LIST

OF

C&I DOCUMENTS/

DELIVERABLES

LIST OF VENDOR DELIVERABLES FOR C&I FOR CPU SYSTEM

Sl.No.	DRAWING NO.	DRAWING/DOCUMENT TITLE	CATEGORY
1	PE-V0-423-158-I901	CONTROL & OPERATIONAL WRITE-UP FOR THE SYSTEM	A
2	PE-V0-423-158-I902	CONTROL SCHEME/LOGIC DIAGRAM(TO BE IMPLEMENTED IN DCS)	A
3	PE-V0-423-158-I903	HMI PICTURES/PLANT SCHEMATICS	I
4	PE-V0-423-158-I904	INSTRUMENT SCHEDULE with set points	A
5	PE-V0-423-158-I905	GROUPING AND TERMINATION	A
6	PE-V0-423-158-I906	I/O LIST (ANALOG & BINARY)	A
7	PE-V0-423-158-I907	DRIVE LIST/SOLENOID/ACTUATOR VALVE LIST WITH LOCATION DATA	A
8	PE-V0-423-158-I908	DATASHEETS FOR INSTRUMENTS, JBs,Analysers etc.along with catalogue	A
9	PE-V0-423-158-I909	INSTRUMENT HOOK-UP DRAWING	A
10	PE-V0-423-158-I910	QUALITY PLANS/CHECK LISTS (For all applicable instruments)	A
11	PE-V0-423-158-I911	CABLE SCHEDULE & INTERCONNECTION	I
12	PE-V0-423-158-I912	ANNUNCIATION & SOE LIST	A

NOTES:
1. ANY OTHER DOCUMENT DECIDED DURING DETAILED ENGINEERING SHALL BE PROVIDED BY BIDDER WITHOUT ANY COMMERCIAL/TECHNICAL IMPLICATION.

2. CONTRACTOR TO SUBMIT REUSABLE DATABASE FORMATS IN BHEL/CUSTOMER APPROVED FORMATS LIKE MS EXCEL,MS ACCESS OF DOCUMENTS LIKE INSTRUMENT SCHEDULE, I/O LIST, DRIVE LIST,FIELD JB TERMINATIONS, CABLE SCHEDULE & INTERCONNECTION, etc.
SOFT COPY OF FORMATS SHALL BE PROVIDED TO SUCCESSFUL BIDDERS.

ACTUATORS

FORM NO. PEM-6666-0

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-SS-423-145-I007 VOLUME II B SECTION D REV. NO. 01 DATE: 03.03.17 SHEET 2 OF 4

Data Sheet A & B

	DATA SHEET-A (TO BE FILLED BY PURCHASER)		DATA SHEET-B (TO BE FILLED-UP BY BIDDER)	
GENERAL*	* PROJECT	1x 800 MW NORTH CHENNAI PROJECT		
	OFFER REFERENCE			
	* TAG NO. SERVICE			
	* DUTY	■ ON / OFF ■ INCHING		
	* LINE SIZE (inlet/outlet): MATERIAL			
	* VALVE TYPE	☐ GLOBE ☐ GATE ☐ REG. GLOBE ☐ BUTTERFLY		
	* OPENING / CLOSING TIME			
	* WORKING PRESSURE			
	AMBIENT CONDITION	SHALL BE SUITABLE FOR CONTINUOUS OPERATION UNDER AN AMBIENT TEMP. OF 0-55 DEG C AND RELATIVE HUMIDITY OF 0-95%		
	VALVE SEAT TEST PRESS	BIDDER TO SPECIFY		
	REQUIRED VALVE TORQUE	BIDDER TO SPECIFY		
	ACTUATOR RATED TORQUE	BIDDER TO SPECIFY		
CONSTRUCTION AND SIZING	CONSTRUCTION	TOTALLY ENCLOSED, WEATHER PROOF, IP:68		
	MECHANICAL POSITION INDICATOR	TO BE PROVIDED FOR 0-100% TRAVEL		
	BEARINGS	DOUBLE SHIELDED, GREASE LUBRICATED ANTI-FRICTION.		
	GEAR TRAIN FOR LIMIT SWITCH/TORQUE SWITCH OPERATION	METAL (NOT FIBRE GEARS). SELF-LOCKING TO PREVENT DRIFT UNDER TORQUE SWITCH SPRING PRESSURE WHEN MOTOR IS DE-ENERGIZED.		
	SIZING	OPEN/CLOSE AT RATED SPEED AGAINST DESIGNED DIFFERENTIAL PRESSURE AT 85% OF RATED VOLTAGE. FOR ISOLATING SERVICE THREE SUCCESSIVE OPEN-CLOSE OPERATIONS OR 15 MINS. WHICHEVER IS HIGHER. **FOR INCHING SERVICE - 150 STARTS/HR MINIMUM & FOR REGULATING SERVICE - 600 STARTS/HR MINIMUM.**		
HANDWHEEL	* REQUIRED	■ YES ☐ NO		
	* ORIENTATION	☐ TOP MOUNTED ☐ SIDE MOUNTED		
	*TO DISENGAGE AUTOMATICALLY DURING MOTOR OPERATION.			
ELECTRIC ACTUATOR	ACTUATOR MAKE/MODEL	BIDDER TO SPECIFY		
	MOTOR MAKE / MODEL / TYPE / RATING (KW)	BIDDER TO SPECIFY		
	@ MOTOR TYPE	SQUIRREL CAGE INDUCTION MOTOR, STARTING CURRENT LIMITED TO SIX TIMES THE RATED CURRENT-INCLUSIVE OF **I.S.** TOLERANCE		
	ACTUATOR APPLICABLE WIRING DIAGRAM	☐ ENCLOSED (BIDDER TO CONFIRM) A: ☐DRG. NO. 3-V-MISC-24227 R00 B: ☐ DRG. NO. 3-V-MISC-24550 R00 C: ☐ DRG. NO. 3-V-MISC-24283 R00 D: ☐ DRG. NO. 4-V-MISC-90271 R11 E: ☐ For Thyristor based Integral starter, Bidder/Vendor to furnish wiring diagram		
	COLOUR SHADE	☐ BLUE (RAL 5012) ☐		
	PAINT TYPE **(## Refer Notes)**	☐ ENAMEL ☐ EPOXY ☐		
	SHAFT RPM	BIDDER TO SPECIFY		
	OLR SET VALUE	BIDDER TO SPECIFY		
	@ STARTING / FULL LOAD CURRENT	BIDDER TO SPECIFY		
	NO. OF REV FOR FULL TRAVEL	BIDDER TO SPECIFY		
	@ PWR SUPP TO MTR / STARTER	415V, 3PH, AC		
	@ CONTROL VOLTAGE REQUIREMENT	TO BE DERIVED FROM THE POWER SUPPLY TO THE STARTER ☐ 230 V ☐ 110 V		

FORM NO. PEM-6666-0

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-SS-423-145-I007 VOLUME II B SECTION D REV. NO. 01 DATE: 03.03.17 SHEET 3 OF 4

Data Sheet A & B

		DATA SHEET-A (TO BE FILLED BY PURCHASER)	DATA SHEET-B (TO BE FILLED-UP BY BIDDER)
	@ ENCLOSURE CLASS OF MOTOR	☐ IP 68 ☐ FLAME PROOF	
	@ INSULATION CLASS	CLASS-F TEMP. RISE LIMITED TO CLASS-B	
	@ WINDING TEMP PROTECTION	■ THERMOSTAT (3 Nos.,1 IN EACH PHASE) ☐ ----------	
	SINGLE PHASE / WRONG PHASE SEQUENCE PROTECTION	REQUIRED	
INTEGRAL STARTER	INTEGRAL STARTER	■ REQUIRED ☐ NOT REQUIRED	
	TYPE OF SWITCHING DEVICE	■ CONTACTORS ☐ THYRISTORS	
	TYPE	■ CONVENTIONAL ☐ SMART (NON-INTRUSIVE)	
	IF SMART		
	a) SERIAL LINK INTERFACE	☐ INTEGRAL ☐ FIELD MOUNTED	
	b) SERIAL LINK PROTOCOL	☐ FOUNDATION FIELD-BUS ☐ PROFI-BUS ☐ DEVICE NET ☐.....	
	c) SERIAL LINK MEDIA	☐ TWISTED PAIR Cu-CBL ☐ CO-AXIAL Cu-CBL ☐ OFC	
	d) HAND HELD PROGRAMMER	☐ REQUIRED ☐ NOT REQUIRED	
	e) TYPE OF HAND HELD PROGRAMMER	☐ BLUETOOTH ☐ INFRARED ☐.....	
	f) MASTER STATION	☐ REQUIRED ☐ NOT REQUIRED	
	g) MASTER STN INTRFACE WITH DCS	☐ MODBUS ☐ TCP/IP	
	h) DETAILS OF SPECIAL CABLE	☐ ENCLOSED ☐ NOT REQUIRED	
	STEP DOWN CONT. TRANSFORMER	■ REQUIRED	
	OPEN / CLOSE PB	■ REQUIRED ☐ NOT REQUIRED	
	STOP PB	■ REQUIRED ☐ NOT REQUIRED	
	INDICATING LAMPS	■ REQUIRED ☐ NOT REQUIRED	
	LOCAL REMOTE S/S	■ REQUIRED ☐ NOT REQUIRED	
	STATUS CONTACTS FOR MONITORING	■ REQUIRED ☐ NOT REQUIRED	
	INTEGRAL STARTER DISTURBED SIGNAL	REQUIRED (O/L RELAY OPERATED, CONT./POWER SUPPLY FAILED, S/S IN LOCAL or OFF MODE/STOP PB OPTD, TORQUE SWITCH OPTD. MID WAY/MOTOR THERMOSTAT TRIP)	
INTERPOSING RELAY/OPTO COUPLER (Applicable for integral Starter)	TYPE OF ISOLATING DEVICE	☐ INTERPOSING RELAY ☐ OPTO COUPLER ■ EITHER	
	QUANTITY	☐ 2 NOs. ☐ 3 NOs.	
	DRIVING VOLTAGE	■ 20.5 – 24V DC ☐ _____V DC	
	DRIVING CURRENT	■ 125mA MAX ☐ _____mA MAX	
	LOAD RESISTANCE	■ > 192 ohms - <25 k ohms ☐ > _____ohms - < _____ohms	
TORQUE SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN / CLOSE	■1 No. ☐2Nos. / ■1 No. ☐2Nos	
	CONTACT TYPE	2 NO + 2 NC	
	RATING	5A 240V AC AND 0.5A 220V DC	
	CALIBRATED KNOBS(OPEN&CLOSE TS)	REQUIRED FOR SETTING DESIRED TORQUE	
	ACCURACY	+3% OF SET VALUE	
LIMIT SWITCH (Not Applicable for Smart Actuator) **($$ Refer Notes)**	MFR & MODEL NO.	BIDDER TO SPECIFY	
	OPEN : INT : CLOSE	☐1 No ■2 Nos. / 2 Nos. (ADJ.) / ☐1 No. ■2Nos.	
	CONTACT TYPE	2 NO + 2 NC	
	RATING (AC / DC)	5A 240V AC AND 0.5A 220V DC	

FORM NO. PEM-6666-0

BHEL	**SPECIFICATION FOR MOTORISED VALVE ACTUATOR**	SPECIFICATION NO.: PE-SS-423-145-I007 VOLUME II B SECTION D REV. NO. 01 DATE: 03.03.17 SHEET 4 OF 4

Data Sheet A & B

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

POSITION TRANSMITTER	POSITION TRANSMITTER (For inching duty & other specific applications)	■ REQUIRED ☐ NOT REQUIRED	
	MFR & MODEL NO.	BIDDER TO SPECIFY	
	TYPE	☐ ELECTRONIC (2 WIRE) R/I CONVERTER ■ ELECTRONIC (2 WIRE) CONTACTLESS	1
	SUPPLY	■ 24V DC ☐	
	OUTPUT	■ 4-20mA	
	ACCURACY	± 1% FS	
SPACE HEATER	@SPACE HEATER	REQUIRED	
	@ POWER SUPPLY (NON INTEGRAL)	230V AC,1 PH.,50 Hz	
	@ POWER SUPPLY (INTEGRAL)	BIDDER TO SPECIFY	
	@ RATING		
TERMINAL BOX	ACTUATOR/MOTOR TERMINAL BOX	REQUIRED	
	ENCL CLASS ACTUATOR/MOTOR T.B.	@■ IP 68 @☐.....	
	@ EARTHING TERMINAL	REQUIRED	
	PLUG & SOCKET(9 PIN) (FOR COMMD, LS/TS FEED BACK, PoT)	■ REQUIRED ☐ NOT REQUIRED☐ ☐ 2 NOS. ☐ ----------	1
CABLE GLANDS	@ POWER CABLE GLAND	SIZE: suitable for 3Cx2.5sq mm for motor rating 3.7 kW, 3Cx10 sq mm fr motor from 3.7 kW to 5.5 kW.	
	@ SPACE HEATER CABLE GLAND	SIZE:-Space heater cable gland to be derived internally.	
	OTHER CONTROL CABLE GLANDS-2	QUANTITY & SIZE :-------- (8Px0.5 sq mm)	
WEIGHT	TOTAL WEIGHT (ACTUATOR + ACCESSORIES)	BIDDER TO SPECIFY	_____ Kg.

NOTES:

1. **SCOPE**: DESIGN, MANUFACTURE, INSPECTION, TESTING AND DELIVERY TO SITE OF ELECTRIC ACTUATOR FOR INCHING OR OPEN / CLOSE DUTY.
2. **CODES & STANDARDS**: DESIGN AND MATERIALS USED SHALL COMPLY WITH THE RELEVANT LATEST NATIONAL AND INTERNATION STANDARD. AS A MINIMUM, THE FOLLOWING STANDARDS SHALL BE COMPLIED WITH:
   IS-9334, IS-2147, IS-2148, IS-325, IS-2959, IS-4691 AND IS-4722
3. TEMPERATURE RISE SHALL BE RESTRICTED TO 70 DEG. C FOR AMBIENT TEMPERATURE OF 50 DEG C.
4. CABLE GLANDS OF DOUBLE COMPRESSION TYPE, BRASS MATERIAL SHALL BE PROVIDED.
5. THE TORQUE SWITCHES SHALL BE PROVIDED WITH MECHANICAL LATCHING DEVICE TO PREVENT OPERATION WHEN UNSEATING FROM THE END POSITIONS. THE LATCHING DEVICE SHALL UNLATCH AS SOON AS THE VALVE LEAVES THE END POSITION. IF SUCH PROVISION IS NOT POSSIBLE, THE TORQUE SWITCHES SHALL BE BYPASSED BY END-POSITION LIMIT SWITCHES WHICH OPENS ON VALVE LEAVING END POSITION.THESE LIMIT SWITCHES ARE ADDITIONAL TO THE NUMBER OF LIMIT SWITCHES SPECIFIED ELSEWHERE.
6. THE MOTOR SHALL OPERATE SATISFACTORILY UNDER THE +/- 10% SUPPLY VOLTAGE VARIATION AT RATED FREQUENCY, -5% TO +3% VARIATION IN FREQUENCY AT RATED SUPPLY VOLTAGE, SIMULTANEOUS VARIATION IN VOLTAGE & FREQUENCY THE SUM OF ABSOLUTE PERCENTAGE NOT EXCEEDING 10%.
7. THE MOTOR SHALL BE SUITABLE FOR DIRECT ON LINE STARTING.
8. 2 No. OF EARTHING TERMINALS SHALL BE PROVIDED FOR THE MOTOR BODY EARTHING. 1
9. IN ADDITION TO ABOVE, 2 No. OF CABLE GLANDS (NPT) SHALL BE PROVIDED.
10. LOCAL DIGITAL POSITION INDICATOR SHALL BE PROVIDED FOR INCHING DUTY DRIVES.

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

EPOXY PAINT IS RECOMMENDED FOR COASTAL AREAS.

