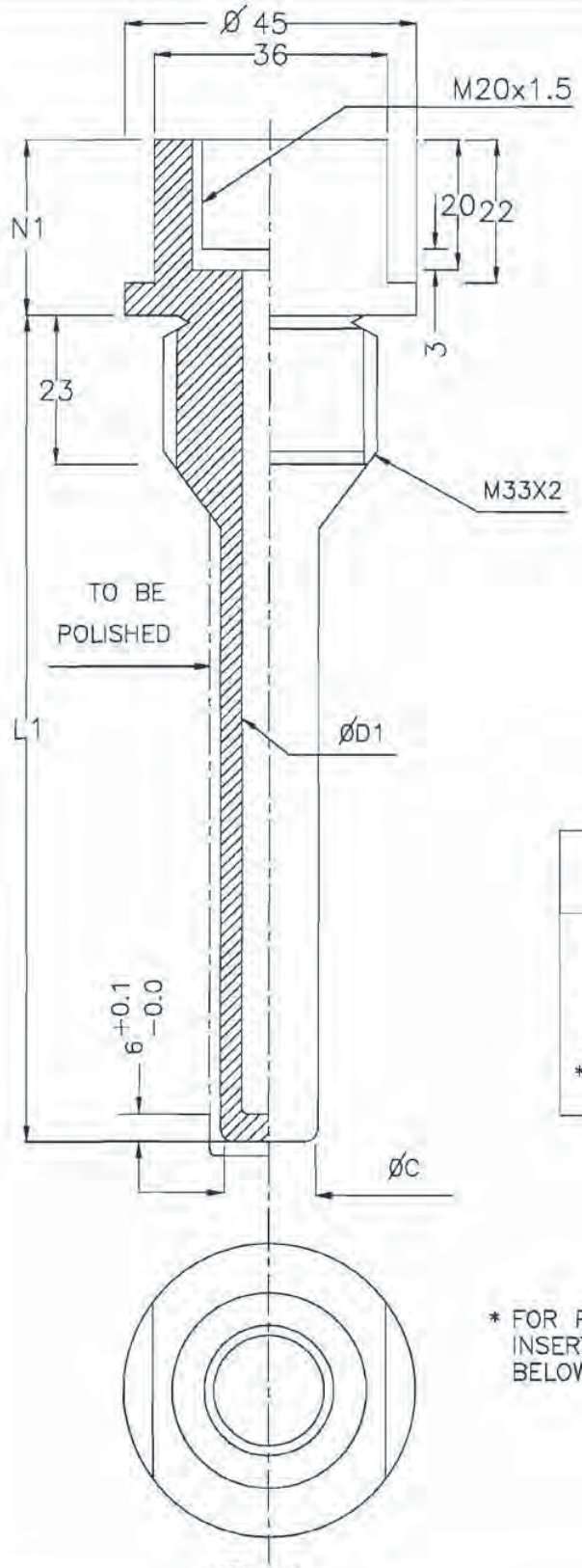
- Data sheet A&B for Temperature Element (With Thermowell) : Data sheet no. PES-145-03A-DS1-0

- Data sheet C for Temperature Element (With Thermowell) : Data sheet no. PES-145-03A-DS2-0

FORM NO. PEM - 6666-0

THERMOWELL MEDIUM PRESSURE (40 Kgf/Cm2)

SPECIFICATION NO PES-145-03A	
VOLUME IIB	
SECTION D	
REV. NO. 01	DATE 27-7-94
SHEET 4	OF 8



PIPE O.D.	INSERTION LENGTH (L1)
Ø 509 & ABOVE	325
Ø 506 TO 369	250
Ø 368 TO 274	175
*Ø 273 BELOW	150

* FOR PIPE O.Ds UP TO 159mm THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE O.Ds BELOW 159mm, THE INSERTION SHALL BE SLANT.

Fig.1

FORM NO. - 6666-0

	SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)	SPECIFICATION NO. : PES - 145 - 03A
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE 27.07.94
		SHEET 5 OF 8

THERMOWELL-MEDIUM PRESSURE
(40 KG/CM2)

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corres ponding element length(L)
6	6,5	12.5	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
8	8.5	15	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

FORM NO. - 6666-0

BHEL	**SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)**	SPECIFICATION NO. : PES - 145 - 03A VOLUME II B SECTION D REV. NO. 01 DATE 27.07.94 SHEET 6 OF 8

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corrcs ponding element length(L)
12	12.5	19	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
14	14.5	21	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

NOTE: The corresponding element lenghts are given for information only. The elements lengths are worked out as per the formula :

$$L = L1 + N1 - 6$$

FORM NO. PEM - 6666-0

THERMOWELL-HIGH PRESSURE (250 Kgf/Cm2)

SPECIFICATION NO. PES-145-03A	
VOLUME IIB	
SECTION D	
REV. NO. 01	DATE 27-7-94
SHEET 7	OF 8

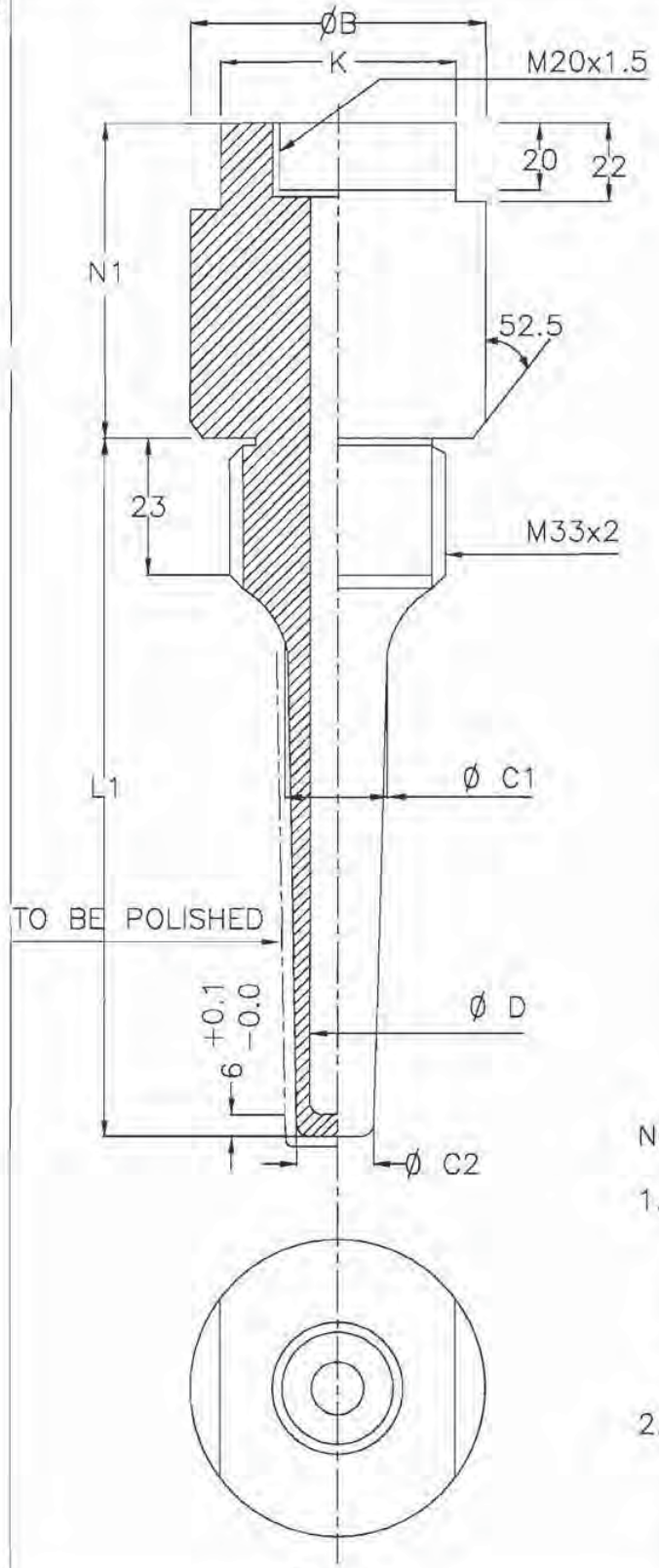


Fig. 2

PIPE O.D.	INSERTION LENGTH L1
Ø 509 & ABOVE	325
Ø 508 TO 368	250
Ø 367 TO 0274	175
Ø 273 BELOW	150

NOTE :-

1. THE CORRESPONDING ELEMENT ELEMENT LENGTHS ARE GIVEN FOR INFORMATION ONLY. THE ELEMENT LENGTHS ARE WORKOUT AS PER THE FORMULA L=L1+N1-6.