NOTES* = TO BE FILLED BY MPL (LEAD AGENCY). @= TO BE FILLED BY ES

FIELD & MEASURING INSTRUMENTS

CHAPTER-3

FIELD AND MEASURING INSTRUMENTS

2.3.3 Field & Measuring Instruments (Primary & Secondary Instruments)

2.3.3.1 General requirements

Instruments, control devices and other equipment accessories covered under this specification shall be furnished in accordance with I&C specification sheets and drawings enclosed herewith and the requirements of all applicable clauses of this specification.

The instrumentation and control equipment shall conform to all applicable codes and standards including those referred in Cl. no. 2.3.1.6 in this Volume. All equipment and systems shall also fully comply with the design criteria stated in chapter-2 of this part.

The instrumentation/control equipment and accessories shall be from the latest proven design for which the performance and high availability have been demonstrated by a considerable record of successful operation in power station service for similar applications. The bidder shall furnish sufficient evidence to fully satisfy the Owner in this regard.

For plug in type instruments, the plug & sockets shall be polarized to prevent wrong connections and have facility for secure coupling in plug-in position to prevent loose connections.

Signal/Electrical connection shall be screwed connection with double compression type Nickel-plated brass cable glands for Explosion proof area, Flame proof area and high vibration prone area.

Every instrument requiring power supply shall be provided with a pair of easily replaceable glass cartridge fuse of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.

All field instruments shall be weatherproof, drip tight, dust tight and splash proof suitable for use under outdoor ambient conditions prevalent in the subject plant. All field-mounted instruments shall be mounted in suitable locations where maximum accessibility for maintenance is achieved. The enclosures of all electronic instruments shall conform to IP-65 unless otherwise specified (Explosion proof for NEC article 500, class 1, Division 1 area & flame proof) and an anticorrosive paint shall be applied to the field mounted enclosures / instruments. All the field instruments shall also be provided with SS tag nameplate and double compression type Nickel-plated brass cable gland. Gaskets, Fasteners, Counter and mating flange shall also be included wherever required with the field instruments.

Following minimum requirement of field instruments shall be fulfilled by Bidder (In addition, Redundancy criteria for field instruments shall be as specified elsewhere in specification): -

a. Level switches / pressure switches / flow switches/any other process switches etc. for OLCS / Alarms / Interlocks / Protection. Pressure switches at inlet, outlet of individual pumps and discharge header of pumps for protection and auto start / stop & alarms.

b. Level switches (Type as per Owner approval) for sump/tank level high/normal/ low/very low interlocks.

c. Level Transmitters (Type as per Owner approval) for open sump/ tank/bunker/vessel/heaters.

d. Stand pipes on both side of tank for all level instruments (LT, LS & LG).

e. Flow elements (Type as per Owner approval) with flow transmitter & Flow meter for flow measurement of process medium like Steam, Water, Air, Flue Gas, Fuel oil, open channel liquid, solid fuel, ash flow, DM water, Raw water, Instrument and Service air etc. as decided by owner.

f. Pressure gauges and temp. Gauges at inlet and outlet of each heat exchanger and cooler.

g. DPG, DPT & DPS across the filters/strainers.

h. Tapping points/test points shall be provided.

i. All primary Instruments, hardwares & JBs etc. used for measurement for HFO, LDO & Turbine Lube Oil system shall be flame proof (IEC-79.1, Part I). All primary Instruments, hardwares & JBs etc. used for measurement for Hydrogen shall be intrinsically safe and explosion proof as per NEC article 500, class 1, Division 1 area I.

j. All Thermocouples & RTDs (Type as per Owner approval) shall be Duplex. Thermocouples shall be provided for Services with Temperature > 200 deg C.

k. All Field Instruments used in acid or alkaline atmosphere shall be with standard Anti corrosion coating i.e. the combination of Polyurethane and epoxy resin baked coating (ANSI/ISA-71.04).

l. All primary instruments installed at “Minus level or Floor” shall be with protection class of IP 68.

m. Transmitters (all type) for monitoring & controls purpose.

n. Bidder shall provide electronics weighing in motion system as per IS-11547, hermitically sealed load cell of precision strain gauge type,100% over load protection of cell and 250% overload protection for the construction; one calibrator attachment with two Weigher.

o. All field mounted push button, selector switch etc. shall be as per IEC or NEMA 4X protection.

p. All limit switch shall be conform to IEC-60947-5-1 and shall have minimum 2SPDT/DPDT contacts.

q. At APH, temperature measuring device of different lengths forming grid shall be provided to have average temperature for variable flow of flue gas, secondary air and primary air. These temperatures may be connected to nearest remote I/O panel.

r. On both left and right sides of furnace, separate lines shall be laid and provided with furnace pressure transmitters having wide range than the furnace pressure transmitters used for modulating control.

s. Temp. Transmitters are envisaged with RTD & Thermocouples for monitoring services / application only. However any RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS using instrumentation & Extension cables respectively.

t. As for the water flow/ steam flow measurements, necessary flow elements/ transmitters are chosen in the process line and supplied such that their algebraic summation shall be mass balanced for calculating the system efficiency.

u. Non-contact type electronic 2-wire position transmitters shall be provided for all inching type motorised valves and dampers.

v. For CW sump level, Turbine oil tank, Ash Silo, LDO/HFO tank, DM water tanks, CS tank, Acid and alkali applications, only noncontact type level transmitters like Acoustic, Ultrasonic, and Radar based (Type as per Owner approval) shall be provided by bidders as specified in Tender Specification and as approved by owner.

w. For Turbine oil, HFO/LDO applications & H2 Gas application, Zener protection on power supplies shall be included.

x. Where the process fluids are corrosive, viscous, solid bearing or slurry type, diaphragm seals shall be provided. Parts below the diaphragm shall be removable for cleaning. The entire volume above the diaphragm shall be completely filled with an inert liquid suitable for the application. For HFO, LFO Applications, SS capillary with thin wafer element with ANSI RF flanged ends are to be provided. For hazardous area, explosions proof enclosure as described in NEC article 500 shall be provided.

y. Considering the type of application, wireless technology to bring signals to DDCMIS may be adopted by interfacing with OPC gateway to avoid cabling for smart level transmitters specified above at sr. no. xxi, in case used for monitoring only. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wirelss transmitters shall have the same minimum specification/ parameters as mentioned for wired transmitters.

z. Gauges (all type) for local monitoring in field.

aa. Each switching element including the limit and torque switches of valve actuators shall be provided with minimum two contacts i.e. 2SPDT OR DPDT.

bb. All instruments should be supplied with valid calibration and test certificates provided by OEM.

cc. Canopy/Enclosure shall be provided for field instruments like transmitters, switches & flow meters, etc and any other equipment to protect from direct sun light, lightning & rain.

Field instruments shall be supplied & offered as per data sheets specified below:

2.3.3.2 Transmitters, Switches, Gauges and Panel Mounted Instruments

i) Pressure, Differential Pressure, DP type Level and Flow Transmitters (PT, DPT, LT & FT)

Smart Transmitters of the electronic type shall be furnished. All Transmitter shall be installed in closed LIE in the boiler area. Similarly transmitter for TG shall also be in LIE except the transmitters located in covered area on TG floor and these shall be mounted in LIR. Transmitters shall be equipped with mounting brackets suitable for a mounting in transmitter enclosures.

In general, Transmitters are envisaged to be grouped at several places as to be decided during detailed engg. Stage. For this purpose, suitable enclosures complete with all tubing, fittings, purge meters, loop cable trays etc. shall be provided.

S.No	Features	Essential / Minimum Requirements
1	Type/Construction	Sealed capacitance/ Inductance/ Silicon resonance type
2	**Material**	
	Body	Die cast Aluminium with epoxy coating for air & flue gas, SS316 for other services
	Diaphragm	SS316 With Teflon seal for process requirement/process media for other services
	Measurement element	316 SS (Suitable material/coating for Hydrogen pressure transmitters/Differential pressure transmitters) the suitable material/coating shall be chosen as per the suggestion of transmitter manufacturer.
	Valves	Carbon steel for non-corrosive applications & SS316 for corrosive applications
3	Output Signal	4 to 20 m Amp. DC (Two wires) HART Compatible
4	Local Indicator	LCD indicator (5 digit) with scale of Engg. unit
5	Overall Accuracy	± 0.04% or better of Span for BTG package ± 0.065% or better of Span for BOP packages ± 0.2% or better of span for remote seal type transmitter.
6	Turn down ratio	100:1 in general

S.No	Features	Essential / Minimum Requirements
		10:1 for vacuum/very low pressure applications. 10:1 for very high pressure application. 30:1 for other applications.
7	Stability	+ 0.15% of URL for 5 years.
8	Response time	150 msec.
9	Power supply	24V DC nominal
10	Load Impedance	500 Ohms (min.)
11	Drive capability	600 Ohms nominal
12	Enclosure Class	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
13	Span and Zero	Locally adjustable, non-interacting
14	Zero suppression / elevation	At least 100% of Span
15	**Connection**	
	Process	Half (1/2) inch NPT (F) Quarter (1/4) inch NPT with / without oval flanges
	Electrical	Suitable for Plug in type connection (Both side of transmitter), unused entry with blind plug.
16	**Accessories**	
	For Absolute Pressure Transmitters	Two (2) valve SS316 manifold
	For Gauge & Vacuum pressure transmitter	Three (3) valve SS316 manifold
	For DP, level & flow transmitter	Five (5) valve SS316 manifold
	For oil and corrosive liquids	Separator diaphragm seals
	For all transmitters	Mounting bracket
	Steam Service	Syphon
	Pumps Discharge service	Snubbers
17	Adjustment / calibration From hand held calibrator / centralized OWS based system / maintenance (as applicable).	From hand held calibrator/centralized OWS based system
18	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

Manifold should not be mounted on the transmitter, Manifold shall be non integral and standalone type. Snubbers/Pulsation dampners shall be used where the process media is unstable for measurement such as the discharge of a pump. Over range protection shall be used where necessary. The coil syphons & condensate pots shall be used for steam services. Transmitters shall be provided with suitable drain & vent points.

Transmitters, smart positioner & other HART based instruments shall be supplied along with 4 Nos. of universal type hand held/portable calibrators. Temperature transmitters shall be supplied along with 4 Nos. of hand held/portable mV source generators/signal reader.

If one type of hand held type calibrator is not suitable for communicating with all types of transmitters then separate hand held calibrator will be provided.

Following minimum accessories shall be provided with each set:-

a) Soft carrying case with adjustable shoulder straps & lead compartments.
b) HART lead set.
c) Rechargeable batteries.
d) Battery charger.
e) Power adaptor.
f) Universal plug kit for power adaptor.
g) Load resistor.
h) Interfacing cables of each type as per requirements.
i) Protective boot.
j) Standard banana jack.
k) Operation manual & software CD.
l) Analysis & Diagnostic Software.

For flanged remote seal diaphragm:

a) Maximum pressure rating : To meet 200 percent of process pressure
b) Availability of seals : for both high and low pressure sides with capillary connection in case of differential pressure transmitters and
c) Single Capillary connection for pressure transmitters.
d) Capillary length : 6.0 m
e) Fill fluid : Suitable oil
f) Process connection size : 1 inch
g) Flange size and Accessories : As per process requirement. Flange pressure rating : Required Class (ANSI)
h) Process liquid : Sea water, Ash water, chemical, hydrogen gas, sealoil etc.,
i) Process fluid temperature : 25°C to 60°C
j) Diaphragm and wetted part material : Suitable for sea water, ash water and chemical applications.(offered material to be specified)
k) Flushing option : To be made available with 1/4 inch (necessary drain and gasket suitable for sea water application to be provided)

ii) Pressure Switches (PS) & Differential Pressure Switches (DPS)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standards	IS3624 - 1966/ISA-RP-8.1 except as modified in spec.
2	**Materials**	
	Bellows	316SS
	Bourdon tube	316SS
	Movement	316SS
	Enclosure	Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
3	Type/Construction	Bourdon/Sealed Diaphragm Piston Actuated preferable. Indicators with contacts are not acceptable.
4	Protective Diaphragm	Teflon
5	Accuracy	± One (1) percent or better of full range

S.No	Features	Essential / Minimum Requirements
6	Repeatability	± 0.5(half) percent or better of full range
7	Setting & Differential	Adjustable
8	**Contact**	
	Number	DPDT /2 SPDT
	Type	Auto reset with internal Adjustable snap action micro switch
9	Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
10	End connection	½" NPT (F) / Manufactures Standards
11	Connection - instrument	Half (1/2) inch NPT Male Process
12	Electrical	Suitable for Plug in type connection. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
13	Over range protection	One Fifty (150) percent of full scale
14	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
15	Dead band adjustment	Adjustment up to 10% at set points.
16	**Accessories**	
	3 / 5 valve manifold	As applicable for all switches
	Self cleaning type pulsation dampners / Snubbers (Material SS316)	Pump and compressor
	Syphon	For all steam lines
	Protective separating diaphragm	For fuel oil & corrosive liquid lines.
	Mounting	Local (in LIE/LIR for BTG package)
17	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

iii) Pressure & Differential Pressure Gauges (PG & DPG)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standards	IS:3602-1966, IS/3624, ASME B 40.1
2	**Type / construction**	
	760 mm to 1.0Kg/cm2	Bellows/Diaphragm
	Above1.0Kg/cm2	Bourdon Tube
	Suction side of pumps	Compound gauge
3	**Materials**	
	Bellows	316SS
	Bourdon tube	316SS
	Movement	316SS
	Case Enclosure	SS 316 / Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere.
4	End connection	½" NPT (M)
5	Protective Diaphragm	Teflon
6	Dial Size	150mm with shatter proof glass

S.No	Features	Essential / Minimum Requirements
7	Scale Details	Graduations in black lines on white dial, on white dial, 270 Deg. pointer deflection scale provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller. Pointer stop for all gauges.
8	Range Selection	Cover 125% of max. of scale
9	Accuracy	± One (1) percent or better
10	Instrument process connection	½" NPT Male (Back Entry)
11	Mounting Type	Local / 1/2 inch NPT Male (Back entry) mounted on local gauge board.
12	Protection Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
13	**Accessories**	
	3 way needle valve / manifolds	For all gauges
	Self cleaning type	Pump and compressor discharge (Pulsation dampener / Snubbers (S316) lines
	Syphon	For all steam lines
	Protective separating	For fuel oil and corrosive liquid lines
14	**Other Particulars**	
	External Zero adjustment / Safety device	For all gauges
	Ranges 5 to 20 Kg/cm2	Rubber blow out disc with open front construction.
	Ranges above 20 Kg/cm2	Neoprene safety diaphragm at the back with solid front construction.
16	Over range protection	One Fifty (150) percent of full scale
17	Over Range Test	Test pr. For the assembly shall be 1.5 to the max. Design pr. At 38°C
18	**Other Requirements**	Movement mechanism shall be glycerine filled for oil services & vibration prone area.
		For Fuel oil & corrosive liquid lines diaphragm type sensors required. Armoured capillary of 10 M for Fuel oil & Corrosive liquid service.
		Contact type pressure gauges are not acceptable for interlock & protection.
		For condensate storage tank the pressure gauge in terms of0-10000 mmwcl or suitable range having **dial size of 300mm or bigger size** shall be provided.
19	IBR Requirement	For high pressure service, Process tapping and root valves are as per IBR rules and regulations

2.3.3.3 Temperature Related Instruments

a) Temperature Transmitters (TT)

S.No	Features	Essential / Minimum Requirements
1	Type	SMART type configurable from control room through HART protocol (HMS System).
2	Display type	Indicating type (5 digit LCD Display),
3	Accuracy	±0.10%,

S.No	Features	Essential / Minimum Requirements
4	Ambient temperature error	0.1% per 10°C change
5	Input	Same transmitter shall be capable to handle Pt- 100 RTD, Thermocouples –K&R types (input type to be selectable at site through HART terminal)
6	Output	4-20 mA DC (2 wire system) HART compatible signals for analogue monitoring inputs to the distributed control system (DDCMIS), DCS & PLC.
7	Isolation	Min. 500 V AC
8	EMC compatibility	as per EN 61326
9	Operating ambient temperature	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
10	Protection class	NEMA 4 / IP66 or equivalent degree of protection for enclosure)/ (Explosion/Flameproof for NEC Class-1, Division 1 area)/flame proof (IEC-79.1, Part I). As applicable).
11	Material of accessories	SS316
12	Stability	± 0.1 % or ± 0.1 deg C of reading (whichever is great) for 2 years in case of RTD inputs and for 1 year in case of Thermocouples inputs.
13	Operating Voltage	16 – 48 V DC
14	Calibration	As per NIST monograph 125 for T/C & European Curve Alpha = 0.00385 for RTD.
15	Ref. Junction compensation	Provided
16	Span/zero adjustment	Locally adjustable, Non interacting
17	Auto calibration	Provided
18	Burn out protection upscale	Provided
19	Input - output isolation	Provided
20	Circuit ungrounded	Provided
21	Accessories	Mounting arrangements including Clamps etc.
22	Composite Accuracy	For head mounted and DIN-rail mounted type RTD =<0.4% of 0-250 deg C span For dual-input type: RTD =<0.25% of 0-250 deg C span
23	For head mounted and DIN-rail mounted type RTD =<0.4% of 0-250 deg C span For dual-input type: RTD =<0.25% of 0-250 deg C span	Temperature transmitters of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature up to 70 deg C. These modules shall be connected to DDCMIS through field bus such as Profibus, Foundation Field bus etc. directly from the transmitter. Maximum Number of inputs per such temperature transmitter shall be eight. These shall be mounted in cabinets in non-AC areas. As an alternate, these signals from temperature transmitters can be connected to DDCMIS through standard remote I/O modules of the DCS, in which case, the temperature transmitter signals will be acquired through 4-20mA input modules in the remote I/O cabinet for connecting to DDCMIS through remote I/O bus.

Any RTD or Thermocouples shall be directly wired to DDCMIS/DCS/PLC for metal temperature application, bearing & winding temp application only.

The Temperature transmitter shall accept Universal dual inputs of all types of thermocouples & RTD, 0-5V input signals etc.

Temp. Transmitter shall be extremely stable against ambient temp variation, the accuracy figure shall be inclusive of effect due to ambient temperature variation.

For BFPs' differential temperature protection by 2 out of 3 logic, DTT shall be employed to deliver 4-20 mA output to DDCMIS using suction & discharge temperature measurements.

Temperature Transmitters shall not be used for CLCS, OLCS, interlock & protection services anywhere in the plant with RTD & Thermocouples. However RTD & Thermocouples are used for control, interlock & protection application, same shall be directly wired to DDCMIS/DCS/PLC using instrumentation & Extension cables respectively.

These transmitters shall be connected with duplex sensors and shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed.

Considering the monitoring application & distance involved for monitoring parameters wireless technology shall be adopted by interfacing with DDCMIS through OPC connectivity. However Wireless technology as adopted by Bidder shall be reliable and field proven in power plants and same shall be approved by Owner. Wireless transmitters shall have the same minimum specification/parameters as mentioned for wired transmitters.

b) Resistance Temperature Sensors (RTD) with Thermo wells

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	ASME PTC 19.3 - Latest Revision DIN EN 60751:1996, BS EN/IEC60751: 2008
2	Element	Platinum, R0=100 ohm 4-wire, Duplex for Process Temp. Measurement Platinum, R0=100 ohm 3-wire Duplex for Bearing & Winding Temp. Measurement
3	Sheath Material/ Insulation	316SS/Compacted Magnesium Oxide (Purity above 99.4%)
4	Sheath O D	8 MM
5	Gauge	18 AWG
6	Terminals	Spring loaded high temperature ceramic base with silver plated brass for high vibrating locations.
7	Calibration	As per DIN Standard – 43760/IEC 60751, Class A
8	Head	Hex Head, Die Cast Aluminium (Screwed) with galvanized SS chain
9	Response Time	6-10 Sec bare & 30 Sec. With protective sheath/thermo well
10	Accuracy	± 0.35 degree C or Class-A whichever is better.

S.No	Features	Essential / Minimum Requirements
11	Electrical connection	Gold plated Plug in type. Double entry – one unused entry with blind plug
12	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
13	Response Time	Repeat and contradictory.
14	Accessories	i. Adjustable nipple-union-nipple with thermo well ii. Compression fittings/unions Flanges etc. (for flanged connections only) iii. SS 316 forged thermo well as per ASME PTC
	THERMOWELL	
15	Applicable Standard	ASME PTC 19.3 TW - 2010
16	Construction	Tapered drilled from Bar stock (Straight for Air & Gas systems)
17	Material	316 SS/F11/F22/F91 - water and steam Services depending upon process parameters. Inconel for air & flue gas services For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges. For Mill classifier outlet long life solid sintered tungsten carbide material or better of high abrasion resistance. Bidder shall provide calculation for thermo well as per ASME – PTC-19.3 2010. "All Thermo wells in high velocity steam service shall be checked for Strouhal's frequency limit to arrive at a safer size and design of Thermo wells".
18	Process Connection	(i) M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
19	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
20	Immersion length	Within ± 10 mm of centre line of pipe and as per ASME – PTC-19.3 - 2010
21	Extension neck length	Minimum 100 mm above insulation of pipe and Minimum 160 mm when there is no insulation on pipe.
22	IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
23	**Note** : **Extension /Compensating/paired cable exposed to atmosphere in the conventional method melts away due to high temperature or the head shall be more than 300 mm above the top of mill or due to coal burning. Hence The terminals of temperature sensors shall not be at the top of mills itself. The temperature sensors wires are to be laid up to JB though SS tube of required diameter and the head shall be placed nearer to the JB.** **In case, Duplex RTDs are not provided by bidder due to system/equipment limitation, two no. simplex RTD shall be provided instead of Duplex RTD. Both Simplex RTD shall be terminated at local JB/Termination Box.**	

S.No	Features	Essential / Minimum Requirements
13	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

e) Temperature Switches (TS)

S.No	Features	Essential / Minimum Requirements
	Type / Construction	
1	Switch	Industrial type inert gas filled with capillary and separable thermo well and contacts directly connected to Bourdon element/vapour pressure sensing, gas filled bellows type preferred.
2	Thermo well	Bar stock
a	Enclosure Class	IP 65 or better/ (Explosion/Flame proof for NEC Class 1/2, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable.
	Material	
3	Bulb	316 SS
4	Capillary	Armoured Stainless Steel
5	Bourdon	316 SS
6	Bourdon Movement	SS 316
7	Casing	Die-cast aluminium with stoved enamel black finish Epoxy coating shall be provided for corrosive atmosphere.
8	Setting and Differential	Adjustable
9	Accuracy	± One (1) percent of setting and differential
10	Repeatability	One half (1/2) percent of setting.
	Contacts	
11	Number	DPDT/2 SPDT
12	Type	Auto reset with internal Adjustable snap action micro switch
13	Rating	5 Amp, 240V AC / 0.2 Amp, 220V DC
14	Pipe Connection	M33 x 2
15	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
16	Thermo well	To suit Temp. switch with same design criteria as specified for RTDs.
17	Electrical	Suitable for Plug in type. All the switches are internally connected and brought to the surface with Amphenol male/female connection. Cabling need not terminated inside the switch. Cable ends are to be soldiered in connector and to be inserted for easy maintenance.
	Other Particulars	
18	Capillary length	As per requirement (min 10 meters)
19	Immersion Length	Within + ten (10) mm of centre line of pipe with adjustable nuts.
20	Extension neck length	Minimum 50 mm above insulation of pipe /As per approved hook up drawings

S.No	Features	Essential / Minimum Requirements
21	Packing glands	Yes
22	IBR Certification	For high pressure service, Steam Temp, Fuel oil temp. measurement as per IBR rules and regulations
23	N.B	Switches designed for cross ambient operation shall be used in applications where the ambient temperature will approximate or exceed the switch set point.

f) Temperature Gauges (TG)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	IS : 3602,BS:5235 ISA:RP:8.1 except as modified in this specification
	Type/Construction	
2	Thermometer	Industrial type, Gas in Filled type with separable thermo well
3	Thermo well	Bar stock
	Material	
4	Bulb	316 SS
5	Capillary	Armoured SS (Applicable for capillary Type)
6	Casing	SS 316/ Die-cast aluminium with stoved enamel black finish. Epoxy coating shall be provided for corrosive atmosphere
7	Dial Size	150mm with shatter proof glass
8	Scale Details	270 degree dial rotation/deflection. Graduations in black lines on white dial provided with glass cover. Smallest scale division shall be one (1) percent of full scale value or smaller .Pointer stop for all gauges
9	Accuracy	± One (1) percent or better
10	Response time	Maximum 15 seconds without thermo well and 30 seconds with thermo well
	Connection	
11	Pipe	M33 x 2
12	Thermo well	To suit instrument with same design criteria specified for RTDs.
13	Process Connection	M 33 x 2 (ii) SS316 Flanged, for Air & Gas systems, with mating flanges, fasteners, gaskets etc.
14	Extension	Threaded union (SS316) 1/2" NPT (F) with two nipples of SS 316 having 1/2"NPT(M) threads at both ends
15	Other Particulars	
16	Capillary length	5Meters/10 Meters as required
17	Immersion Length	Within + ten (10) mm of centre line of pipe with adjustable nuts.
18	Extension neck length	Minimum 50 mm above insulation of pipe /As per approved hook up drawings.
19	Stop at Maximum value	For all gauges of scale
20	Pointer	i) Externally adjustable

S.No	Features	Essential / Minimum Requirements
		ii) In general, Contact type Temp. gauges are not acceptable for interlock & protection. iii) Contact type Temp. gauges are acceptable for interlock & protection in case of bearing temp. Only.
21	Over range protection	150 percent (%) of full scale
22	IBR Certification	For high pressure service, Steam Temp., Fuel oil temp. measurement as per IBR rules and regulations
23	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)

g) Test Thermo wells (TW)

S.No	Features	Essential / Minimum Requirements
1	Applicable Standard	ASME PTC 19.3 TW-2010
2	**Type/Construction**	Machined from Bar stock
3	**Material**	316 SS/F11/F22/F91
	Connection	
4	Pipe	M33 x 2
5	Test Instrument	To suit test instruments
6	Accessories	Plug with chain
7	IBR Certification	For high pressure service, Steam temperature Fuel oil temperature measurement as per IBR rules and regulations. Bidder shall provide calculation for thermo well as per ASME – PTC- 19.3 TW - 2010.

Test wells shall be provided on main steam, reheat steam, extraction steam, feed water, condensate, spray water lines and other piping as required to meet ASME test requirements.

2.3.3.4 Level Instruments

a) Direct mounted level transmitter (LT)

Displacer type level transmitter shall not be used in the process anywhere in the plant.

b) Ultrasonic Level Transmitter (for Water sump/Tank level measurements)

S.No	Features	Essential / Minimum Requirements
1	Principle of Operation	Detection of reflected ultrasonic pulse
2	Measuring Ranges	Up to 30 meters (typical)
3	Signal Processing	Microprocessor Controlled Signal Processing
4	Operating Freq.	10 KHz to 50 KHz (typical)
5	Display	Head mounted alpha-numeric back lit LCD/LED
6	Calibration & Configuration	Accessible from front of panel & HART calibrator.
7	Diagnosis	On-line
8	Status	For power, Hi / Lo / V. Hi / V. Lo- level indication, fault etc.

S.No	Features	Essential / Minimum Requirements
9	Construction	Plug-on board
10	Power supply	240 V AC 50 Hz / 24V DC
11	Signal Output	4-20 mA DC with HART (isolated) - 600 Ohm load.
12	Hysteresis	Fully adjustable preferred
13	Output contacts	2SPDT Potential free changeover contacts @ 8A 230V AC.
14	Accuracy & Repeatability	± 0.25% of span or better
15	Resolution	± 0.1% of span
16	Temperature Compensation	To be provided with Transducer.
17	Operating temp.	Transmitter-50 deg C and Sensor – 80 deg C
18	MOC Sensor	Body- PVDF and Face – Polyurethane
19	Humidity	1% to 95% non-condensing.
20	Enclosure	IP-67 Epoxy painted die cast Aluminium or SS316L housing.
21	Cable Connection	3/4" ET
22	Mounting	2" – 4" NPT or flanged
23	Accessories	Cable gland, prefab cable, mounting accessories like EPDM seal, SS316 flanged etc. Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering. All weather canopy for protection from direct Sunlight, lightening and direct rain.

c) Capacitance type Level Transmitter

The total system shall consist of capacitance probe, pre-amplifier and transmitter.

S.No	Features	Essential / Minimum Requirements
1	Type	Capacitance type
2	Probe	a) Rod or suspended electrode. b) Rope type probes may be used only where required probe length is greater than 3 meters
3	Probe Mounting	Stainless steel 1-1/2 ANSI RF Flange / ¾" NPT (M)
4	Material of construction	316 SS
5	Insulation	PTFE Part/Full as per service
6	Transmitter	The transmitter shall receive output of the preamplifier and convert it into 4-20 mA DC output signal.
7	Accuracy	± 1% of Full scale
8	Repeatability	± 0.5 % of Full scale
9	Load	Min 600 Ohms
10	Enclosure	Powder/Epoxy coated Die cast aluminium with neoprene gasket conforming to IP-65. (Explosion proof for NEC Class-1, Division 1 area).
11	Ambient temperature	0-60 ºC.
12	Mounting	Wall / Surface

13	Supply voltage	240V AC, 50Hz / 24V DC
14	Response time	100 m sec or better
15	Cable connection	¾" ET
16	Accessories	Counter flange, Cable gland, prefab cable if any
17	Preferable features	Alarm output contacts with adjustable set point facility

d) Guided wave Radar / Radar Level Transmitter

S.No	Features	Essential / Minimum Requirements
1	Type	Guided wave Radar (Contact type)/Radar (Noncontact type) as finalized by owner.
2	Application	a) For Turbine Lube oil tank, HFO & LDO tank level, Condenser Hot well, LP heaters, CBD tank level, Stator water expansion level, and other Low pressure, Vacuum vessels. b) HP Heaters, Deaerators are to be appended in the existing list c) Also Bulb type with Teflon coating & drop antenna shall be used acid /chemical tank applications d) For oil tank applications, four wire transmitter shall be supplied with zener barrier protection for power supply connected to level transmitters.
3	Environment Class	Highly abrasive with Gases and Fumes
4	Orientation	Vertical
5	Probe Type	Flexible Single lead with chuck
6	Probe Material	SS 316L
7	Connection Size & Type	2" Flanged ANSI 300 lb SS316L material
8	Connection material	SS 316L
9	Accuracy	+/- 5 mm
10	Resolution	+/- 1 mm
11	Type (Transmitter)	SMART, 2 Wire
12	Operating Principle	Time Domain Reflectrometry
13	Output	4-20 mA, DC with HART protocol and 600 Ω output load.
14	Electrical Connection	½" NPT
15	Enclosure Class	IP-65 or better (Explosion/Flame proof for NEC Class-1, Division 1 area)
16	Electrical Power	11-42 V DC
17	Housing material	Die Cast Aluminium
18	Vent & Drain Plug material	SS
19	Side Flange Material	SS
20	Local Display	Provided (LCD Digital)
21	Units of Measurement	Length M
22	Electromagnetic compatibility	EN-61326

7	Ambient temperature	0-60 ºC.
8	Mounting	On Top
9	Supply voltage	240V AC, 50Hz from UPS/ 24V DC
10	Relay output	2SPDT
11	Contact rating	5A min. at 240V AC on resistive load
12	Response time	100 m sec or better
13	Cable connection	¾" ET
14	Accessories	Counter flange, Cable gland, prefab cable and stainless steel name plate engraved with alpha-numeric.