2. FOR PIPE OD'S UPTO 159mm, THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE OD'S BELOW 159mm, THE INSERTION SHALL BE SLANT.

FORM NO. - 6666-0

SPECIFICATION FOR TEMPERATURE ELEMENT (WITH THERMOWELL)

SPECIFICATION NO. :	PES - 145 - 03A
VOLUME	II B
SECTION	D
REV. NO. 01	DATE 27.07.94
SHEET 8	OF 8

ALL DIMENSIONS IN mm

Instrument stem dia D (+0.0 -0.1)	DIA D1 (+0.2 0.0)	DIA C1	DIA C2	K	DIA B	Insertion Length L1	Extention Length N1	Corresponding Element Length (L)
6	6.5	19	12.5	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
8	8.5	21.5	15	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
12	12.5	25.5	19	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
14	14.5	27.5	21	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
16	16.5	29	23	46	55	150	27 75 100	171 219 244
						250	27 75 100	271 319 344

FORM NO. PEM-6666-0

BHEL	**CHECK LIST FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE (MECHANICAL AUXILIARY PACKAGES)**	SPECIFICATION NO.: PE-TS-375-145-I054 VOLUME SECTION REV. NO. 00 DATE: 15.02.2012 SHEET 16 OF 16

SL NO	TESTS/CHECKS	QUANTM OF CHECK	REFERENCE DOC. ACCEPTANCE NORMS	AGENCY P	AGENCY W	AGENCY V	REMARKS
1.0	CHECK FOR		APPROVED TECHINCAL REQUIREMENT/ DATA SHEET				MFR TO CARRY OUT ROUTINE TEST ON 100%. WHEN MATL CORELATION ARE NOT AVAILABLE MFR'S COMPLIANCE TO BE PROVIDED
	1.1 DIAL SIZE	100%		M	C	C	
	1.2 MODEL NO/TAG NO	100%		M	C	C	
	1.3 RANGE/SCALE	100%		M	C	C	
	1.4 END CONNECTION	100%		M	C	C	
	1.5 SWITCH CONTACT RATING & NOS	100%		M	C	C	
2.0	CALIBRATION						
	2.1 ACCURACY	100%		M	C	B	
	2.2 REPEATABILITY (FOR SWITCH)	100%		M	C	B	
	2.3 SET POINT ADJUSTMENT FOR SWITCH	100%		M	C	C	
3.**0**	OVER PRESSURE & LEAK TEST	100%		M	C	C	
4.0	OPERATION OF PR. RELEIF DEVICE	ONE PER TYPE		M	C	C	
5.0	REVIEW OF T.C. FOR MATERIAL OF--						
	5.1 SENSOR	FOR LOT		-	-	B	
	5.2 MOVEMENT			-	-	B	
	5.3 PROCESS CONNECTION			-	-	B	
	5.4 HOUSING			-	-	B	
6.0	REVIEW OF T.C. FOR DEGREE OF PROTECTION	TYPE TEST		-	-	B	
7.0	REVIEW OF T.C. FOR CONTACT RATING OF SWITCH	ONE PER TYPE		-	-	B	
8.0	ACCESSORIES AS APPLICABLE	100%		M	C	C	

LEGEND:
M: MANUFACTURER/ SUB CONTRACTOR, C: CONTRACTOR/ NOMINATED INSP AGENCY, B: BHEL. P: PERFORM, W: WITNESS, V: VERIFICATION.

NOTE:
CONTRACTOR TO PROVIDE COMPLIANCE CERTIFICATE FOR TESTS/CHECKS VERIFIED BY CONTRACTOR AND SUBMIT THE SAME ALONGWITH TEST CERTIFICATES TO BE VERIFIED BY BHEL.

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE** Refer Specific Technical Requirement for details	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PE-DC-999-145-I026**

Data Sheet A & B

	DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	PRESSURE ELEMENT	▌BOURDON ☐ DIAPHRAGM ☐ BELLOW	
	MATERIAL	SENSING ELEMENT – AISI 316 SS MOVEMENT – AISI 304 SS Refer Specific Technical Requirement for details	
	ENCLOSURE	☐ IP-55 ▌IP-65 ☐ FUEL GAS HAZARDOUS APPL. EXPL. PROOF	
	DIAL	SIZE: ☐ 100MM ▌150MM COLOR: WHITE NUMERALS: BLACK SCALE: ▌LINEAR ☐ SQUARE ROOT	
	CASE	COLOUR : BLACK	
	ADJUSTMENT	▌EXT. MICROMETER SCREW ☐ INT. MICRO SCREW	
	MOUNTING	▌LOCAL ☐ PANEL OR RACK	
	OVER RANGE PROTECTION	▌150% OF MAX. PRESSURE ☐ 125% ABOVE 150 KG/CM2 FSD ☐ AS REQUIRED	
	BLOW OUT DISC	SUITABLE MATERIAL	
	SWITCHING FACILITY NO./TYPE OF CONTACTS COJNTACT RATINGS SETTING RANGE REPEATABLITY POWER SUPPLY	Refer Specific Technical Requirement for details	
PERFORMANCE	ACCURACY	± 0.5% OR BETTER OF FULL SCALE DEFLECTION	
CONNECTION	PROCESS	AS APLLICABLE	
	LOCATION	☐ BACK ☐ BOTTOM ▌AS REQUIRED	
ACCESSORIES	NAME PLATE / METAL TAG	SS	
	MOUNTING	☐ WALL ▌PIPE – U CLAMPS & BOLTS ☐ PANEL / RACK ☐ AS REQUIRED	
	OTHER	Refer Specific Technical Requirement for details	

NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 1

TAG No. ……. Qty..... Data Sheet No.: **PE-DC-999-145-I026**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE GAUGE
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	PRESSURE ELEMENT	
	MATERIAL	
	ENCLOSURE	
	DIAL	
	CASE	
	ADJUSTMENT	
	MOUNTING	
	OVER RANGE PROTECTION	
	BLOW OUT DISC	
	SETTING RANGE	
PERFORMANCE	ACCURACY	
CONNECTION	PROCESS	
	LOCATION	
ACCESSORIES	NAME PLATE / METAL TAG	
	MOUNTING	
	OTHER	

NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 4

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS1-0**

Data Sheet A & B

		DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	TYPE	☐ INDUCTANCE ☐ CAPACITANCE ☐ STRAIN GAUGE ☐	
	POWER SUPPLY	24V DC	
	TRANSMITTER MEASUREMENT	☐ PRESSURE ☐ DIFF. PRESSURE	
	OUTPUT SIGNAL	4-20MA	
	NO. OF WIRE	TWO	
	ACCURACY	± 0.5% OF SPAN	
	LINEARITY, HYSTERISIS, DEAD BAND AND REPEATABILITY	± 0.1% OF SPAN	
	STABILITY	± 0.25% OF SPAN OR BETTER FOR 6 MONTHS	
	SENSITIVITY	± 0.05% OF SPAN	
	MATERIAL		
	A) BODY	FORGED CARBON STEEL	
	B) ELEMENT	316 SS	
	C) SEAL	TEFLON	
	CONTINUOUSLY ADJUSTABLE SPAN AND ZERO ADJUSTMENT PROVIDED	☐ YES ☐ NO	
	MOUNTING	☐ WALL/PIPE STAND ☐ TRANSMITTER RACK	
	ENCLOSURE	☐ NEMA-4 ☐ NEMA-7	
	TURN DOWN RATIO	TO BE SPECIFIED BY BIDDER	
	INSULATION RESISTANCE	TO BE SPECIFIED BY BIDDER	
	ZERO SUPPRESSION RANGE	TO BE SPECIFIED BY BIDDER	
	ZERO ELEVATION RANGE	TO BE SPECIFIED BY BIDDER	
	INTEGRAL INDICATOR	☐ YES ☐ NO	

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 4

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS1-0**

Data Sheet A & B

DATA SHEET-A FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER (TO BE FILLED BY PURCHASER)			DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	TRANSMITTER SHALL BE ABLE TO DRIVE OUTPUT IMPEDANCE OF 500 OHMS.	YES	
	ZERO DRIFT	< 0.1%	
	SPAN DRIFT	< 0.1%	
	MANIFOLD		
	a) PRESSURE MEASUREMENT	3 WAY	
	B) DIFFERENTIAL PRESSURE MEASUREMENT	5 WAY	
	CABLE ENTRY DETAIL	SUITABLE FOR DIA OF 17.5 mm	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS2-0**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	TYPE	
	POWER SUPPLY	
	TRANSMITTER MEASUREMENT	
	OUTPUT SIGNAL	
	NO. OF WIRE	
	ACCURACY	
	LINEARITY, HYSTERISIS, DEAD BAND AND REPEATABILITY	
	STABILITY	
	SENSITIVITY	
	MATERIAL	
	A) BODY	
	B) ELEMENT	
	C) SEAL	
	CONTINUOUSLY ADJUSTABLE SPAN AND ZERO ADJUSTMENT PROVIDED	
	MOUNTING	
	ENCLOSURE	
	TURN DOWN RATIO	
	INSULATION RESISTANCE	
	ZERO SUPPRESSION RANGE	
	ZERO ELEVATION RANGE	
	INTEGRAL INDICATOR	