k) RF type level switch

S.No	Features	Essential / Minimum Requirements
A	**Electronic Controller**	
1	Input supply	240 V AC from UPS
2	Construction	Cast Aluminium Housing
3	Relay Output	2 Nos. Relay Changeover Potential Free Contacts(2SPDT)
4	Contact Rating:	5A at 240 V AC & 0.25 at 220 V DC
5	Class of Protection	IP-66
6	Ambient Temperature	55 Deg. C(Max)
7	Local Indication	Local LED Indications
	Green	Normal Level
	Red	Alarm Level
	Yellow	Probe Healthy
8	Cable Connection	3/4" ET(2 Nos.) for Supply and Output & 5/8" ET(1 No.) for Probe Connection
9	Repeatability	100%
B	**Sensing Probe**	
1	Type of Probe	Rigid
2	Material	Stainless steel SS 316
3	Probe Head Housing	Cast Aluminium
4	Insulation (B/W Active & Shield And Shield & Ground)	PTFE
5	Probe Head Protection	IP-66
6	Mounting	Side Mounted
7	Cable Connection	5/8" ET (1No.)
8	Process Connection	40 NB BSP THREADED
9	Signal Cable	Coaxial cable for Connection Between Sensing probe and electronic Controller (@ 10 Metres. Per Level Probe)
10	Application	Ash Silos

l) Level Indicators (Gauge Glass)

S.No	Features	Essential / Minimum Requirements
1	Type/Construction	a) Reflex b) Tubular (For tanks open to atmosphere only)
2	**Material:**	

S.No	Features	Essential / Minimum Requirements
a)	Glass	Tempered borosilicate resistant to thermal shock
b)	Case	Carbon steel
c)	Integral cocks	i) Forged carbon steel with drain valves stainless steel internals ii) Rubber lined corrosion resistant 316 stainless steel (for Demineralised and Osmosis water service)
d)	Fittings	i) Forged carbon steel ii) Rubber lined 316 steel/PVC for corrosive liquids Demineralised and Osmosis water service) iii) 304 Stainless Steel for non-corrosive liquids
e)	Packing	Teflon
3	Dial size/scale	150 mm /1.5 Meters maximum length with
4	Scale details	Aluminium/SS316 scale Graduated in mmwcl
5	Connection	25 Nb/40 Nb ANSI Flanged
6	Accessories	a) Integral cocks b) Drain valves c) Bolts, nuts and gaskets d) Illuminating lamps as required e) Periscope as required
7	Tests	Tested at two hundred (200) percent of the maximum process pressure
8	Other details	For larger lengths, additional gauge glasses shall be provided with minimum of 50 mm overlap.

m) Float & Board type level gauge

S.No	Features	Essential / Minimum Requirements
1	Type of Instrument	Mechanical Type (Float Operated)
2	Service/ Application	As per service requirement
3	Measuring Range	as per requirement
4	Material Specification	
a	Float Material	SS316 having 2 nos. Guide wires
b	Float Wire Pulley	Shall comprise of 2 nos. Cast Aluminium Pulley hosing Assembly with SS 304 pulley and pulley shaft. Steel ball bearings shall be provided in pulley housing for easier float movement. Float wire material shall be SS316L. Between 2 pulleys, 1" NB G.I. short pipe with tentative length as per P&ID
c	Guide wire Assembly	CS chamber with spring and adjuster having 1" Class 150 ANSI RF MS flange. Guide wire rope shall be SS316L.
d	Counter Weight	MS counter – weight with Aluminium Pointer and Brass assembly Pull Chain.
e	Scale	SS 316/Aluminium material in mm with 1 % accuracy.
5	Nozzle Details	For float wire pulley assembly, one tapping and for guide

S.No	Features	Essential / Minimum Requirements
		wire assembly two tapping at the top of the tank; Size 1" NB (Top Mounting Type)
6	Process Connection	Flanged as per ANSI B 16.5 to suit 1" NB nozzle (Nozzle length - 150 mm for float wire, 100 mm for guide wire)
7	**Accessories (to be supplied with the instrument)**	
a	Counter flange	All mating Flanges, Nozzle
b	Mounting Accessories	All mounting accessories
c	Tag Plate	To be provided (material SS316)

2.3.3.5 Flow Instruments

a) Mass flow meter

S.No	Features	Essential / Minimum Requirements
	Sensor	
1	Measuring Principle	Coriolis Mass flow.
2	Primary Element	Flow Tube of 316SS or better
3	Heating Arrangement	Integral with Flow meter
4	Temperature Control	To be provided.
5	For Heating Process Connection	ANSI RF Flanged and rating as per process requirement.
6	Drain	Self-draining facility
7	Accessories	Counter flanges, Mounting nuts, bolts, gaskets etc.
	Transmitter	
8	Measured quantities	Mass Flow rate, Total Mass Flow, Density, Temperature as minimum.
9	Input Signal Processing	Digital Processing.
10	Display	Digital Display (LCD)
11	Output	2 Nos. isolated output of HART, 4-20mA DC selectable from four measured quantities
12	Load	< 600 ohms
13	Power supply	240V AC, 50 Hz. From UPS
14	Accuracy	0.15% of measured value for Liquid & 0.5% of measured value for Gas
15	Repeatability	0.05%
16	Housing	IP 65 (Explosion proof for NEC Class-1, Division 1 area)
17	Hazardous duty Version	FM Standards.
18	Nameplate	Tag number, service engraved in stainless steel tag plate
19	Accessories	a) As required for field mounting, Handheld configurator & complete Software, External zero adjustment facility b) Mounting U-bolts, nuts, bolts, prefab cable etc.
20	Application	HFO main line, LDO lines, HFO recirculation lines etc.
21	Fault Signal	Instrument fault signal through DPDT/2 SPDT for Diagnostics shall be provided and connected to DDCMIS.

S.No	Features	Essential / Minimum Requirements
3	Input	Input from Sensor
4	Display	4 1/2 digit LCD
5	Output	Isolated 4-20mA DC HART
6	Measuring Accuracy	0.5% of full scale range
7	Totalized Value	Required
8	Housing	IP-65 (Explosion proof for NEC Class-1, Division 1 area)
9	Nameplate	Tag number, service engraved in stainless steel tag plate
10	Accessories	Clamping strip, bracket, prefab cable etc. and Calibration or configurator kit.

d) Flow Transmitter (Ultrasonic)

S.No	Features	Essential / Minimum Requirements
	Sensor	
1	Type	Ultrasonic, 2 Wired
2	Sensing Elements	Non-contact
3	Output Signal	4-20mA with HART Protocol
4	Accuracy	+ / - 0.1% FS
5	Supply	24 V DC
6	Enclosure class	P-65
	Transmitter	
1	Mounting	On Nozzle
2	Mounting Position	Top Mounted
3	Housing	Plastic
4	Display	Head mounted LCD Display and remote LCD display
5	Process connection	NPT/Flanged
6	Electrical connection	NPT
7	Turn Down ratio	1:100
8	Measuring range	Adjustable (as per process requirement)
9	Totalizer	Required
10	Application	Open channel cooling water flow measurement
11	Accessories	As per process requirement Additional separate local display unit with large Alphanumeric back light LCD/LED & to be provided for the applications which will be decided during detailed engineering.

e) Positive Displacement Flow Transmitter

Positive displacement flow transmitters shall be offered. An electronic totalizer shall be provided for each flow meter and the location of the totalizers shall be acceptable to the Owner. Air eliminators shall also be provided to ensure maximum accuracy.

S.No	Features	Essential / Minimum Requirements
1	Type	Hall effect sensor
2	Body material	AISI 316L/Die Cast Aluminium.

S.No	Features	Essential / Minimum Requirements
3	Wetted part Material (Like Piston, Bearing, gear etc.)	AISI 316L/Die Cast Aluminium.
4	O ring material	PTFE / higher based on temperature
5	Flow range	As required
6	Accuracy	+ / - 0.5% or better of reading
7	Repeatability	+ / - 0.03% or better.
8	Ambient temperature	50 deg C
9	Mounting	On-Line mounting with flanges of stainless steel.
10	Electronics	Solid State
11	Power Supply	240V AC, 50Hz. UPS
12	Display	4 1/2 digit LCD for Flow rate & totalized value.
13	Output	Isolated 4-20mA DC
14	Turn Down ratio	1:30
15	Totalized Value	Required
16	Housing	IP-65/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I). As applicable).
17	Nameplate	Tag number, service engraved in stainless steel tag plate
18	Accessories	a) Clamping strip, bracket, prefab cable, battery etc. & Nuts, bolts, gaskets, mesh etc. b) Special tool kit for calibration/configuration.

f) Electromagnetic Flow meter

Electromagnetic flow meters shall have separate transmitter having accuracy +0.2% with zero stability feature, suitable for process medium with >20 micro siemens/cm for demineralised water for water / chemicals. Conductivity, flanges material SS-316, electrode & measuring tube material SS-316, liner material Teflon and enclosure IP-66, local digital display configurable as totalizer, 4-20 mA output signal HART compatible with zero and span field adjustable. Application – DM Water and for other application as decided by owner.

g) Flow Gauges (FG) and Flow Gauge cum Transmitter

S.No	Features	Essential / Minimum Requirements
1	Type / Construction	a) On-line type Rotameter for 50 Nb and below lines b) Bypass type Rotameter for above 50 Nb lines.
	Material – For On line type	
2	Metering Tube	Borosilicate glass
3	Float	316 SS
4	Packing	Teflon
5	End fittings	304 SS
	Material – For Bypass type	
6	Metering Tube	Borosilicate glass
7	Float	316 SS
8	Packing	Teflon
9	End fittings	304 SS

S.No	Features	Essential / Minimum Requirements
10	Orifice Plate	316 SS
11	Carrier ring	304 SS
12	Flanges & Mating flanges	Same as pipe material, 200 lbs ANSI - RF
13	Impulse pipe	Same as pipe material
14	Fittings	2000 ANSI, SW ends to match with pipe material.
15	Dial Size/Scale length	250 mm
16	Scale Details	Direct reading type engraved on detachable Aluminium scale
17	Output	4-20 mA DC output shall be provided so as to have remote monitoring at OWS of respective control rooms.
18	Accuracy	+/- Two (2) percent
19	Reproducibility	Half (1/2) percent
20	Rangeability	1:10
21	Connection	SCRD NPT
22	Accessories	a) Isolating valves (for Bypass type only) b) Bolts, Nuts and Gaskets as required
23	Tests	Shall be tested at two hundred (200) percent of the maximum process pressure

h) Sight Flow Indicators

S.No	Features	Essential / Minimum Requirements
1	Type / Construction	Flapper type.
	Materials	
2	Body	Carbon steel / SS316 as per process requirement
3	Glass	Toughened Borosilicate
4	Gaskets	Neoprene
5	Bolts & nuts	SS
6	Flappers / Rotating Wheel	316 SS
7	Flappers / Rotating Wheel holder	304 SS
8	Process Connection	SW (Socket Welded)
9	Accessories	Scale, Bolts, Nuts, Cover plates and Gaskets as required
10	Tests	Tested at two hundred (200) percent of the maximum Process pressure.

i) Solid Flow Meter

S.No	Features	Essential / Minimum Requirements
1	Type / Construction	Online Impact type Microprocessor Based
2	Measuring Principle	The system measurement is basically pertains to the measurement of horizontal deflection using LVDT, created by the impact of solid flow upon online sensing plate. The horizontal deflection being proportional to the impact forces, LVDT convert this horizontal movement into electrical signal. The inbuilt integrator convert this signal

The Bidder shall indicate system wise requirement of instrument air along with his proposal and same shall be included in the compressor capacity as supplied. Filter shall be of minimum 5-micron size & sintered bronze material.

On collection of water in the drains of instrument air lines, mechanical automatic drains and periodically solenoid operated drains (with electronic timer - 15m, 30m, 60m and 2 Hours & Timing adjustable) are to be provided.

For mechanical type & Electrical type, the locations to be provided in the instrument air lines of boiler area, Chimney area, turbine area etc., shall be decided during detailed Engineering.

Bulk header nearby the crowded applications shall be provided and from this bulk header individual air lines with necessary isolation values are laid to the application.

These bulk header are to be provided with mechanical / electronic based automatic Drains. Individual moisture separator for O2 analyser or vital application shall be provided nearby the instrument so as to enhance the cell life or the performance of vital final control elements.

2.3.3.7 Air Filter Regulator (AFR)

Air filter regulator along with gauges shall be provided in each of the

a. Air supply line to valve positioners / power cylinders
b. Air supply line to electric to pneumatic converters.
c. Air supply line to pneumatic interlocked block valves.
d. Constant bleed type AFR with an accuracy of + 1.0 % inlet pressure range of 5-10 kg/ cm2 and suitable spring ranges (AFR) for use with positioners in control valves, control damper, E/P convertors and shut off valves with sintered phosphor bronze filter element; Filtering particles above five microns. IP 65 Weather and water proof enclosure. Material of accessories will be SS316. Body material of filter regulator shall be Die Cast Aluminum or SS316.

2.3.3.8 Electro-Pneumatic Convertors (E/P)

Two wire type E/P convertors with an accuracy of +0.25% accepting 4-20 mA dc signals from control system and converting to 0.2 to 1 kg/cm2 air pressure to operate valve positioner of all final control elements; Housed in cast aluminium casing (with polyurethane paint); NEMA 4 or equivalent degree of protection for enclosure. Material of accessories will be SS. E/P convertors shall have fail freeze (stay put) feature also. Process connection shall be 1/4" NPT (F) and Electrical connection shall be ½" NPT (F). Zero/span adjustment facility shall be provided. The E to P converters shall **retain the pneumatic signal (last value) even in failure of control signal** and shall have **self volume boosters.** Necessary air lock devices and pressure switches for air pressure low alarming shall be provided.

2.3.3.9 Solenoid Valves

Solenoid valves shall be provided with control valves / pneumatic control valves hooked up with process interlock requirements and where direct tripping is involved. The number of ways for solenoid valve shall be provided as indicated below:

a. Two (2) way solenoid valves shall be provided, where process line of less than 50 mm with low pressure and temperature application.

b. Three (3) way solenoid valve shall be provided commonly, where the pressure is admitted or exhausted from a diaphragm valve or single acting cylinder, e.g., Pneumatic operated spray water block valve.

c. Four (4) way solenoid valve shall be provided for operating double acting cylinders, e.g., pneumatically operated on-off type dampers.

d. For operation of the fuel oil corner nozzle valves, fuel oil trip valves etc., double coil solenoid valve (latch coil & relatch coil) shall be adopted. Single coil usage requires always power and loss of power leads to closure of above valves resulting the unit trip or loss of generation.

e. Solenoid Valve coils shall be Class-H high-temperature or Class-F construction as applicable and shall be designed for continuous duty. Three-way solenoid valves shall be designed for universal operation so that the supply air may be connected to any port. Solenoid enclosures shall be NEMA-4)/ (Explosion proof for NEC Class-1, Division 1 area)/ flame proof (IEC-79.1, Part I) as applicable). Body material of solenoid valve shall be Brass or SS316 with epoxy paint as decided during engineering by owner. Material of wetted parts shall be SS316 only. Leakage class shall be class VI (Bubble tight)..

f. All solenoid shall be with Varistors, LED indication, surge suppress diode and circuits.

g. Solenoid valve shall operate on 24V DC, UPS 240V AC or 220V DC as per system requirements.

2.3.3.10 Power Cylinders (Pneumatic)

S.No	Features	Essential / Minimum Requirements
1	Mounting Type	a) Fixed position mounting (End mounting). b) Trunnion mounting
2	Control Signal	a) 0.2 to 1 Kg/Sq. cm. from I/P converter for modulating purposes. 24V/48VDC operated solenoid valve operating on pneumatic line. b) The Pilot solenoid will have separate coils for open closing purpose.
3	Supply Air	0-7 Kg / Cm2.
4	Selection	Based upon thrust / torque, stroke length, angular movement, full-scale travel time, repeatability, space factor etc. Provision for air-to-open and air-to-close

S.No	Features	Essential / Minimum Requirements
		operation.
5	Casing	IP-65.
6	Accessories (as required)	a) Air lock relay b) Hand wheel. c) Air filter regulator with gauge. d) Volume Booster. e) Limit Switches. f) Positioner with Input, Output and supply pressure gauges. g) Pilot Solenoid Valve (Double Coil type) h) Position Transmitter (4-20 mA DC linear output, LVDT or non-contact type).
7	Fail-safe operation	Stay put, open or close position on pneumatic / electrical power supply failure as per process safety criteria.
8	Repeatability	Better than 0.5% of full travel.
9	Hysteresis	Less than 1% of full travel.
10	Material	Internal part's material and material of accessories shall be SS316 only.
	In case of loss of mA signal. Manual adjustment shall be made through available manual knob and locked at required position for sufficient required process fluid flow.	