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 2 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-01-DS2-0**

Data Sheet C

DATA SHEET-C FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER
(TO BE FILLED BY CONTRACTOR AFTER AWARD OF CONTRACT)

TRANSMITTER SHALL BE ABLE TO DRIVE OUTPUT IMPEDANCE OF 500 OHMS.	
ZERO DRIFT	
SPAN DRIFT	
MANIFOLD	
b) PRESSURE MEASUREMENT	
B) DIFFERENTIAL PRESSURE MEASUREMENT	
CABLE ENTRY DETAIL	

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

	DATA SHEET FOR TEMPERATURE GAUGE	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-27-DS1-0**

Data Sheet A & B

	DATA SHEET-A FOR TEMPERATURE GAUGE (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
GENERAL	MANUFACTURER		
	MODEL NUMBER		
TECHNICAL	TYPE - MERCURY FILLED	☐ RIGID STEM ☐ CAPILLARY	
	PRESSURE ELEMENT	BOURDON	
	MATERIAL		
	PRESSURE ELEMENT	☐ AISI 316 SS ☐ CR-MO STEEL	
	CASE	☐ DIE CAST AL	
	BULB & CAPILLARY	☐ AISI 316 SS	
	CAPILLARY ARMOUR	☐ SS 316 ☐ FLEXIBLE	
	MOVEMENT	☐ AISI 304 SS	
	THERMOWELL	☐ AISI 316 SS ☐ CR.MO. STEEL ☐ SCREWED TYPE ☐ WELDED TYPE	
	ENCLOSURE	☐ INDOOR MOUNTED IP-55 ☐ OUTDOOR MOUNTED IP-67 ☐ FUEL GAS HAZARDOUS APPL. EXPL. PROOF	
	DIAL	SIZE : ☐ 100MM ☐ 150MM ☐ 250MM COLOUR: ☐ WHITE CASE : ☐ BLACK NUMERALS: ☐ BLACK	
	MOUNTING & CONNECTION	☐ DIRECT MOUNTED ☐ PANEL OR RACK MOUNTED	
	COMPENSATION	CASE COMP.	
	ZERO ADJUSTER	PROVIDED	
	CAPILLARY LENGTH	5.0 METERS (FOR LOCAL MOUNTED) 15.0 METERS (FOR PANEL/RACK MOUNTING)	
PERFORMANCE	ACCURACY	± 1% OR BETTER OF FULL SCALE DEFLECTION	
CONNECTION	TEMPERATURE GAUGE CONNECTION	M20X1.5(M)	
	LOCATION	BACK	
	THERMOWELL	☐ YES ☐ FORGED BAR STACK TYPE	
	THERMOWELL CONNECTION	☐ M20X1.5 INTERNAL ☐ M33X2 EXTERNAL ☐ DESIGN CODE: ASME PTC	

	PREPARED BY	**CHECKED BY**	**APPROVED BY**	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PRESSURE / DIFFERENTIAL PRESSURE TRANSMITTER**	SPECIFICATION NO.:
		VOLUME
		SECTION
		REV. NO. / DATE:
		SHEET 1 OF 2

TAG No. ……. Qty..... Data Sheet No.: **PES-145-27-DS2-0**

Data Sheet C

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

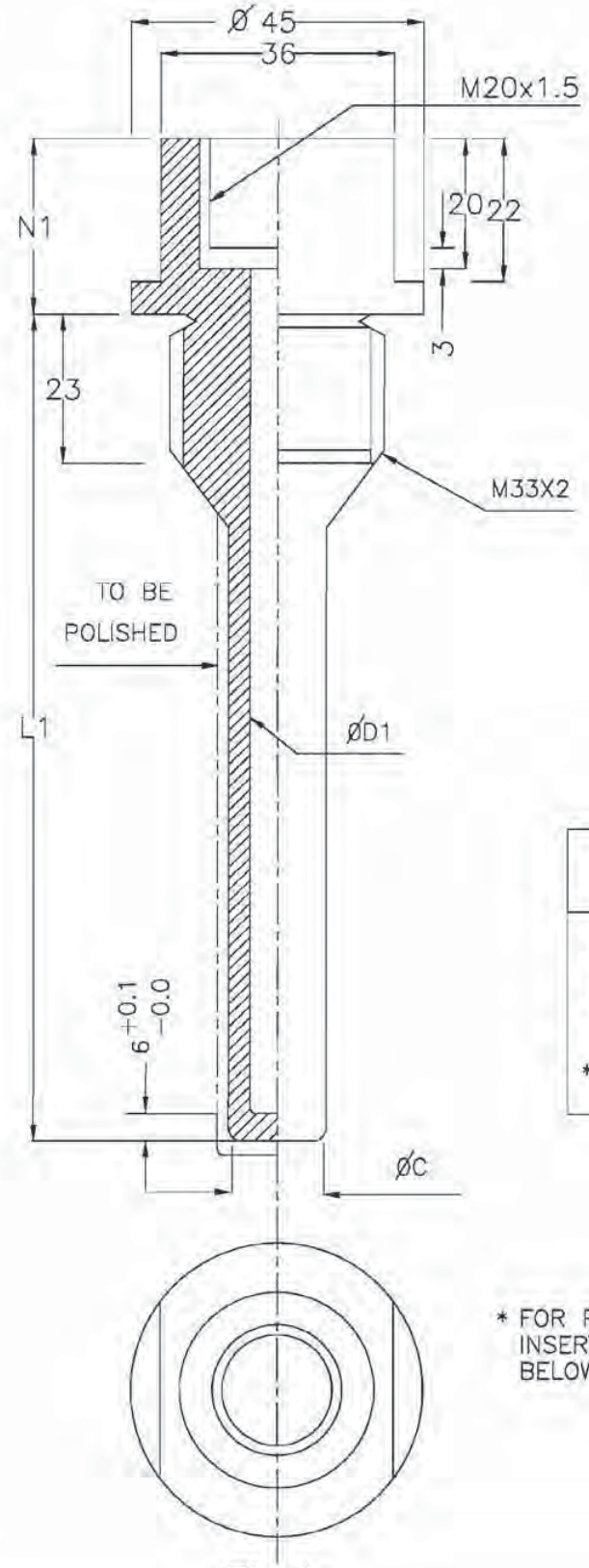
GENERAL	MANUFACTURER	
	MODEL NUMBER	
TECHNICAL	TYPE - MERCURY FILLED	
	PRESSURE ELEMENT	
	MATERIAL	
	PRESSURE ELEMENT	
	CASE	
	BULB & CAPILLARY	
	CAPILLARY ARMOUR	
	MOVEMENT	
	THERMOWELL	
	ENCLOSURE	
	DIAL	
	MOUNTING & CONNECTION	
	COMPENSATION	
	ZERO ADJUSTER	
	CAPILLARY LENGTH	
PERFORMANCE	ACCURACY	
CONNECTION	TEMPERATURE GAUGE CONNECTION	
	LOCATION	
	THERMOWELL	
	THERMOWELL CONNECTION	

	PREPARED BY	CHECKED BY	APPROVED BY	COMPANY SEAL
NAME				NAME
SIGNATURE				SIGNATURE
DATE				DATE

FORM NO. PEM – 6666–0

THERMOWELL MEDIUM PRESSURE (40 Kgf/Cm2)

SPECIFICATION NO PES–145–27A	
VOLUME IIB	
SECTION D	
REV. NO. 01	DATE 27–7–94
SHEET 3	OF 7



PIPE O.D.	INSERTION LENGTH (L1)
Ø 509 & ABOVE	325
Ø 506 TO 369	250
Ø 368 TO 274	175
*Ø 273 BELOW	150

* FOR PIPE O.Ds UP TO 159mm THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE O.Ds BELOW 159mm, THE INSERTION SHALL BE SLANT.

Fig.1

FORMAT NO. - 6666-0

	SPECIFICATION FOR TEMPERATURE GAUGE	SPECIFICATION NO. : PES - 145 - 27A
		VOLUME II B
		SECTION D
		REV. NO. 01 DATE 27.07.94
		SHEET 4 OF 7

THERMOWELL-MEDIUM PRESSURE
(40 KG/CM2)

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corres ponding element length(L)
6	6,5	12.5	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
8	8.5	15	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

FORMAT NO. - 6666-0

BHEL	**SPECIFICATION FOR TEMPERATURE GAUGE**	SPECIFICATION NO. : PES - 145 - 27A VOLUME II B SECTION D REV. NO. 01 DATE 27.07.94 SHEET 5 OF 7

ALL DIMENSIONS IN mm

Instrument stem dia D+0.0 -0.1	DIA D1 +0.2 0	DIA C	Insertion Length L1	Extention element length N1	Corres ponding element length(L)
12	12.5	19	150	27	171
				75.	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419
14	14.5	21	150	27	171
				75	219
				100	244
			175	27	196
				75	244
				100	269
			250	27	271
				75	319
				100	344
			325	27	346
				75	394
				100	419

NOTE: The corresponding element lenghts are given for information only. The elements lengths are worked out as per the formula :

$$L = L1 + N1 - 6$$

FORM NO. PEM - 6666-0

BHEL

THERMOWELL–HIGH PRESSURE (250 Kgf/Cm2)

SPECIFICATION NO. PES–145–27A	
VOLUME IIB	
SECTION D	
REV. NO. 01	DATE 27–7–94
SHEET 6	OF 7

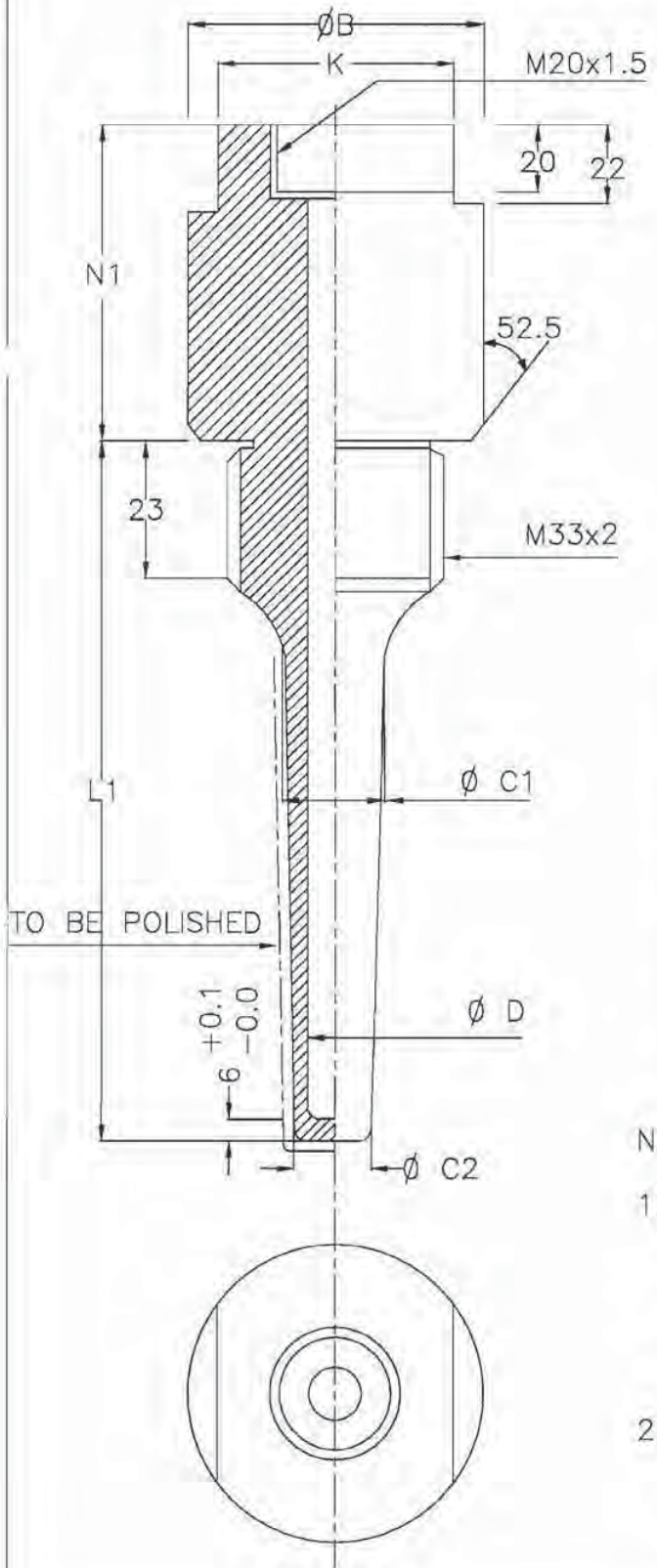


Fig. 2

PIPE O.D.	INSERTION LENGTH L1
Ø 509 & ABOVE	325
Ø 508 TO 368	250
Ø 367 TO 274	175
Ø 273 BELOW	150

NOTE :–

1. THE CORRESPONDING ELEMENT ELEMENT LENGTHS ARE GIVEN FOR INFORMATION ONLY. THE ELEMENT LENGTHS ARE WORKOUT AS PER THE FORMULA L=L1+N1–6.

2. FOR PIPE OD'S UPTO 159mm, THE THERMOWELL INSERTION WILL BE STRAIGHT. FOR PIPE OD'S BELOW 159mm, THE INSERTION SHALL BE SLANT.

FORMAT NO. - 6666-0

BHEL	**SPECIFICATION FOR TEMPERATURE GAUGE**	SPECIFICATION NO. : PES - 145 - 27A VOLUME II B SECTION D REV. NO. 01 DATE 27.07.94 SHEET 7 OF 7

ALL DIMENSIONS IN mm

Instrument stem dia D (+0.0 -0.1)	DIA D1 (+0.2 0.0)	DIA C1	DIA C2	K	DIA B	Insertion Length L1	Extention Length N1	Corresponding Element Length (L)
6	6.5	19	12.5	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
8	8.5	21.5	15	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
12	12.5	25.5	19	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
14	14.5	27.5	21	36	45	150	27 75 100	171 219 244
						250	27 75 100	271 319 344
16	16.5	29	23	46	55	150	27 75 100	171 219 244
						250	27 75 100	271 319 344

GENERAL TECHNICAL REQUIREMENTS FOR PLC

FORM NO. PEM-6666-0

	DATA SHEET FOR PLC SYSTEM **1 X 700 MW BELLARY**	SPECIFICATION NO.: VOLUME II B SECTION D REV. NO. 02 DATE: 19.07.2008 SHEET 1 OF 1

Data Sheet No.: **PES-145-36-DS1-0**

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	**1 X 700 MW BELLARY**	
	SERVICE	**OZONE GENERATION PLANT**	
	QUANTITY	■ UNITISED ☐ COMMON	
	LOCATION	■ INDOOR ☐ OUTDOOR	
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 ☐ 48 V	
	LOCATION OF COUPLING RELAYS	■ MCC ☐ PLC PANEL	
	DESKTOP OWS QUANTITY	☐ ONE ☐ TWO ☐ **1 No. LCD**	
	DESKTOP MONITOR TYPE	☐ 19" ☐ 21" TFT/CRT MONITOR	
	PRINTER (A4) - QUANTITY	INKJET _____ LASER B/W _____ 1 No COLOR INKJET _____ COLOR LASER _____	
	PRINTER (A4) - MODEL	INKJET _____ LASER B/W _____ COLOR INKJET _____ COLOR LASER _____	
	PROGRAMMING / CONFIGURATION FACILITY	A) ☐ HAND HELD B) ENGINEERING SOFTWARE ☐ ONE OWS ☐ ALL OWS ☐ _____	
	SAFETY STANDARD	_____	
	COMPUTER FURNITURE	☐ YES ☐ NO	
PANEL	QUANTITY	BIDDER TO INDICATE	
	CLASS OF PROTECTION	■ **IP 65**	
	REMOTE I/O PANEL	☐ YES ■ NO	
	COLOUR	AS PER IS-5 SHADE _____	
	BACK-UP	■ YES ☐ NO	
	MIMIC	■ YES ☐ NO	
	CONTROL HARDWARE	■ PB ■ INDICATORS ☐ FACIAS _____ Nos. ☐ OTHERS	
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	☐ YES ■ NO	
	PURPOSE	☐ CONTROL ■ MONITORING	
	MEDIUM	☐ UTP ■ FIBRE OPTIC ☐ OTHERS	
	TIME SYNCRONIZATION SIGNAL FORMAT	☐ PULSE ☐ RS-485 ■ IRIG-B	
	SOFTLINK	☐ MODBUS ☐ OPC	
	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	