2.3.3.11 Non - Nucleonic (Vibration) type Density Meter (For DM Plant)

S.No	Features	Essential / Minimum Requirements
1	Type	Non - Nuclear type radiation
2	Application	Liquid Density measurement
	Detector	
3	Orientation	As per requirement
4	Case Material	SS 316/ Cast Aluminium alloy
5	Wetted part material	SS 316
6	Operating Principle	Vibration Density measurement
	Convertor	
7	Output	4-20 mA DC isolated.
8	Electrical Connection	½" NPT
9	Enclosure Class	IP 65
10	Local Display	Digital 5 digit, density display with temp. Compensation.
11	Accuracy	+/- 1%
12	Response time	< 1 minute
13	Power Supply	240 V AC, +/- 10%, 50 Hz. From UPS

2.3.3.12 Junction Box

S.No.	Features	Essential/Minimum Requirements
1	Type of Enclosure	Dust tight, Flame Proof / Weatherproof and Waterproof, generally conforming to IP 65.

S.No.	Features	Essential/Minimum Requirements
2	Material	16 SWG sheet steel hot-dip galvanized / Cast aluminium LM6.
3	Type of Cover	Solid unhinged with retention chain
4	Mounting	Indoor / Outdoor
5	Cable Entry	Downwards
6	Cable Glands	Double compression type – Nickel plated brass with PVC hoods.
7	Terminals	Phoenix / Wago (screw less cage clamp type spring loaded)
8	Gasket	Neoprene
9	Grounding	Two terminals for body and shield ground
10	Number of Drain Holes	Two at bottom capped.
11	Door	Hinged, lockable type
12	Color	In General same as provided for control panels, and for special services, To be decided during detailed engineering & subject to owner's approval.
13	Note: i. Suitable mounting clamps and other accessories shall be in scope of bidder. ii. The brackets, bolts, nuts, screws, glands, lugs required for erection shall be of brass, included in bidder scope of supply. High voltage & insulation resistance test shall also be conducted. iii. M6 Ni plated Brass earthing stud shall be provided (external 2 nos. internal 1 no.) iv. Gasket (Normal)- Neoprene thickness 6.0 mm	

2.3.3.13 Interposing Relays (IPR)

Electromagnetic type IPRs with modular design, plug-in type connections, suitable for channel/DIN rail mounting in cabinets; coil rating 24V D.C; 2 set of silver plated change over contacts rated for 0.5A 220 V DC/8 A 240 V AC. Freewheeling diode across relay copper coil and self reset type status LED indicator flag (electronic) shall be provided. Manual forcing/override facility is required. The test voltage for relay shall not be less than 4 KV with operating temperature from as per ambient temperature condition at site. The relay shall have the necessary approvals like V0 inflammability class in accordance with UL94", IEC60664/IEC60664A/DIN VDE 0110. Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing relay shall be of same make only.

The operating temperature of the Relay & Sockets shall be from –20 deg. C to 60 deg. C. The operating/release time of the relay shall not be more than 10/5 ms respectively.

The relay and DIN Rail sockets shall have the necessary approvals like UL/VDE and V0/V2 inflammability class in accordance with UL94", IEC60664/IEC60664A/ DINVDE0110.

Facility to stimulate IPR manually shall be provided. The VA burden of relays shall be suitable to match the capacity of output modules. Interposing relay & sockets for mounting the interposing

relay shall be of same make only and sockets shall have the plug in RC circuits/Varistors, required for EMI suppression.

2.3.3.14 Recorders (Chartless)

S.No.	Features	Essential/Minimum Requirements
1	Type	Micro-processor based, Digital TFT display type
2	No. of Channels	Six (6) Points & Forty Eight (48) point).(Simultaneous parameter display preferred)
3	Input Signal	Fully configurable multi range (Programmable) universal (input)
4	Recording method	Continuous with different colour, for each channel
5	Display colour	Desired display color using RGB value
6	Bar graph facility	To be provided
7	Digital indication	To be provided
8	Accuracy	+/- 0.1 % for reading for DCV Input And 0.1 Deg for TC/RTD input
9	Programmability	Front key board
10	Data Storage	hard disk/ Flash Memory
11	Data Retrieval	Compact 4 GB flash Memory card and USB port with 8 GB USB drive.
12	Scan rate	< 100 m secondor less for individual channel. Selection of scan time for individual channel is required.
13	No. of Alarm relays with change over Contacts	6 Nos
14	Backup Battery	To be provided.
15	Communication	Ethernet connectivity for remote viewing in PC & file transfers to PC
16	Software to be supplied along With instrument	Software required for data archives from chartless recorder through Ethernet, remote viewing in PC through Ethernet, file transfer through Ethernet to PC.
17	External Storage media	Compact USB flash drive & Compact flash memory card with high capacity to be provided.
18	Math Function	General Arithmetic function, Summation for each channel and group of channels, Statistical operations like Average Maximum, Minimum etc.,
19	Ethernet Cable with Connectors	50 metres for each recorder
20	For virtual memory of chartless recorder	Provision of Modbus Protocol and its communication interface card in Chartless recorders for reading/writing of measurements/data from third party system/ electronic modules through digital communication. The recorder shall carry 48 or More channels of virtual measurements through data communication from third party system/ electronic modules
21	Color laser Multi function printer	1 No. A3 size color laser Multi Function printer for Print, Scan & Copy for complete set. 1 No. lap top computer with necessary CR application software to integrate with CR

2.3.3.33 Push buttons (PB)/ ILPBs for ON/OFF, OPEN/CLOSE, START/STOP

S.No.	Features	Essential/Minimum Requirements
1	Type	Momentary/Miniaturized Suitable for mosaic grid 24x48 Mm with 2 PB and 3 coloured LED
2	Contact Configuration	2 NO + 2 NC
3	Contact Material	Hard Silver Alloy
4	Contact Rating	500V / 10 A
5	Insulation Voltage	2 KV for 1 minute between terminals and earth
6	Lamp Rating :- a) Voltage b) Watt	 240 V AC 2 Watt (approx.)
7	**Colour**	
	i. Red	ON/Start/Open ILPB, energized, running, Start, valve open LED/Lamp, OFF/Stop/Close PB, Emergency trip push buttons with red flap / hinged Transparent acrylic cover.
	ii. Green	OFF/Stop/Close ILPB, de-energized, stopped, valve closed LED/Lamp, ON/Start/Open PB
	iii. Light yellow	Abnormal, discrepancy LED/Lamp

2.3.3.34 Push Button for Control DESK

Momentary mosaic grid mounted 24x48 mm size, single PB 18x40 mm Colours for DESK RELEASE - Yellow, Desk Lamp test - Blue, Desk Acknowledgement – Green

2.3.3.35 Push Button for Sequence Start/Release

Momentary (Miniaturised) suitable for mosaic grid 24x48 mm3 PB + 5 LED

2.3.3.36 Push buttons for annunciation

S.No.	Features	Essential/Minimum Requirements
	Contacts	
1	Number & Type	As per requirement
2	Breaking capacity	1 Amp, 220V DC 10 Amp, 600V AC Different colours for Accept/Ack. - Green, reset Grey, Lamp test – Blue, System Test – Yellow & Audio Ack. - Black.

2.3.3.37 Hydrogen Gas System Instruments / Analysis

i) Hydrogen Gas Hygrometer

S.No.	Features	Essential/Minimum Requirements
A	Performance	

S.No.	Quantity of root valves	Size of stub and root valve	Service Condition
Pressure and Differential Pressure Measurement			
(i)	2	25NB	≥ 40 bar (g) OR 425^{0}C
(ii)	1	15NB	< 40 bar (g) AND 425^{0}C.
Level Measurement			
(a)	**Level Gauge & Switch**		
(i)	2	25NB	≥ 40 bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
(b)	**Level transmitter (displacement type)**		
(i)	2	40NB	>40 bar(g) OR 425^{0}C
(ii)	1	40NB	<40 bar(g) AND 425^{0}C
(c)	**Stand pipe for level measuring instrument**		
(i)	2	80 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	80 NB	< 40 bar(g) AND 425^{0}C
Flow Measurement			
(i)	2	25NB	≥ 40bar(g) OR 425^{0}C
(ii)	1	25NB	< 40 bar(g) AND 425^{0}C
Sampling system measurement (Steam and Water Service)			
(i)	2	25 NB	≥40 bar(g) OR 425^{0}C
(ii)	1	25 NB	< 40 bar(g) AND 425^{0}C

Wiring in the sampling section shall be routed in covered metallic trays located as distant as is practicable from sampling lines and drains with due care taken to isolate electric wiring, termination etc. from liquid areas.

2.3.5.9 Power Supply

Power supply to all instruments and control systems shall be separately fused with MCB and it should be possible to disconnect any instrument without interrupting power supply to any other equipment / device. UPS shall provide power supply to the complete SWAS system.

2.3.5.10 Lighting and Receptacles

Sample table and analyser section shall be provided with rapid start, low noise, fluorescent strip fixtures installed in a continuous row along the top of each section. The panel shall have a ceiling mounted LED lamps for illumination. Light switches shall be provided within the panel sections at suitable locations.

Universal type three receptacles shall be provided on the front of the sample table below the work surface. These will be equally spaced. Two more receptacles shall be provided inside the sample table and one receptacle shall be installed inside the panel.

Wiring for lighting and receptacles shall be run in flexible metallic conduits.

2.3.5.11 Grounding

One earthing terminal with accessories shall be provided at each end of strip for connecting G.I. earthing strip of 50 x 6 mm size.

2.3.5.11.1 Technical Specifications of Conductivity Analyser

S.No	Features	Essential / Minimum Requirements
a	Applicable standard	ASME PTC 19.11-1970 except as modified in this specification.
b	Type: i) Cell ii) Monitors	 Flow through type/ removable type (withdraw able with sealing valve) Electronic (Microprocessor based) indicating type with multi range facility
c	Material : i) Cell ii) Electrode iii) Monitors body	 Epoxy resin/SS316 Platinised/SS316 Carbon steel/Aluminium/Polycarbonate
d	Monitor output	i) 4-20 mA D.C. with HART protocol spare out put ii) 4-20mA DC with HART protocol for DDCMIS
e	Output load	500Ω

S.No	Features	Essential / Minimum Requirements
f	Power supply	240V AC, 50 Hz from UPS
g	Accuracy	+/- 1% of full scale span
h	Stability	+/- 1% of full scale per month non-cumulative
i	Repeatability	+/- 0.3% of span
j	Annunciation contacts from monitors	
	i) Number ii) Type iii) Rating	2SPDT Snap action micro switch 5 amp, 240 V, 0.2 Amp, 220V DC
k	Connection:	
	Cell	On line/pipe mounted (ON LINE in sample table) 1/4 (Quarter) inch NPT (F) SCRD for on-line type and Three quarter (3/4) inch NPT (M) SCRD for pipe mounted.
l	Monitors	Flush panel mounting
m	Electrical	Half (1/2) inch NPT (F) SCRD
n	Accessories	i) Automatic temperature compensation in the range 0-100°C ii)Ammonia (NH3) removal equipment. iii) Sample coolers iv) Flow and pressure regulators v) SS316 impulse tubing and fittings vi) Isolation & drain valves as required vii)Other accessories as required viii)Adequate length of cables for connecting coils to monitors ix) Sample rate set valves x) Alarm settings and Alarm indications on monitor.
o	Other particulars	i. Cell shall be suitable for maximum pressure of 7 kg / cm2 and maximum temp. of 100°C ii. For Hotwell conductivity (specific & cation) measurement, the bidder shall provide direct insertion/withdrawal type conductivity cell, whereas for all other samples it shall be continuous flow through type. iii. Monitors/transmitters for Hotwell conductivity (specific and cation) shall be shall be mounted in air conditioned room. iv. Dual cation exchange column shall be provided for cation conductivity.
p	Response time seconds	< 3 seconds

2.3.5.11.2 Conductivity comparator

S.No	Features	Essential / Minimum Requirements
a	Applicable standard	ASME PTC 19.11-1970 except as modified in this specification.
b	Type: i) Cell	Flow through type/ removable type (withdraw able with

	ii) Transmitter	sealing valve) Electronic (Microprocessor based) indicating type with multi range facility
c	Material : i) Cell ii) Electrode	 SS316 Platinised/SS316
d	Monitor output	i) 4-20 mA D.C. with HART protocol spare out put ii) 4-20mA DC with HART protocol for DDCMIS
e	Output load	500Ω
f	Power supply	240V AC, 50 Hz from UPS
g	Accuracy	+/- 1% of full scale span
h	Stability	+/- 1% of full scale per month non-cumulative
I	Repeatability	+/- 0.1% of span
J	Protection class	IP-65
k	Electrical Connection	½ inch NPT (F) SCRD
l	Process connection	¼ inch NPT (F) / SCRD for on line type. ¾ inch NPT (M) SCRD for pipe mounted
m	Accessories	Automatic temp. Compensation in the range of 0-100 Deg.C

2.3.5.11.3 Technical Specification of pH Cell and Transmitters

S.No	Features	Essential / Minimum Requirements
a	Applicable standard	pH electrodes shall conform to IS: 6804-1972 except as modified in this specification
b	Type: i. Cell ii. Monitors	 Measuring and Reference Electrode Combination with Flow through type (SS316/Polypropylene flow chambers) for power plant's steam & water application. Sensor shall not be affected by flow variation. Sensor shall be designed for power plant applications. Electronic (Microprocessor based) indicating type with multi range facility
c	Material : i) Measuring & reference ii) Electrode iii) Monitor body	 Toughened sensitive pH glass Carbon steel/Aluminium/Polycarbonate
d	Monitor output	i) 4-20 mA D.C. with HART protocol spare out put ii) 4-20mA DC with HART protocol for DDCMIS
e	Output load	500Ω
f	Power supply	240V AC, 50 Hz from UPS
g	Accuracy	+/- 0.03pH/+0.02pH%
h	Resolution	+/- 0.01 pH or 1 mV. 1C
i	Stability	0.02 pH per week
j	Annunciation contacts from monitors	
	i) Number ii) Type iii) Rating	2SPDT Snap action micro switch 5 amp, 240 V, 0.2 Amp, 220V DC
	Connection:	

S.No	Features	Essential / Minimum Requirements
k	i) Process	One-quarter (1/4)inch NPT(F) SCRD ON-LINE
	ii) Electrical	Half (1/2) inch NPT(F) SCRD
l	Mounting: a) Cell b) Monitors	 Pipe Mounted Flush panel mounting
m	Accessories	i) Automatic temperature compensation in the range 0-100°C ii) Co-axial cable as required iii) Sample coolers iv) low and pressure regulators v) Standard pH solutions vi) SS316 impulse tubing and fittings vii) Isolation & drain valves as required viii) Electrode holders ix) Other accessories as required x) Sample rate set valves xi) Alarm settings and indications on monitor. xii) RFI/EMI shielded, weather and corrosion proof casing

2.3.5.11.4 Technical Specification of Dissolved Oxygen Analyser

S.No	Features	Essential / Minimum Requirements
a	Applicable standard	ASME PTC 19.11-1970 except as modified in this specification.
b	Type	Microprocessor based Electro-chemical
c	Material	Die-cast aluminium/SS/Polycarbonate
d	Monitor output	i) 4-20 mA D.C. with HART protocol spare out put ii) 4-20mA DC with HART protocol for DDCMIS
e	Output load	500Ω
f	Power supply	240V AC, 50 Hz from UPS
g	Accuracy	± 5 % of reading
h	Response	
	i. Sensitivity	+ Two (2) per cent overall
	ii. Time(Sensor)	Less than 30 seconds for 90% step change.
i	Process connection	One quarter (1/4) inch NPT(F) SCRD
j	Electrical	Half (1/2) inch NPT (F) SCRD
k	Accessories	i) Sample cooler assembly with shut off valve at cooling water inlet, with thermometer and reducing valve at sample outlet. ii) Flow stabilizer iii) Automatic temperature compensation iv) Other accessories as required v) Calibration device.
l	Ranges	As per sample stream detail table
m	Mounting	Flush
n	Annunciation contacts i) Number	 2 SPDT

S.No	Features	Essential / Minimum Requirements
	ii) Type iii) Rating	Snap action micro switch 5 Amp 240V AC, 0.2 amp 220V DC

2.3.5.11.5 Technical Specification of Silica Analyser (SI OX)

S.No	Features	Essential / Minimum Requirements
a	Applicable standard	ASME PTC 19.11-197 except as modified in this specification
b	Cell Type:	Multi-Channel (max of each Three channel) Colorimetric Analyser (with auto reagent shut off feature in case of sample loss or power loss) built in phosphate inhibition feature. Microprocessor based variation. Sensor shall be designed for power plant applications.
c	Case Material	Die cast aluminium
d	Cycle/Response Time	Twelve (12) minutes Maximum
e	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
f	Power Supply	240V AC, 50 Hz from UPS
g	Accuracy	+/- 1% of span
h	Repeatability	+/- 2% of full scale
i	Sensitivity	0.2 micrograms/litre
k	Connection:	
	i) Process ii) Electrical	Quarter (1/4) inch NPT(F) SCRD Half (1/2) inch NPT (F) SCRD
l	Ranges	As per sample stream detail table
m	Mounting	Flush
n	Annunciation contacts:	
	i) Number	2 SPDT
	ii) Type	Snap action micro switch
	iii) Rating	5 amp 240V AC 0.2 Amp 220V DC
o	Accessories	i) Automatic temperature compensation between 5 to 50 deg C ii) Automatic zeroing provision iii) SS316 tubing & vessels iv) All chemical reagents for 12 months operation of the analyser v) Sample rate set values vi) Comprehensive diagnostic and alarm features. vii) Auto sampling facility with necessary valves & solenoids in the sample lines shall be provided.