FORM NO. PEM-6666-0

BHEL	**DATA SHEET FOR PLC SYSTEM**	SPECIFICATION NO.:
		VOLUME II B
		SECTION D
		REV. NO. 02 / DATE: 19.07.2008
		SHEET 1 OF 1

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

Data Sheet C

DATA SHEET – C
(TO BE FILLED BY BIDDER AFTER AWARD OF CONTRACT)

GENERAL*	PROJECT	
	SERVICE	
	QUANTITY	
	LOCATION	
PLC EQUIPMENT	MAKE / MODEL NO.	
	PROCESSOR	
	DATA BUS (HMI)	
	DATA BUS (I/O - CPU)	
	DATA BUS (REMOTE I/O - CPU)	
	FIELD CONTACTS INTERROGATION VOLTAGE	
	LOCATION OF COUPLING RELAYS	
	DESKTOP OWS QUANTITY	
	DESKTOP MONITOR TYPE	
	PRINTER (A4) - QUANTITY	
	PRINTER (A4) - MODEL	
	PROGRAMMING / CONFIGURATION FACILITY	
	SAFETY STANDARD	
	COMPUTER FURNITURE	
PANEL	QUANTITY	
	CLASS OF PROTECTION	
	REMOTE I/O PANEL	
	COLOUR	
	BACK-UP DESK	
	MIMIC	
	CONTROL HARDWARE	
COMMUNICATION TO OTHER SYSTEM	HARDWIRED	
	PURPOSE	
	MEDIUM	
	TIME SYNCRONIZATION SIGNAL FORMAT	
	SOFTLINK	
	SERIAL LINK	
POWER SUPPLY INPUT FEEDER	PLC PANEL	
	REMOTE I/O PANEL	

Form No. PEM-6666-0

	TITLE:	SPECIFICATION NO. PES-145-36	
BHEL	**SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLER SYSTEM**	VOLUME **II-B**	
		SECTION **D**	
		REV. NO. 02	DATE: July 19, 2008
		SHEET 1	OF 9

1. SCOPE

This specification covers the Design, Manufacture, Assembly, Inspection and Testing at manufacturer's works, proper packing and delivery to site, erection and commissioning of the PLC Control & Monitoring System comprising PLC Control panel/Remote I/O panel (housing Processors, I/O cards, power supply packs etc.), Operator workstations(OWS), Printers, Annunciation system, UPS, cables and all other equipments and accessories required for completeness of the system as mentioned in different sections of this specification.

2. GENERAL

2.1. The PLC shall perform protection logic, interlock and sequential control functions such as binary logic operation, set/reset operation, timers, counters, logic blocks, math functions, input quality checking engineering unit conversion, Boolean functions & PID control (Analog logic function).

2.2. The system shall be redundant in processor, power supply and communication interfaces unless otherwise specified. The system shall have self-diagnostic features. The control of all drives and equipment shall be effected through the keyboard/mouse / panel mounted push button / control switches as per Data sheets-A&B.

2.3. The system shall have facility for connecting to Main Plant's Distributed control system (DCS) using hardware / software interface for two-way transfer of signals.

2.4. The mimic shall be displayed on the OWS screen and may also be provided on the control desk/panel (as per Data sheets).

2.5. In case OWS is provided, HMI functions like Trends, Curves, Bar charts, Historical storage of Data, Logs and reports etc. shall be provided in addition to Plant-schematics. The necessary catalogue / literature elaborating the features of HMI shall be supplied along with the bid.

2.6. It shall be possible to use the same OWS as programming station.

2.7. The PLC system shall be sized to meet process/system requirements as per the approved P&IDs and Control write-up.

2.8. The PLC system shall be designed to ensure that no single device failure should result in failure of any other device.

2.9. Signal multiplication where required shall be done in PLC. Use of relays for multiplication of contacts (for control, monitoring and alarm) is not acceptable. The control/ monitoring components on the control panel/ desk shall be driven through I/O modules.

3. TECHNICAL REQUIREMENTS

Details of various PLC system components shall be inclusive of but not limited to the following:

3.1. CODES AND STANDARDS

3.1.1. The equipment covered under this specification shall meet the requirements of latest edition of all applicable codes and standards like ANSI, NEMA, IEEE, IEC, NEC & IS.

3.1.2. PLC shall conform to IEC: 1131

3.1.3. The offered PLC shall comply with safety standards as per Data sheet-A&B.

3.2. CONTROL PANEL

3.2.1. PLC control panel shall be freestanding type with provision for mimic display, push-button stations, control switches, indicating lamps, metering instruments like Indicators, ammeters etc. and facia windows for critical alarms.

3.2.2. The salient features of construction shall be:

Sheet material: Cold rolled sheet steel
Frame thickness: Not less than 3.0mm
Enclosure thickness: Not less than 2.0 mm for load bearing sections (mounted with instruments) and Not less than 1.6 mm for others
Gland plate thickness: 3.0mm
Base channel: ISMC 100 with anti-vibration mounting & foundation bolts.

3.2.3. Each panel shall be identified by a name plate, which shall be of non-rusting metal or three ply lamicold, with engraved lettering.

3.2.4. 25 x 6 mm Copper ground bus to be provided for each panel.

3.2.5. 240V AC single phase, thermostatically controlled space heaters shall be provided. Each free standing panel shall have a door switch operated fluorescent lamp and a 240V AC plug point.

3.2.6. Painting treatment shall be as per IS: 6005. Two coats of lead oxide primer shall be followed by powder coating. Paint shade shall be as specified in the “Data sheet for PLC system”-Data Sheet-A&B.

3.2.7. The annunciation system shall be facia window type, driven by the PLC. Audible alarm, Acknowledge, Reset and lamp test facility shall be provided as per ISA sequence – S18.1, M.

3.3. PROCESSORS

3.3.1. The microprocessors shall be 32 bit, and Hot redundant.

3.3.2. Hot redundancy: PLC shall be provided with two processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete operation automatically. This transfer from main processor to standby processor shall be bump less and shall not cause any disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processor as master and other as standby.

3.3.3. An authorized forcing facility shall be provided for changing the status of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements.

3.3.4. The standby processor shall be updated automatically in line with the changes made in the working processor.

3.3.5. In the event of any replacement of the processor, synchronization of the replaced processor shall be automatic upon live insertion.

3.3.6. The cycle time for input scanning, execution of logics, overheads and output scan shall not exceed 120 m sec.

3.3.7. The processor & memory shall be loaded up to 50% at normal conditions and maximum up to 60% under worst loading conditions.

3.3.8. The memories shall be field expandable.

3.4. INPUT / OUTPUT Modules

3.4.1. Input/output card assignments shall be modular i.e. no single card shall be assigned with more than one drive of a particular sub-system. The maximum number of channels per I/O module shall be as follows.

- Analog Input Module: 16
- Analog Output Module: 16
- Binary Input Module: 32
- Binary Output Module: 32
- Analog Input/output combined: 16
- Binary Input/output combined: 32

3.4.2. On line I/O replacement: All I/O cards shall have quick disconnect terminations allowing for card replacement without disconnection of external wiring and without switching off the power supply.

3.4.3. 10% spare capacity shall be ensured in each card channel assignment. Overall minimum 20% spare channels shall be provided.

3.4.4. Output command to MCC/Switchgear shall be through coupling relays, whose mounting location shall be as per "Data sheet A & B for PLC System". In case coupling relays are located in PLC Panel, the same shall be in PLC vendor's scope of supply.

3.4.5. Status feedback from MCC shall be in the form of potential free contact.

3.5. DATA BUS/ I/O BUS

3.5.1. The Data bus connecting PLC and HMI work stations shall be TCP/IP on Ethernet.

3.5.2. The Data bus and I/O bus communication medium shall be twisted pair shield copper conductor for indoor locations and those areas not subjected to induced signals. Repeaters/signal amplifiers shall not be used. Copper conductor cable used shall be Category-5 or better. The communication medium shall be Fibre optic cable in the event any portion of communication cable run is in outdoor or where distances are beyond 500 meters.

3.6. OPERATOR WORK STATION (OWS)

3.6.1. The OWS and Keyboard shall be desktop mounted and shall be used for controlling, monitoring and programming function.

3.6.2. Colour CRT(s) with keyboard and mouse shall be as per Data Sheet-A&B. CRT shall have graphic display facility.

3.6.3. The OWS shall be with Windows based operating system having necessary Engineering/Configuring software.

3.7. PRINTER

Printers shall be provided as per Data Sheet-A&B.

3.8. COMMUNICATION WITH PLANT DCS

3.8.1. The PLC system shall be provided with hardwired/serial interface for communication with plant DCS.

3.8.2. Serial communication to / from DCS where provided shall be engineered to ensure that signal communication time from / to DCS shall not exceed 1 seconds for control / feedback.

3.8.3. Serial communication to DCS shall be OPC (Data access 2.0), Ethernet based TCP/IP Protocol. Alternatively the serial communication shall be MODBUS protocol on RS 485 network.

3.8.4. Data transmitted from PLC to DCS shall include all information necessary for the DCS graphic displays to monitor and control the process equipment and PLC. Such data may include pertinent analog and digital status information, interlock, alarms and maintenance conditions. Data transmitted from DCS to the PLC shall include necessary signals to provide operator control interface from DCS for the process/ equipment being controlled by PLC.

3.8.5. Bidder to include 'Light interface units, converters, Ethernet switch, accessories at PLC end for connectivity to other system. The bidder's terminal point shall be Ethernet port in case of copper medium connection to DCS or LIU in case of Fiber optic medium for connectivity with plant DCS. In case distance between PLC & DCS is greater than 1.8 Km, single mode of optical fiber cable with compatible accessories shall be used. For distance less than 1.8 Km multimode optical fiber ports shall be used.

3.9. POWER SUPPLY Scheme

3.9.1. PLC Panel and I/O Cabinets: PLC system shall be provided with 2x100% UPS fed from Two Nos. redundant 415V, 3-ph feeders, as per the scheme PE-SD-999-145-001, sh-08 of 08. Each UPS shall have 30 minutes back up. Input feeder failure shall be monitored in the PLC system. Necessary redundant power pack and transformers shall be provided (in the PLC panel) to derive the power supply for control desk, PLC panel and input / output cabinets etc

3.9.2. Remote I/O panels: Similar power supply arrangement as for PLC panels shall be provided if it is not possible to extend the power cable form UPS of PLC panels.

3.9.3. Each OWS and associated HMI peripherals shall be provided with a feeder from either one of the UPS

4. DRAWING/DOCUMENT AND DATA TO BE FURNISHED AFTER AWARD OF THE CONTRACT:

4.1. For Approval:

- PLC system configuration drawing along with functional write-up.
- Input/Output signal list.
- BOM of PLC
- List of PLC controlled devices
- Control panel/control desk GA drawings.
- Control desk/panel component layout drawing.
- Control panel/control desk Foundation detail and cutout drawings
- Power distribution scheme.

- Block logic diagrams.
- Annunciation list.
- PLC control room layout drawing.
- List of soft signal exchange with Plant DCS.
- List of mandatory spares
- Quality plan
- Data Sheet-C
- CRT display
- Power supply scheme for PLC system, HMI & peripherals, Remote I/O etc.

4.2. For Information:

- Cable schedule and cable interconnection drawing(in BHEL approved format)
  - Between Field and PLC
  - Between Field and MCC
  - Between MCC and PLC
- Electronic earthing requirements.
- Panel Heat dissipation data
- Product/component catalogues.
- Operation & Maintenance Manual on CDs.
- Softcopy of Final/As-built drawings on CDs.
- Calculation for Processor, Memory & Data bus loading

The above list is the minimum requirements. Additional documents/calculations required shall be finalized during contract stage.

5. DRAWINGS AND DOCUMENTS TO BE SUBMITTED ALONG WITH THE BID

- Proposed PLC system configuration drawing with write-up
- Product catalogues and specifications for PLC as well as HMI application.
- Proposed power supply schemes for PLC system, peripherals, and Remote I/O panels.

6. TESTING AND INSPECTION

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

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

6.3. The complete PLC system, including all instrument and devices shall be subjected to standard factory tests (i.e. Type Tests and Routine Tests) as per relevant IS, NEMA, IEEE, IEC.

6.4. Factory Acceptance Test-FAT (Functional Tests) shall be performed prior to shipment and Owner/Purchaser shall be notified 15 days before the schedules dates of the test.

6.5. The certificates for following type tests, as per IEC Standard, shall be submitted: -

- Surge protection test as per IEC-225-4
- Dry heat test as per IEC-68-2-2
- Damp Heat test as per IEC-68-2-3

- Vibration Heat test as per IEC-68-2-6
- Electrostatic discharge test as per IEC-801-2 or equivalent
- Radio frequency Immunity test as per IEC-801-6 or equivalent
- Electromagnetic Immunity test as per IEC-801-3 or equivalent

7. SPARES AND CONSUMABLES

7.1. Commissioning Spares and consumables

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

7.2. Mandatory Spares

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

7.3. Recommended Spares

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

7.4. Special Tools & Tackles

The bidder shall supply all Special Tools & Tackles 'as required' during Start-up and further maintenance of the system, as part of the main equipment supply.

7.5. Spares, Service support

Bidder shall provide availability of spares and service support for minimum 10 years after guarantee period.

8. MARKING AND PACKING

8.1. Marking:

A stainless steel name-plate shall be permanently fixed on each equipment giving its Tag/serial Number and salient technical specification.

8.2. Packing:

All equipment/materials shall be suitably packed and protected for the entire period of dispatch, storage and erection against impact, abrasion, corrosion, incidental damage due to vermin, sunlight, high temperature, rain, moisture, humidity, dust, sea-water spray (where applicable) as well as rough handling and delays in transit and storage in open.

9. PERFORMANCE AND GUARANTEE

The PLC system shall be guaranteed to meet the performance requirement as specified and also for trouble-free continuous operation for 12 months from the date of commissioning or 18 months from the date of delivery at site whichever is later unless specified otherwise in Vol-IIB Section - B or Section - C.

10. APPLICABLE DATA SHEET FORMS

This document shall be read with the following data sheet forms :

- Data Sheet A & B for PLC system - PE-DC-999-145-I036-1
- Data Sheet C for PLC system - PE-DC-999-145-I036-2

11. Bidder shall provide at least 20% wired spare capacity of I/O modules over and above system requirement.

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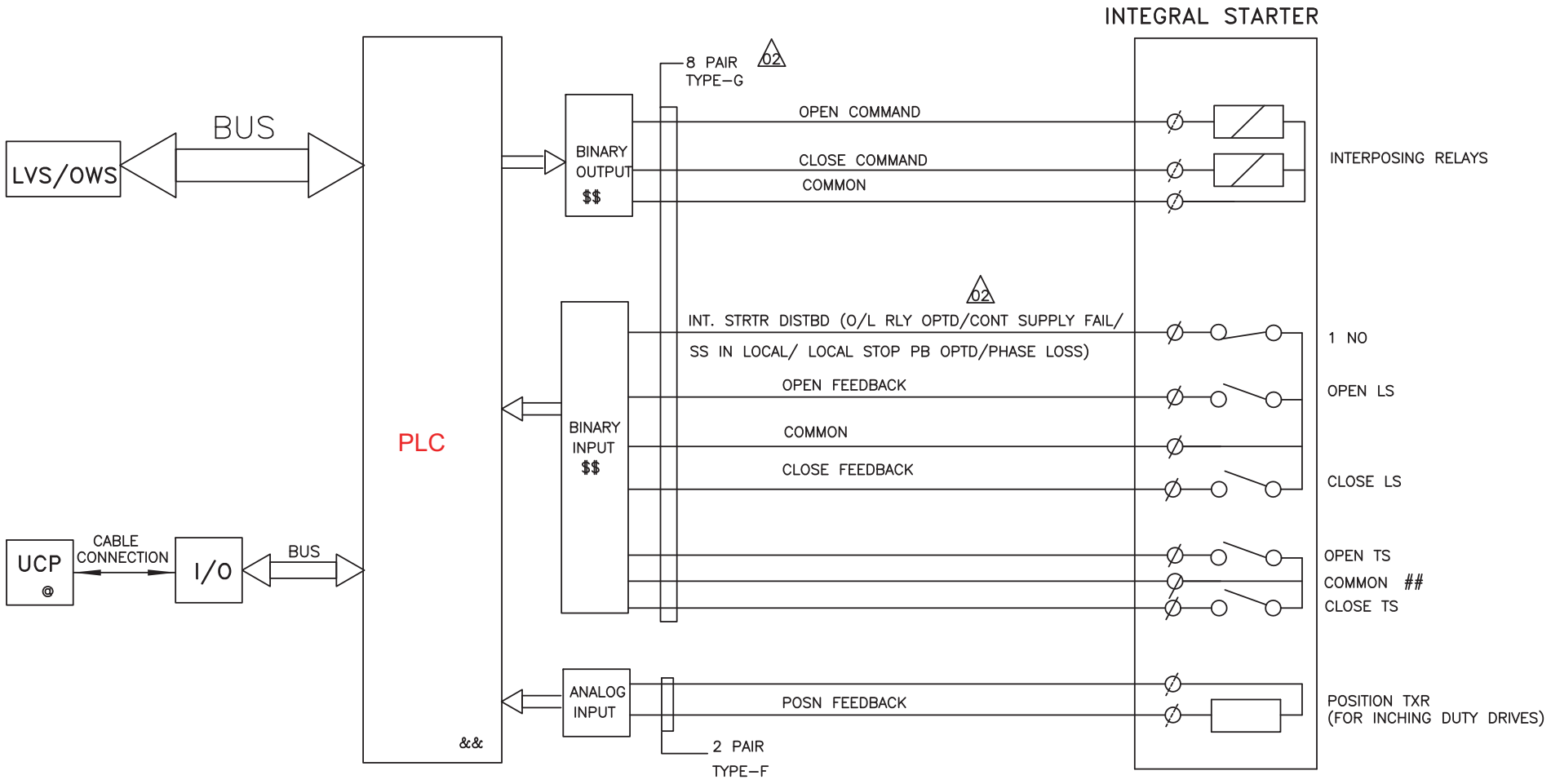
12. Bidder shall include 10% or 1 No. (whichever is higher) each type of module, which shall include controller card, communication card, I/O card, Power supply card/ unit, relays, push button, lamps etc.