2.3.5.11.6 Technical Specification of Hydrazine Analyser

S.No	Features	Essential / Minimum Requirements
a	Type	Microprocessor based Electrochemical
b	Case material	Die-cast aluminium/SS/Polycarbonate
c	Analyser output	i) 4 to 20 m Amp DC for spare output

		ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
d	Power Supply	240V AC, 50 Hz from UPS
e	Accuracy	± 2% of span
f	Response Time	<4 minutes
g	Sensitivity	1.0 micrograms/litre
h	Annunciation contacts: i. Number ii. Type iii. Rating iv. Mounting	 2SPDT Snap action micro switch 5A 240V AC, 0.2 A, 220V DC Flush mounting
i	Accessories	i) Flow regulator ii) Flow gauges iii) Other accessories as required iv) Sample rate set valves v) Chemical reagents as applicable for 12 months consumption

2.3.5.11.7 Technical Specification of Sodium Ion Analyser

S.No	Features	Essential / Minimum Requirements
a	Type	Microprocessor based Continuous flow through sample type with sodium responsive electrode and reference electrode having pH adjustment facility (Max 3 streams)
b	Case material	Die-cast aluminium/SS/Polycarbonate
c	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
d	Power Supply	240V AC, 50 Hz from UPS
e	Accuracy	Better than ± 5% of full scale
f	Response Time	6 minutes max
g	Sensitivity	0.1 ppb
h	Annunciation contacts: i. Number ii. Type iii. Rating iv. Mounting	 2SPDT Snap action micro switch 5A 240V AC, 0.2 A, 220V DC Flush mounting
i	Terminal points	All components piped & wired to terminal points
j	Accessories	i) Flow regulator ii) Flow gauges iii) Other accessories as required iv) Sample rate set valves v) Chemical reagents as applicable for 12 months consumption

2.3.5.11.8 Technical Specification of Phosphate Analyser

S.No	Features	Essential / Minimum Requirements
a	Type	Microprocessor based Continuous flow through sample

S.No	Features	Essential / Minimum Requirements
		type with colorimetric detection system (Max 3 streams)
b	Case material	Die-cast aluminium/SS/Polycarbonate
c	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
d	Power Supply	240V AC, 50 Hz from UPS
e	Accuracy	Better than ± 4% of full scale
f	Sensitivity	Better than 1 ppm
g	Annunciation contacts: i. Number ii. Type iii. Rating iv. Mounting	 2SPDT Snap action micro switch 5A 240V AC, 0.2 A, 220V DC Flush mounting
h	Terminal points	All components piped & wired to terminal points
i	Accessories	i) Flow regulator ii) Flow gauges iii) Other accessories as required iv) Sample rate set valves v) Chemical reagents as applicable for 12 months consumption

2.3.5.11.9 Technical Specification of Chloride Analyser

S.No	Features	Essential / Minimum Requirements
a	Type	Microprocessor based Continuous flow through sample type.
b	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
c	Power Supply	240V AC, 50 Hz from UPS
d	Accuracy	Better than ± 10% of full scale
e	Sensitivity	Better than 1 ppm
f	Annunciation contacts: i. Number ii. Type iii. Rating iv. Mounting	 2SPDT Snap action micro switch 5A 240V AC, 0.2 A, 220V DC Flush mounting
g	Terminal points	All components piped & wired to terminal points
h	Accessories	i) Flow regulator ii) Flow gauges iii) Other accessories as required iv) Sample rate set valves v) Chemical reagents as applicable for 12 months consumption

2.3.5.11.10Technical Specification of Chlorine Analyser

S.No	Features	Essential / Minimum Requirements
a	Type	Microprocessor based Continuous flow through sample type with automatic temperature compensation.
b	Analyser output	i) 4 to 20 m Amp DC for spare output ii) 4 to 20 m Amp DC Isolated output for DCS/PLC
c	Power Supply	240V AC, 50 Hz from UPS
d	Accuracy	0.005 mg/ltr. or 1% of range.
e	Sensitivity	0.001 mg/ltr. (1 ppb)
f	Range	As per schedule
g	Annunciation contacts: i. Number ii. Type iii. Rating iv. Mounting	 2SPDT Snap action micro switch 5A 240V AC, 0.2 A, 220V DC Flush mounting
h	Terminal points	All components piped & wired to terminal points
i	Accessories	i) Flow regulator ii) Flow gauges iii) Other accessories as required iv) Sample rate set valves v) Chemical reagents as applicable for 12 months consumption

2.3.5.11.11 Technical Specification of Residual Chlorine Analyser

S.No	Features	Essential / Minimum Requirements
Sensor		
a	Method	Amperometric
b	Electrodes	Gold Cathode/Silver Anode
c	Cell Material	PVC
d	Electrolyte	Potassium Bromide
Transmitter		
a	Type	Microprocessor Based with self diagnostic features
b	Transmitter Output	4-20mA DC
c	Enclosure Protection	IP – 65
d	Enclosure Material	Polyester coated AL.
e	Electrical Connection	: ½" NPT (F)
f	Mounting	Field
g	Display Type	LCD
h	Display Details	4 digit backlit LCD matrix
i	Diagnostics	Required
j	Meter Range	0-1 mg/l
k	Resolution	0.01 ppm
l	Area Classification	SAFE
m	Electromagnetic Compatibility	Built in
n	Temp. Compensator	Auto built in
o	Temp. Compensating element	PT 100

CHAPTER-12

FLOW ELEMENTS

12.00.00 This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR'S/SUB-VENDOR'S WORKS and delivery to site of Flow Elements.

The equipment furnished to this specification shall conform exactly to the requirements herein, unless modified by the respective Data Sheet of the equipment.

12.01.00 The design, material, construction features, manufacture, inspection and testing of flow elements shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the Bidder of this responsibility.

12.02.00 Technical Requirement

316SS long radius, weld in flow nozzles with D and D/2 pressure tapings; 316SS flow orifice plate assembly with flange tap connections; β ratio of 0.4 to 0.7. Element material of SS 316. The material of Flow nozzle shall be A182F91, where pipe material is A335P91. The material of all type of accessories will be SS316. End connections for flow elements will be butt welded except orifice plate on condensate return line to CST, which will be flanged. The accuracy of the flow element shall be $\pm$ 0.5% or better.

Standards

The flow elements (Orifice plates) shall be designed in accordance with ASME PTC – 19.5 (Pt – II), ISA RP3.2, 1960 or BS 1042/ISO 5167.

The flow elements (Flow Nozzles) shall be designed in accordance with ASME PTC – 19.5 (Pt – II), or BS 1042/ISO 5167.

Construction and installation of flow nozzles and orifices shall conform to the requirements of ASME Performance Test Code PTC-19.5 as mentioned above and discharge coefficients shall be predicted in accordance with data published in ASME Research Report on Fluid Meters.

Flow nozzles shall be provided for critical measurements where weld-in construction is required. Flow nozzles shall be made with quater, triple or dual sets of pressure taps installed in the pipe wall where required considering spare one set of pressure tap. Installation of flow nozzles and pressure taps shall be made in the pipe fabricator's shop.

Anubars shall be used where pressure loss is critical and/or conditions permit their reliable installation.

Concentric orifice plates shall only be provided for other flow measurements where flanged construction and higher pressure losses are acceptable. Orifice plates shall be

made of stainless steel. Orifice flanges shall be of the raised face weld neck type with dual sets of taps. Thickness of Orifice plate shall be 3 mm for pipe diameter up to 300 mm and 6 mm for pipe diameter above 300 mm.

Coriolis principle based mass flow meters shall be used for flow (mass & volume) measurement of liquid fuel.

Aerofoil/ Venturi tubes shall be provided for Air flow measurement.

Flow element shall be accompanied by IBR certification. Hydraulic test pressure shall be considered 1.5 times of design pressure at normal temperature.

SS nameplate to flow elements shall include Tag no/ KKS No./Sl. No./ Body Material/Beta ratio/line size & thickness/ direction of flow.

BIDDER to ensure that maximum pressure drop/loss shall be limited to 30% of Differential Pressure for flow Nozzle & 60% of DP for Orifice plate.

12.03.00 **ANNUBAR/Averaging Pitot tube**

Type/Construction	:	Averaging Pitot tube with direct mounting type on pipe
Materials	:	
Body	:	SS316
Nipple	:	SS316
Gaskets	:	Teflon
Bolts & nuts	:	SS316
Flange	:	SS316
Process Connection	:	1 ½" Flanged
Instrument connection	:	½" NPT (F) through needle valve
Differential range	:	(To suit the accurate flow)
Accessories	:	Bolts, Nuts, Cover plates, Adapter and Gaskets SS tag plate as required
Tests	:	Tested at two hundred (200) percent of the Maximum process Pressure

12.04.00 **Aerofoil**

Materials	:	As per IS 2062 in line with Duct material
Accuracy	:	+/- 1to2%
Repeatbility	:	+/- 0.1% to 0.2%
Type of tappings	:	Total 4 pairs of tapings (3 pairs of tapings with stubs & 1 spare pair plugged)
Tap size	:	½" SW
End connection	:	Flanged with mating flange
Beta ratio	:	0.4 to 0.7
Accessories	:	SS tag plate, nuts, bolts, packing & hardware, etc.
Standards	:	ASME PTC – 19.5 (Pt - II), or BS 1042/ISO 5167

~~Pressure Loss : <20% of DP~~

12.05.00 PERFORMANCE

The Bidder shall submit type test certificate from a recognized test house certifying evaluation of construction standard, accuracy of calibration.

12.06.00 TESTS AND INSPECTION

All equipment. components shall be individually tested to ensure correct functioning. Following tests shall also be conducted:

a) Calibration test
b) Dimensional check
c) Material test

Wet calibration shall be carried out as on each size and design of flow element as per ASME PTC or BS 1042/ISO 5167. The other tests shall conform to ASME-PTC 19.5. The Bidder shall submit the reports for all the tests carried out for Owner's review and records. The functional test shall also be witnessed by owner as per approved QAP.

CHAPTER-10

CONTROL VALVES WITH ACTUATORS

2.3.10 Control Valves, Actuators and Accessories

2.3.10.1 General Requirements

This section covers the design and construction requirements of Control Valves, their Actuators and Accessories. Except as otherwise specified herein, the Control Valves and accessory equipment furnished under this specification shall be designed, constructed and tested in accordance with the latest applicable requirements of code for Pressure Piping ANSI B31.1, the ASME Boiler and pressure vessel code, Indian Boiler Regulation (IBR) and other standards referenced herein as well as in accordance with all applicable requirements of the "Federal Occupational Safety and Health Standards, USA", or acceptable equal standards.

The design of Control Valves shall comply with relevant codes and standards, account for relevant design criteria viz. environmental conditions, power and air supply, established reliability (reliability target and life expectancy), design of enclosures as specified in Sections earlier.

All Control Valves and accessories furnished under the Section shall be of owner approved make, fully meeting the qualifying requirements.

Each control valve station shall be provided with pneumatic bypass control valve or Inching type motorised bypass valve as per process requirement and subject to owner approval. In addition each control valve shall also have upstream motorised valve. Downstream motorised valve shall also be provided as per process requirement and as finalized during detailed engineering.

2.3.10.2 Control Valve Construction and Sizing

1. Valve Construction shall be in accordance with the requirements specified herein. (Bidder to also refer tender drawing no: LII-GEOE15066-I-45986-001).

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

3. The valve sizing shall be suitable for obtaining maximum operating conditions with valve opening at approximately 80% of total travel. Valves shall be open not less than 15 % of full opening for minimum flow condition and shall be capable of handling at least 120% of the required maximum flow at full open condition. Actual pressure drop is indicated in the specification sheets. Permissible pressure drop shall be calculated and used by the Bidder for sizing calculations. Valve sizing shall be in compliance with the latest edition of ISA Handbook on control valves, ISA standards “ANSI/ISA-75.01.01, Flow Equations for Sizing of Control Valves” with due consideration for the measures to avoid choked flow. Bidder shall ensure

that the valve outlet velocity does not exceed 8 meters/second for liquid services, 150 m/second for steam services and 50% of sonic velocity for flashing services by selecting proper body size for the required Cv.

a. The Bidder shall provide valves designed to prevent capitations, wire drawing, flashing on the downstream side of valve and in downstream piping, when operating through full range under the specified conditions. For cavitation services, valves with anti cavitation trims shall be offered. This shall ensure cavitation prevention by multiple stages of pressure drops. Detailed calculations shall be furnished by bidder to establish cavitation occurrence or otherwise for various process conditions each service wise.

b. For flashing services such as heater drains, control valve design shall be specially effected to ensure suitability for the adverse high pressure drops and minimise its detrimental effects on control valve parts. Bidder shall furnish detailed catalogue, calculations, write ups to establish compliance to these stipulations with the selection of each valve. No price implications during engineering stage would be admissible to comply with these stipulations and intents of specification.

c. The Liquid pressure recovery factor (FL) shall be 0.995 or better for severe flashing/cavitation services.

d. The Liquid pressure recovery factor (FL) shall be 0.985 or better for low flashing/cavitation services.

4. Each valve shall be designed for tight shut-off against pressure, the valves shall have maximum permissible leakage rate as per ISA RP 39.6 Leakage Class IV (0.01% of rated valve capacity) or specified otherwise. Control Valves for Application such as HP/LP heaters emergency level control, SH spray & RH Spray control, Emergency makeup to Hot well, Deaerator drain to condenser hot well & heavy oil heating, HFO & LDO and Pressurizing control system, condenser normal make up control valve shall have permissible leakage rate as per leakage class V (ANSI/FCI). All SH/RH block valves, shut off valve of LDO & HFO and BFP recirculation valve shall have leakage class MSS-SP-61.

5. The valve design shall take into account noise abatement considerations. The design objective will be to limit the generation of valve induced noise to 85 dBA at 1 Meter from the valve surface under actual operating conditions. The noise abatement shall be obtained by valve body and trim design and piping arrangement and not by the use of silencers.

6. The Bidder shall be responsible for proper sizing of the valve and selection of appropriate model and materials of constructions for meeting the operating requirements specified herein and details subsequently furnished during the detailed engineering stage.

7. The valve travel time shall be less than 10 second for non critical services valves.

8. Rangeability should be 50 to 1 (min.) for non critical services valves.

9. Control Valve's Linearity, Hysteresis, Accuracy shall be < +1% and Sensitivity shall be < + 0.5%.

10. Bidder shall furnish the Control Valve data sheets and sizing calculations with the proposal which will be subjected to owner approval during detailed engineering. The bidder shall furnish all valves as per owner approved data sheets and drawings.