PLC INTERFACE FOR BIDIRECTIONAL DRIVE

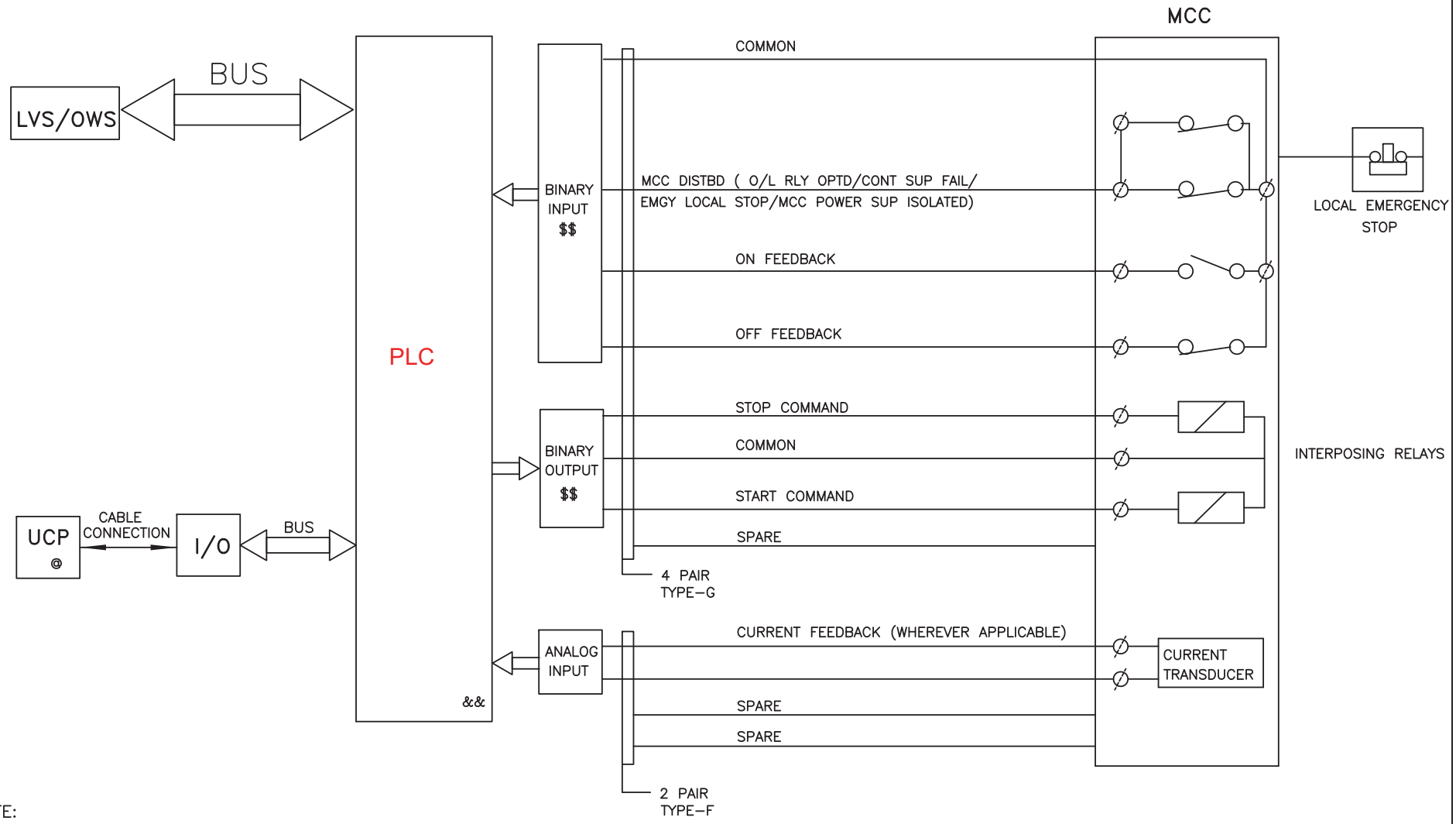


NOTE:

1. TYPE–G : OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
2. 'TYPE–F INDIVIDUAL & OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
3. '$$' REDUNDANT INPUTS/ OUTPUTS FOR CRITICAL SERVICES..
4. '&&' REDUNDANT PROCESSOR .
5. @ REFER CL. NO. 1.0(C).
6. ## FOR IMPORTANT DRIVES, AS INDICATED IN DRIVE LIST.

BHEL	KARNATAKA POWER CORPORATION LIMITED BELLARY THERMAL POWER STATION STAGE – III (1 x 700MW)	DRG NO.	PE-DM-367-145-I002
		DATE	25.11.2011
	PLC INTERFACE FOR BIDIRECTIONAL DRIVE	REV. NO.	02
		SH. 8	OF 13 SHS

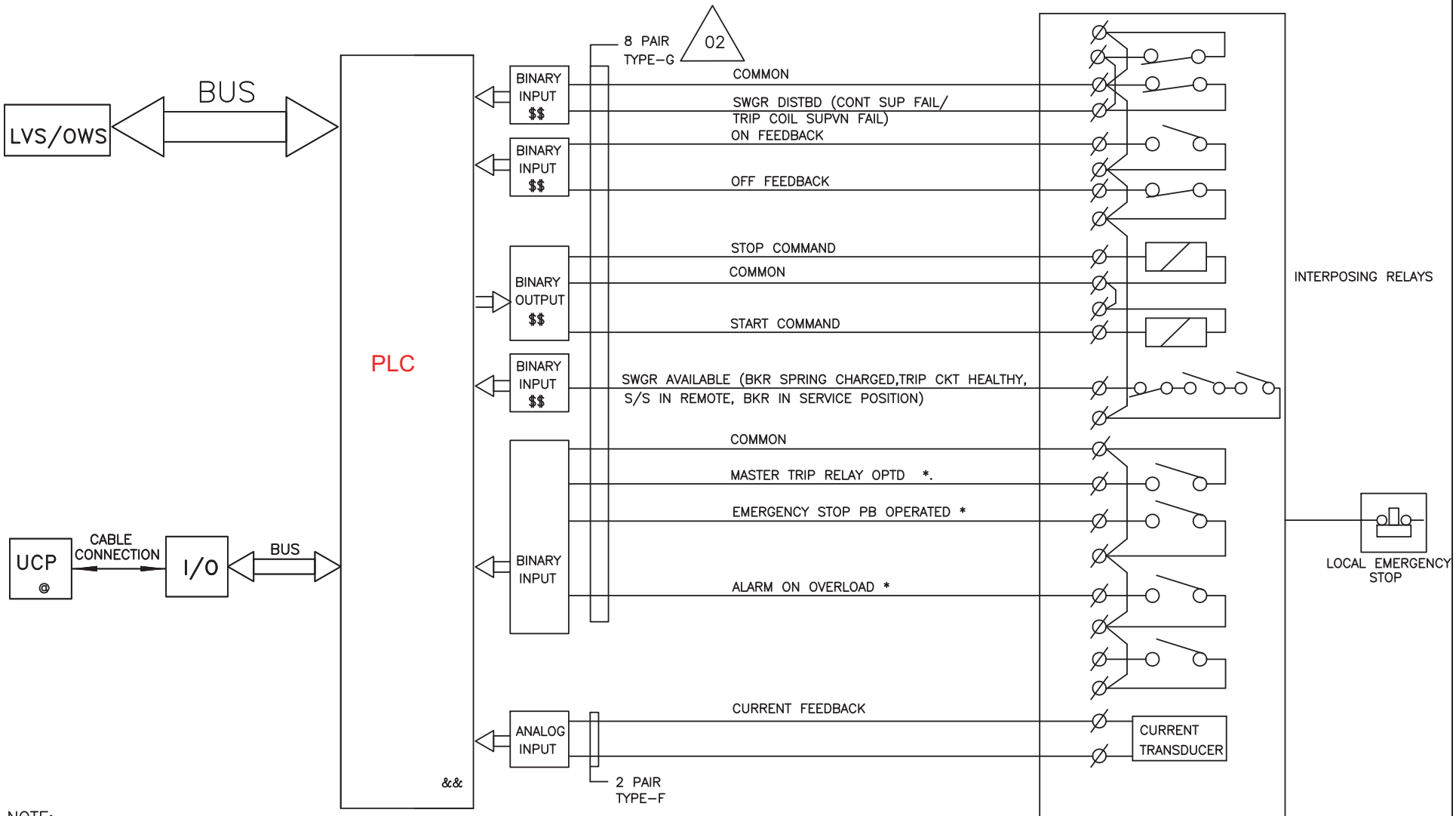
PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE



NOTE:

1. TYPE-G : OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
2. 'TYPE-F INDIVIDUAL & OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
3. '$$' REDUNDANT INPUTS/ OUTPUTS FOR CRITICAL SERVICES .
4. '&&' REDUNDANT PROCESSOR .
5. @ REFER CL. NO. 2.0(b).

BHEL	KARNATAKA POWER CORPORATION LIMITED BELLARY THERMAL POWER STATION STAGE - III (1 x 700MW)	DRG NO.	PE-DM-367-145-I002
		DATE	25.11.2011
	PLC INTERFACE FOR UNIDIRECTIONAL LT DRIVE	REV. NO.	02
		SH. 9	OF 13 SHS

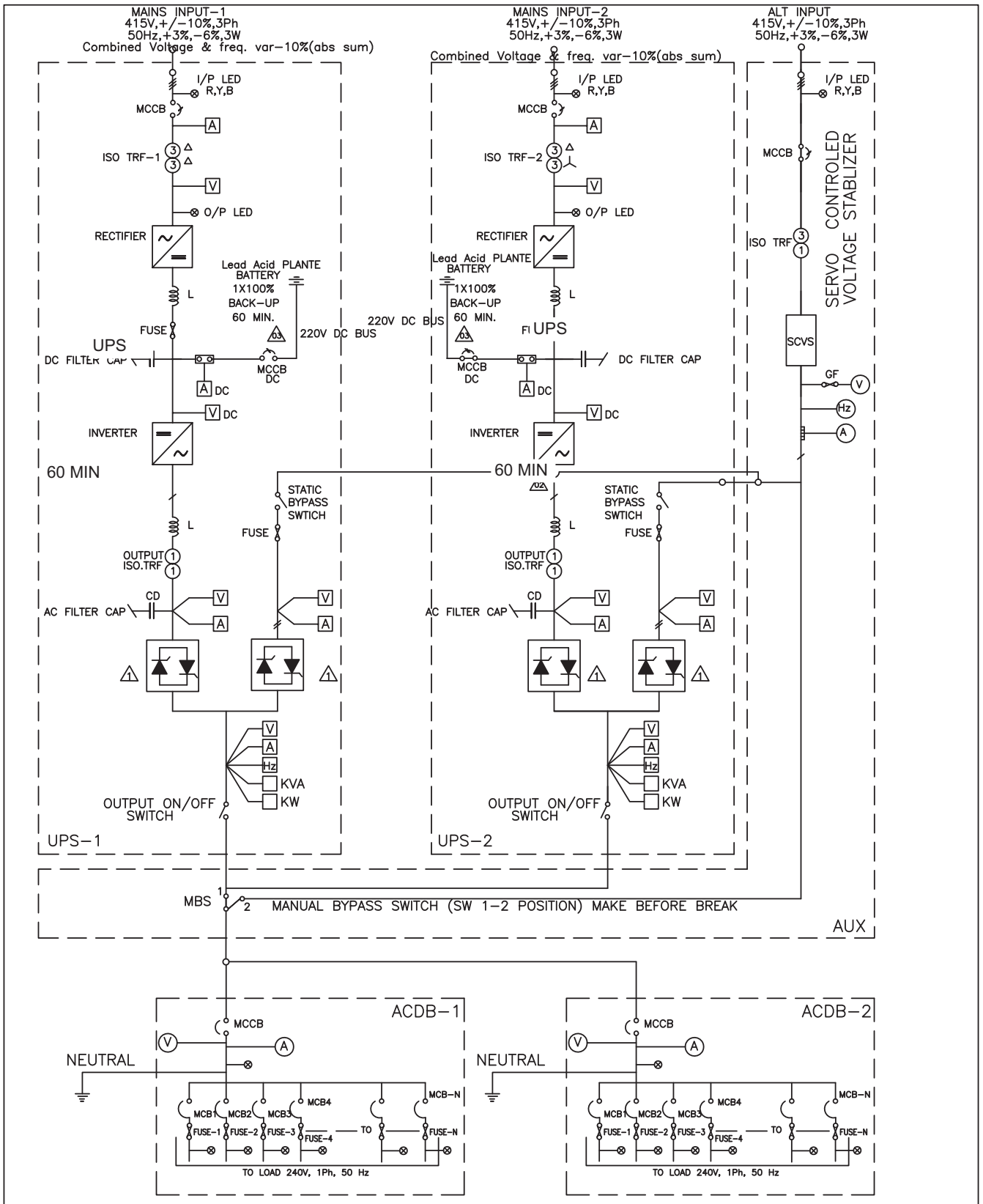


NOTE:

1. TYPE-G : OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
2. 'TYPE-F INDIVIDUAL & OVERALL SCREENED TWISTED PAIR CABLE (0.5 sq mm)
3. '$$' REDUNDANT INPUT/OUTPUT FOR CRITICAL SERVICES.
4. ** REFER CLAUSE 5.0
5. '&&' REDUNDANT PROCESSOR
6. '*' FOR ANNUNCIATION
7. @ REFER CL.NO 4.0(C).

BHEL	KARNATAKA POWER CORPORATION LIMITED BELLARY THERMAL POWER STATION STAGE - III (1 x 700MW)	DRG NO.	PE-DM-367-145-I002
	PLC S INTERFACE FOR UNIDIRECTIONAL HT DRIVE	DATE	25.11.2011
		REV. NO.	02
		SH. 12	OF 13 SHS

SINGLE LINE DIAGRAM OF UPS



NOTES:

1. ACDB-1&2 NEUTRAL TO BE GROUNDED TO A DEDICATED GROUND.
2. ALL OUTPUT FEEDERS OF ACDB SHALL BE PROVIDED WITH AN LED AFTER THE FUSE FOR FEEDER ON INDICATION WITH FEEDER DESCRIPTION.
3. REDUNDANT FEEDERS SHALL BE LOCATED IN DIFFERENT ACDBs.
4. FOR FURTHER DETAILS REFER TECHNICAL SPECIFICATION SECTION D2.25 VOL IV SHT 233-246

THIS IS A PART OF TECHNICAL SPECIFICATION FOR COOLING WATER OZONE GENERATION PLANT
(TECHNICAL SPECIFICATION NUMBER: PE-TS-367-174-14000-A001 REV 00)

DRG PE-DG-367-145-I004
REV 03
SHEET 2 OF 2

L1

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

A Device Specific :

SN	Parameters	Options available	Remarks if any
1	Model 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		
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	

THIS IS A PART OF TECHNICAL SPECIFICATION FOR COOLING WATER OZONE GENERATION PLANT
(TECHNICAL SPECIFICATION NUMBER: PE-TS-367-174-14000-A001 REV 00)

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 exchange of signals with DDCMIS

Serial No	Tag name	Tag Description	Modbus address	Point Type	ENGG. UNIT	Range	Function Code

Note:

1	Tag Name and Descriptions are of that of Slave devices
2	Modbus Address is register address in Slave Device
3	Engg unit is unit of measurement Ex Pressure - bar, Temp Deg C etc
4	Point type is Analog or packed binary
5	Range applicable for analog value and is instrument range
6	Function code is Modbus function code used to update data from slave to master Ex Function Code for Read Input Register etc
7	Kindly Indicate Start and end register address for each function type and each block of data