2.3.10.3 Valve Construction

1. All valves shall be of globe body design and straightway pattern. Straightway pattern valves shall be either single or double ported as specified. Double ported and single ported valves shall have high lift cage guided plugs, unless otherwise specified.

2. Where specified, valves with cage guided plugs and quick change trim shall be supplied. The quick change trim shall consist of a cage and seat ring clamped in the valve body by the valve bonnet and sealed with a spiral wound stainless steel asbestos gasket. The trim shall be removable through the top after bonnet removal without any cutting or welding of the valve. Where applicable, plugs shall be designed to include pressure balancing for cage guided valves.

3. Direct acting and self-contained pilot type valves may have low lift plugs.

4. Cast iron valves are not acceptable.

5. Bonnet joints for all control valves shall be of the flanged and bolted type or other construction acceptable to the owner. Bonnet joints shall be designed for easy disassembly and for assurance of correct valve stem alignment. Bonnet joints of the internal threaded or union type will not be acceptable.

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

7. When Teflon packing is used, the lower valve stem which passes through the stuffing box shall be polished to at least 2x10-4 millimeters r.m.s.

8. Valves gland packing shall normally be Teflon on liquid and gas services up to 100kg/cm2 and 230 Deg.C Teflon impregnated asbestos shall be used above 230 Deg.C and graphite impregnated asbestos with lubrication shall be used for steam services.

9. All valves shall be arranged so that the plugs may be removed from the valve bodies from the bonnet side.

10. Each valve shall have an arrow permanently fixed on the valve body to indicate the correct direction of flow.

11. Each valve shall have a stainless steel name plate permanently fastened to the yoke which shall be visible when the valve is in service. The name plate shall include

a. Tag No. and Valve Serial No.
b. Body material, size and pressure rating
c. Trim material, size characteristics
d. Action on air failure
e. Spring range
f. Stem travel
g. Valve action, etc.

2.3.10.4 Valve Materials

a. Valve material shall be as specified in suppliers approved Control Valve Specification sheets. The following table defines abbreviations used for valve materials:

S.No.	Abbreviations	Description
1	BR	Bronze ASTM B 61
2	CS	Carbon Steel Forged - ASTM A 105 Cast - ASTM A 216 Grade
3	1- ¼ CR	1-1 / 4 % Chromium Alloy Steel Forged – ASTM A 182 Grade F11 Cast – ASTM A 217 Grade WC6
4	2- ¼ CR	2-1 / 4 % Chromium Alloy Steel Forged – ASTM A 182 Grade F22 Cast – ASTM A 217 Grade WC9
5	5 CR	5% Chromium Alloy Steel Forged – ASTM A 182 Grade F5 Cast – ASTM A 217 Grade C5
6	SS	Stainless Steel AISI Type 316 ASTMA 351 Grade CF8M

b. Body material shall be selected by the Bidder to be compatible with the nature of the fluid, service conditions, and piping material to which it is welded and shall be subjected to Owner approval. In general, cast or forged carbon steel bodies shall be provided for non-corrosive process applications up to 275 Deg.C. Alloy Steel castings shall be provided when the media is non-corrosive and the temperature exceeds 275 Deg.C and is within 550 Deg.C. Stainless Steel of suitable grade shall be provided when media is corrosive and the temperature is below 300 Deg.C.

S. No.	Service	Body Material
1.	Non Corrosive, Non Flashing, and non cavitation Service for process temp. up to 275 deg. C like Aux. steam flow to Deaerator, Cond. Flow to Deaerator, Fuel Oil, Atomising steam service etc.	Cast Carbon Steel ASTM A216 Gr. WCB / WCC

2.	Non Corrosive, Non Flashing, and non cavitation Service for process temp. above 275 deg. C. and up to 550 deg. C. and for CRH flow to Deaerator.	Cast Alloy Steel ASTM A217 Gr. WC9
3.	Severe Flashing / cavitation service like Feed Control Valve, Spray Control valves, LP / HP heater emergency level control valve, HP BP spray control valve, Deaerator Overflow control valve etc.	Cast Alloy Steel ASTM A217 Gr. WC9
4.	Low Flashing / cavitation service like LP / HP heater normal level control & Condensate / feed water below 275 deg. C.	Cast Alloy Steel ASTM A217 Gr. WC6
5.	DM Water Application (Condenser Hot well normal & Emergency make up etc.)	Cast type 316 Stainless Steel ASTM A351Gr. CF8M

c. Unless otherwise specified, all control valves shall have stems, guide bushings, plugs, seat rings, stem lock pins, stuffing box parts, and other trim, all made of stainless steel. Valve guide posts and bushings shall be stellited faced for valves where specified. Stellate faced guide posts and bushings shall be differential hardened. For applications involving high pressure drop as also for flashing and cavitation services, trim material shall be properly chosen to ensure required degree of hard facing (such as17-4 PH SS) so as to avoid erosion.

S. No.	Service	Trim Material
1.	Non Corrosive, Non Flashing, and non cavitation service for process temp. up to 275 deg. C. like Aux. steam flow to Deaerator, Cond. Flow to Deaerator, Fuel Oil, Atomising steam service etc.	SS316 Stellited
2.	Non Corrosive, Non Flashing, and non cavitation service for process temp. above 275 deg. C. and up to 550 deg. C. and for CRH flow to Deaerator.	SS316 Stellited
3.	Severe Flashing / cavitation service like Feed Control Valve, Spray Control valves, LP / HP heater emergency level control valve, HP BP spray control valve, Deaerator Overflow control valve etc.	440 SS
4.	Low Flashing / cavitation service like LP / HP heater normal level control & Condensate / feed water below 275 deg. C.	17-4 PH SS
5.	DM Water Application (Condenser Hot well normal & Emergency make up etc.)	17-4 PH SS

d. Where stellate facing is not specified, hardened stainless steel shall be furnished for all surfaces subject to wear.

e. Manufacturer recommended materials for cage guided valves may be substituted for materials specified provided they satisfy the specified service conditions. Also where substitutions are made, the manufacturer shall guarantee performance of recommended materials to be equal to or better than the specified materials for conditions specified. Bidder may offer valve with body and trim material better than the specified material and in such case, bidder shall furnish the comparisons of properties including cavitation resistance,

corrosion resistance, temp. resistance, erosion resistance, hardness etc. of the offered material vis a vis specified material for owner approval.

2.3.10.5 End Preparation

a. Valve body ends shall be butt-welded type.

b. Flanged ends shall be of a pressure class equal or greater in pressure-temperature rating to the body design pressure and temperature indicated on the control valve. Unless otherwise specified, steel flanges shall be raised face type. Flanged ends for valves shall be in accordance with ANSI B 16.5.

c. Welded end for control valves where specified shall be socket-weld per ANSI B 16.11 for control valves of sizes 50 mm (2") and below and Butt welded connections per ANSI B16.25 for control valves 65 mm (2-1/2") and above. The end preparation for butt welded control valves shall be matched to the corresponding details for the piping on which the valve is installed.

d. All end preparations shall be as per Owners requirements indicated during Contract stage.

2.3.10.6 Miscellaneous Parts

a. Extension bonnets shall be used on all valves when the maximum temperature of the flowing fluid is greater than 275 deg. C or when specifically required in the control valve.

b. Stem travel indicators shall be provided on all valves.

2.3.10.7 Valve Operations

a. All control valves shall be furnished with pneumatic spring opposed diaphragm, spring less diaphragm, or piston operators as specified herein. The bidder shall be responsible for proper selection and sizing of valve operators in accordance with the pressure drop and maximum shut-off pressures.

b. Valve operators and stems shall be adequate to handle the unbalanced forces occurring under the specified flow conditions or the maximum differential pressure specified. An adequate allowance of stem force, at least 0.15 kg/sq. cm per linear millimetre of seating surface, shall be provided in the selection of the operator to assure tight seating unless otherwise specified. The operators shall be designed to produce the required stem force with supply air pressure of 3.5 kg/sq. cm maximum unless otherwise specified.

c. Diaphragms shall be moulded synthetic rubber and diaphragm housing shall be of pressed steel construction. Diaphragms shall not be fabricated of natural rubber. Piston operators shall use cast pistons and cylinders with 0-ring seals. Operators shall be supplied with name plates which indicate the diaphragm air pressure at full open and full closed positions. For single

seated valves the pressures shall be listed for maximum differential and for zero differential across the valve.

d. Pistons and cylinders shall be cast aluminium. Piston rod and extension shall be chrome plated stainless steel. Cylinder seal bushings shall be brass and seal rings shall be nitrile. Yoke shall be cast iron. Valve operators shall be capable of operating at 60 °C continuously.

2.3.10.8 Control Valve Accessories & Devices

The following accessory equipment shall be provided for control valves:

i) Air Locks:

Air locks shall be designed to shut off the diaphragm loading airline if the supply air pressure to the associated pilot or Positioner fails. Air locks shall be of the automatic reset type and shall be furnished with alarms.

ii) Hand Wheels:

Hand Wheels shall be provided. Hand wheels shall be side mounted unless specified to be top mounted. However the mounting shall be as decided during engineering to offer maximum accessibility.

iii) Limit Switches:

Each control Valves shall be provided with limit switches for monitoring of end position in DDCMIS/DCS. Switches shall have not less than two normally open and two normally closed contacts in both open and close directions. Electrical rating of the limit switch contacts shall be 240V AC, 5 amp or 220V DC, 0.5 amp. Limit switches should be National Acme Co., or Honeywell micro switch type or owner approved equal. The enclosures of the limit switches shall be as per NEMA-4 Standard. Limit switches shall be constructed to withstand the temperatures encountered in the actual service. Explosion proof construction shall be furnished where required by applicable code or these specifications. Limit switches shall be factory mounted on the valves with provisions for adjusting the mounting. The Bidder shall stroke the valves to check limit switch operation prior to shipment. Limit/micro switches can be offered as an integral part of Smart valve positioner.

iv) Smart Valve Positioner:

Control valve actuators for modulating and throttling services shall be provided with HART protocol based smart electro pneumatic valve Positioner to ensure accuracy & repeatability of response. The valve Positioner shall be designed suitable for vibration and service conditions of a steam electric power station. The Positioner shall have the following features:

a. Shall provide a pneumatic output signal of range 0.2 to 1.0 kg/cm^2 or as desired for the actuator.
b. Shall have integral type position transmitter, input & output gauges, local keypad, display, 4-20 mA input and 4-20 mA output for position indication in DDCMIS/CCR.
c. Shall be suitable for direct mounting on control valve assembly both for rotary & linear valves.
d. Shall be capable of functioning under hot, humid & vibrating conditions.
e. Shall have dust tight, corrosion resistant & weather proof IP 65 metal casing.
f. Shall be operated at signal range of 4-20 mA for full travel of the valve. Split range operation in few case may be required. This facility shall also be available in positioner.
g. Shall have in built mechanical position indicator.
h. Shall have fail safe & fail freeze function as per loop process requirement.
i. Shall have in built auto tune facility.

v) Solenoid Valves:

Solenoid Valve will be provided for the following

1. ON / OFF Duty type Control Valve
2. For over-riding the controller signal with Modulating type Control valves.
3. For control valve stay put position requirement on controller signal failure with Modulating type Control valves.
4. For construction and detailed specification of Solenoid valve, Chapter 3, Vol. II shall be referred by bidder.

vi) Diffusers:

Diffusers shall be provided as per service application requirements. The diffuser shall be designed to reduce the pressure drop across the control valve below the critical value and reduce the sound pressure level. Details of the diffusers shall be submitted.

vii) External Volume Chambers:

External volume chambers with adjustable bleed valves shall be provided for Control Valve. Volume chambers shall be furnished, mounted on the control valve yoke assembly.

viii) Position Transmitters:

Position transmitters shall be provided for control valves as a part of smart positioner. The signal shall be 4-20 mA DC range, 24 V DC. For non smart positioners applications and power cylinders, contact less position transmitter shall be provided by bidder.

ix) Tubing and Air Sets:

All pneumatic tubing required to interconnect devices assembled together shall be furnished complete with each control valve. The tubing shall be fully annealed soft temper copper tubing conforming to ASTM B68 to B75 (USA). Swagelok flare less tubing fittings shall be used for tubing connections (Swage lock or approved equal).

Each device requiring an air supply shall be equipped with a combination filter-regulator. Devices mounted together on a valve yoke may be served by a single regulator, provided the supply pressure is satisfactory and the regulator capacity is not exceeded. Filter-regulators shall be mounted on the device served. Filter- regulators shall be suitable for a 10 kg/sq. cm maximum inlet pressure. Filter- regulators shall have built-in housing blow down valves and a 2 inch pressure gauge. The filter shall be have size not more than 5 microns and shall be made of sintered bronze.

x) Pressure Switch

Pressure switch suitable for the above the pneumatic system shall be provided. The contact rating shall be 2 A for 240 AC, .2 A, 220 VDC 2 SPDT Contact. Enclosure IP 65.

xi) I/P Converter

For non smart positioners applications and power cylinders I/P converters shall be required and owner approval shall be obtained for the use of I/P converter for such applications.

Electro pneumatic, outdoor type, field mounted Linear. 4-20 MA DC input and 0.2 – 1.0 kg/Cm2 output. Die cast aluminium casing with IP65 or equivalent enclosure class. Accuracy of + 0.5% of span or better and repeatability of + 0.5% of span or better will be provided. Easily accessible span and zero adjustment will be provided I/P converter shall be provided with all accessories and erection hardware. The I to P converters shall retain the pneumatic signal (last value) even in failure of control signal and shall have self volume boosters.

Separate moisture separator unit for ensuring dryness of air entering I/P as well as the power cylinder is to be supplied with each control valve and control damper.

2.3.6.6 Local Instrument Racks & Enclosure

Transmitters and switches located in the field shall be grouped together and shall be installed in the enclosure (closed transmitter racks) in case of outdoor area such as Boiler area etc. And in open type Rack in case of covered area. Racks shall be factory prefabricated & painted and complete with internal tubing, manifold valve, isolation valves, integral junction boxes with outside access door, illumination etc. Racks used for furnace, flue gas and air application shall be provided with intermittent & continuous air purging.

i) Closed Type Instruments / Transmitter Racks

a) Required number of Instruments / transmitter racks shall be furnished to house transmitters, switches and converters by grouping them suitably, area wise / function-wise.

b) The transmitter enclosure shall be constructed of 3 mm thick steel plate. The enclosures shall preferably be of modular construction and with two end plate assembly bolted to the frame.

c) The enclosure shall approximately be 1200 millimetres wide, 1000 millimetres deep and 2200 millimetres high to allow easy access to the internals. Racks shall be reinforced as required to ensure true surfaces and to provide adequate support for instruments and equipment mounted therein. Double interlocking doors with three point locking arrangement shall be provided and shall be arranged for maximum possible access to the interior. Centre posts or any member which would reduce access shall not be provided.

d) Doors shall have concealed quick removal type pinned hinges and locking handles. Doors locks shall accept the same key all over the plant. Neoprene material Gaskets shall be used between all mating sections to achieve dust proof enclosure rating for the modules and an IP-65 waterproof and dust tight rating on the terminal boxes. All Enclosures shall have access doors on front side.

e) Bulkheads, especially designed to provide isolation from process line vibration shall be installed on modular bulk head plates of the transmitter enclosures to meet the process sensing line connection requirements. Removable top and bottom plates shall be furnished.

f) All internal wirings and / or data bus connections, if any, between the transmitters and terminal junction box shall run through flexible dust tight conduits connected to the terminal box hub. No exposed wirings within transmitter racks, both open and closed type, is admissible.

g) All racks shall have a common closed drain trough to connect transmitter drain points to a common header after suitable pressure breaking. Covered funnels shall be used for saturated liquid and steam service, whereas, open funnels may be used for cold liquid services. The trough shall be suitably sloped and shall have one end flanged and extending beyond the rack for connection to plant drain header.

h) Vibration dampeners shall be installed for supporting each enclosure. The loading at each corner of the enclosure shall be determined by actual test weighting when construction is complete to determine the correct length of each dampener for proper loading of the dampener in accordance with owner's recommendations.

i) Service Power and Lighting

Each enclosure shall be provided with universal type power receptacle, light fixture & LED lamps with wire guard and lighting switch etc. Lighting switches shall be door actuated & mounted inside the panel. Outlet box, switch box and device covers shall be of galvanized stamped steel. Light switches and power receptacles shall be installed inside the enclosure on the wall near the latch side of the enclosure door. Light fixtures shall be installed on the ceilings of the enclosures.

Power Supplies for miscellaneous devices shall be provided with 2P MCB located within the enclosures. MCB shall be mounted in Fuse blocks. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

j) Control Air

A control air supply header shall be furnished in each enclosure having pneumatic devices. The header shall be 25 MM NB brass header stock drilled and tapped for 8 millimetre valves.

A valve with double compression end fittings shall be installed in each tap. Not less than three spare connections shall be furnished in each enclosure. The air header shall originate at a bulkhead penetration or fitting located in one of the bulkhead plates. Each pneumatic instrument shall have individual air shut off valve.

Pressure reduction shall be achieved by air filter regulator sets. One filter regulator shall be furnished for each group of components making a system.

k) Service Air

A 15 mm NB service air header shall be furnished in each enclosure housing draft and coal mill instruments. The header shall be furnished complete with a pressure regulating valve, pressure gauge and valve quick disconnect connections. A hose for connecting each header to the draft instrument line four way valve shall be furnished. The hose shall be self-storing nylon tubing having a burst pressure 15 Kg / Sq. cm. The service air header shall originate at a bulkhead penetration or fitting located on one of the bulkhead plates.

l) Power supplies

Bidder shall supply all required transformers, regulators and other power supply equipment to adapt sources of power to the requirements of the enclosure mounted equipment. This shall include but not be limited to internal instrument illumination transformers. The circuits shall be separately isolated with MCBs.

m) Equipment Installation

Special attention shall be given in the piping layout to avoid air traps in liquid filled piping, or water pockets in piping.

n) Impulse piping / tubing

1. Transmitter enclosures shall be complete with impulse piping & tubing, valves from enclosure bulkhead connection to all instruments and necessary drain / blow down connections. The type, size, material and pressure class of pipes / tubes, fittings, valves etc. Shall be suitable for the intended applications.

2. Blow down piping / tubing may be shared, but individual instrument piping / tubing and valves shall be furnished. Piping / Tubing material within enclosures shall conform to the application requirements. The final flexible connection to each instrument shall be fabricated with a double offset so that it may readily be disconnected to permit "in situ" calibration of the instrument.

3. Bulkhead connection shall be used when instrument piping / tubing enters the enclosure. For instruments lines which enter through the bottom of the enclosure,

the primary process line from the instrument valve shall be neatly installed, anchored and terminated at approximately 150 Millimeters above the floor of the enclosure. The enclosure shall have a removable, gasketted floor plate to provide an effective seal around the incoming field primary process line. An angle shall be installed 600 Millimeters above the floor, running the length of the enclosure for anchoring of incoming field process lines.

4. Pulsation dampeners shall be furnished wherever required.

5. Drain pots shall be furnished for instruments measuring flue gas parameters and vacuum.

6. All liquid filled blow down lines, except those measuring vacuum shall be connected to a header extended through one end of the enclosure and turned downward for directing the blow down into drain. Gas filled lines and lines equipped with drain pots shall not be connected to the blow down header. The connection between the blow down valve and blow down header shall be constructed so that it can be removed to permit the connection of test instruments to the blow down valves.

7. The draft instrument line four-way valves shall be installed so that the quick disconnect fitting is readily accessible for connection with the service air hose.

8. Pipe and stainless steel tube welding shall comply with the provisions of the latest applicable ANSI code for Pressure piping.

9. Instrument piping and tubing shall be hydrostatically tested at one and one-half times the maximum system pressure for that instrument except for low pressure and vacuum measurement the test pressure will be as per piping standard.

o) Instrument tubing

a. Pneumatic tubing shall be installed in a neat workmanlike. It shall be supported frequently enough that it does not shake when subjected to vibration. All tubes which enter or leave the enclosure shall be terminated on bulkhead fittings in the bulkhead plate.

b. Pneumatic tubing material shall be 6mm OD brass / 316 stainless steel tubing, unless otherwise specified. Flare less tubing fittings shall be used for tubing connections smaller than one inch. Tubing shall be stretched before installation to assure straightness. Special tolls shall be used for all bending and forming operations. Tubing shall be carefully handled to avoid flat spots, kinks, and short bends. All piping and tubing shall be air blown after erection and before attachment to equipment at either end.

p) Open Type Transmitter Racks

a. Open type transmitter racks may be provided for mounting Transmitters, switches, gauges, converters and other accessories in rooms, buildings and closed areas like the power house building.

b. The open type racks may be shop or site fabricated. Transmitters, switches, converters and transducers of enclosure class IP-65 or better can be directly mounted on open racks. However, enclosures not conforming to the above protection standard shall have to house in enclosures conforming to the above protection standard shall have to be housed in enclosures conforming to IP-65 class prior to mounting them on open structures.

c. Racks shall be constructed on structural members of adequate strength and rigidity to ensure proper support to the mounted instruments and equipment. Racks shall be of welded construction throughout. Major load-bearing posts shall be suitably supported by gusset plates or moment members. Suitable fenders grill shall be welded to the end-posts of the rack to outline a boundary beyond which no mounted equipment shall project to protect instrument from accidental contact during personnel movement. Each rack shall be provided with a canopy (sheet thickness of 3 mm) to protect the instrument from dripping water or falling objects.

d. For Operational convenience, the open type racks shall be used for mounting pressure and temperature gauges and switches and the local operating stations for electrical drives in the vicinity. Gauges mounted in racks shall be bottom connected and secured by double lock nuts. All gauges shall be located within 1500 mm from the floor for easy readability.

e. The structural design shall be such that no item shall interfere with maintenance and removal of instrument, equipment and their accessories.

f. Service Power and lighting

1) Each rack shall be provided with Universal type power receptacle, LED lamp light fixture with wire guard and lighting switch etc. Outlet box, switch box and device covers shall be galvanized stamped steel. Light fixtures shall be installed on the canopy of the rack.

2) Power supply for receptacles and lighting shall be arranged. Power supplies for miscellaneous devices shall be provided with 2P MCB located within the rack JB. MCBs shall be mounted in blocks. MCB ratings will give on electrical schematic diagrams. Nameplates shall be furnished above the MCB blocks, identifying the devices being served.

g. Control Air

Same as for closed type transmitter rack. Refer 2.3.6.6 (j) above

h. Service Air

Same as for closed type transmitter rack. Refer 2.3.6.6 (k) above

i. Power Supplies

Same as for closed type transmitter rack. Refer 2.3.6.6 (l) above

j. Equipment installation

k. Contractor shall prepare rack fabrication and piping drawings indicating the layout of each instrument. The drawings shall clearly indicate contractor's piping arrangement for sharing of process connections between two or more instruments. Special attention shall be given in the piping layout to avoid air traps in liquid filled piping or water pockets in piping intended to be dry.

l. Impulse Piping / Tubing

Same as for closed type transmitter rack. Refer 2.3.6.6 (n) above

m. Instrument Tubing

Same as for closed type transmitter rack. Refer 2.3.6.6 (o) above

q) Wiring of the Racks

A fully enclosed IP 65 type junction box shall be provided in each rack for housing the terminal blocks connectors, power supply fuses and other electrical accessories, as required.

Junction boxes for modular enclosures shall be fabricated externally on one end of each enclosure assembly to accept field wiring / cabling through the top or bottom of the junction box. A hinged door shall give access to the interior of the junction box.

All electrical connections between instruments and the junction box terminal blocks shall be made. In addition all utility wiring for lighting and service power shall be installed.

All wiring used within the enclosures shall conform to NEC / IEC standards. All wiring shall run through flexible or rigid conduits and shall be terminated at suitable terminal blocks. Sufficient clearance shall be provided for all control and instrument leads and all incoming and outgoing leads shall be connected to terminal blocks suitably located for

connecting external circuits.

High impedance circuits shall be connected using shielded or coaxial wire suitable for the service.

Conduits shall be supported properly at regular intervals with suitable conduit clamps.

Wire shall be neatly arranged and routed / laid in PVC trough / tray.

In general, local Instrument enclosures & racks shall be designed considering above mentioned specification.

2.3.2.12 Protection, class of cabinets / panels, enclosures etc.

a) All panels, desks cabinets, consoles & enclosures furnished at least comply with the requirements of protection classes as indicated below.

Ambient Temperature (outside cabinets)	Atmosphere & Pressure	Relative Humidity (RH)	Required Protection Class
Outdoor Locations			
55 degree C max.	Dirty Air @ Atmospheric Pressure	100 % Max.	IP 66***
4 degree C min.	Dirty Air @ Atmospheric Pressure	5 % Min.	IP 66***
Indoor Locations			
55 degree C max.	Air @ Atmospheric Pressure	95 % Max.	IP 54**
4 degree C min.	Air @ Atmospheric Pressure	5 % Min.	IP 54**
Air Conditioned Areas			
24±5 degree C (normal)	Air @ Atmospheric Pressure	95 % Max.	IP 32
50 degree C max.*	Air @ Atmospheric Pressure	5 % Min.	IP 32
* During air conditioning failure. ** For non-ventilated enclosures. For ventilated enclosures, protection class shall be IP 42. *** With a suitable canopy at the top to prevent ingress of dripping water.			

b) Distribution boxes, junction boxes, cold junction compensation boxes, terminal boxes and all other field mounted equipment to be furnished as per this specification shall have weather protection conforming to IP 65.

c) The design of panels, cabinets, enclosures and packaging density of components mounted therein shall be such that the temperature rise does not exceed 10 deg. C above the ambient under the worst conditions.

d) The panels housing electronic hardware shall be provided with flame and smoke detectors by bidder.

e) Enclosures for peripheral equipments like printers, etc. shall take care of noise and shall ensure minimum possible noise disturb to the working personnel.

f) For Hazardous areas the protection class shall be in accordance with the requirements of the relevant NEC code for the location.

g) Workstations, OWS, EWS, Servers, Network Switches, Printers, and other peripherals, maximum temperature limit shall be 40 deg. C. For LVS the same shall be around 30 deg. C.

h) For remote I/O cabinets mounted in non-AC areas, panel redundant AC shall be provided.

i) Specific requirements due to corrosive applications and corrosive environment at project site shall also be considered by bidder.

j) Delivery of all electronic panels from the manufacturer's works are subject to readiness of respective work fronts or readiness of fully covered stores.

Guards, barriers and access doors, covers of plates shall be marked to indicate the hazard, which may occur upon removal of such devices. Danger or caution signs shall be used to warn of specific hazards such as voltage or current. The marking shall be permanently affixed to the equipment.

2.5.3.6 Calibration of Instruments

The Bidder shall carry out the calibration of instruments as indicated below by submitting the test procedure and quality assurance plan for the Owner's approval. Bidder shall also prepare detailed checklist/calibration sheets for each of the systems/equipment clearly indicating the step-by-step procedures to be carried out for calibration pre commissioning, loop checking, powering and commissioning.

The calibration of all instruments shall be checked and calibration records prepared for the Owner's use. If the instruments require recalibration, Bidder shall recalibrate the instruments and revise the calibration records and submit to the Owner.

2.5.3.7 Tests to be performed for Field Instruments

S.No	Tests to be performed
1.	**Pressure Gauges**
	Calibration Hydro test (1.5 times max. pr.)
2.	**Pressure switches**
	Calibration test / Hydro test / Contact rating test / Accuracy test / Repeatability
3.	**Differential Pressure Gauges**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
4.	**Differential Pressure Switches**
	Calibration test / Hydro test / Contact rating test / Leak test / Accuracy test / Repeatability test.
5.	**Thermometers**
	Calibration / Material test / Accuracy test / Bore concentricity : $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
6.	**Temperature switch**
	Calibration / Material test / Accuracy test / Bore concentricity: 1.5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.) / Contact rating test.
7.	**Resistance temperature detector assembly.**
	Calibration / Material test / Bore concentricity test / Insulation test ($\leq$ 500 MΩ at 500V DC) As per ISA, Hydro test for TW. Bore concentricity: $\pm$ 5% of wall thickness, Accuracy test.
8.	**Thermocouple assembly**
	Calibration / Material test, Insulation test ($\geq$ 500 Ω at 500 V, DC) as per ISA, Hydro static test (1.5 times max. pr.), Bore concentricity: $\pm$ 5% of wall thickness.
9.	**Thermo wells**
	Material test / Bore concentricity: $\pm$ 5% of wall thickness / Hydrostatic test for TW (1.5 times max. pr.)
10.	**Level Gauges**

S.No	Tests to be performed
	Hydrostatic test / Material test / Seat leakage test / Ball check test.
11.	**Level switches (Magnetic)**
	Material test / Contact rating test / Hydro test / Calibration test.
12.	**Flow Switch**
	Material test / Hydro static test (1.5 times max. pr.) / function test.
13.	**Flow glasses**
	Material test / Hydrostatic test (1.5 times max. pr.) / function test.
14.	**Variable area flow meters**
	Calibration test / Material test / Hydrostatic test (1.5 times max. pr.)
15.	**Flow element**
	100% Radiography test / Hydro test / Calibration test, IBR Certificate.
	Calibration test for flow element shall be witnessed by Owner.
16.	**Control valves / Pneumatic block valve / Pressure regulating valve – Refer chapter 10.**
17.	**Position transmitters**
	Calibration / hysteresis and Accuracy test
18.	**Electro Pneumatic Convertors**
	Calibration test / Accuracy test
19.	**Solenoid valves**
	Hydro test / Seat leakage test / CV test / Coil insulation test
20.	**Air filter regulators**
	Calibration test / Accuracy test
21.	**Junction Boxes**
	Test for degree of protection / Material test
22.	**Tests for terminal blocks**
	Test for moulding for flame resistant, Non-hygroscopic and Decarbonised / Insulation test between terminals / Insulation between terminal block and frame.
23.	**Thermocouple extension cable**
	Thermo-e.m.f characteristic / Continuity test / Measurement on capacitance, inductance and loop resistance / Insulation resistance / High voltage test as per latest IS / Tensile and elongation test / Oxygen index test / Any other test applicable.
24.	**Mass flow meter**
	Performance test / Calibration test / Hydrostatic test.
25.	**Boiler Level Gauge**
	Hydrostatic test / Material test / Seat leakage test / IBR Certificate
26.	**pH / Conductivity measurement / Silica / Dissolved oxygen analysers**:
	Calibration test, Accuracy test
27.	**Sample cooler :**

S.No	Tests to be performed
	Hydro test, IBR Certificate
28.	**Sampling racks :**
	Hydro test, IBR Certificate for tubes and fittings.
29.	**SO2 / NOx analyser / SPM analyser:**
	Calibration test, accuracy test
30.	**Interposing relay**
	Functional test, temperature rise test, H.V test, Insulation test
31.	**Transmitter Racks** :
	Hydro test, air leak test for piping / tubing and fittings. IBR certification as required for tubing / piping and fittings.
32.	**Pressure Transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
33.	**Differential pressure transmitter**
	Calibration test / Hydro test / Leak test / Over range test / Accuracy test / Repeatability test.
34.	**Temperature Transmitter**
	Calibration test / Accuracy test / Ambient temperature error test
35	**Pneumatic Block Valves**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
36.	**Pressure Regulating Valve**
	a) IBR certificate form III C b) Hydrostatic test : ANSI B 16.34 c) Seat leakage test : As per ANSI B 16-104 d) CV test: As per ISA procedure e) Magnetic particle test ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) f) Liquid penetration test: ANSI B 16.34 special class (applicable for pr.>70 bar & temp< 400 Deg.C) g) Radiography test: ANSI B 16.34 special class h) Calibration and Hysteresis test i) Actuator leakage test
37.	**Local Panels :**
	Visual inspection, wiring & continuity check, H.V. and I.R. tests on panels, checking of bill of materials, functional tests.
38	**Wiring Termination & Accessories**

S.No	Tests to be performed
	Routine test: Conductor resistance test / High voltage test / Impulse dielectric test / insulation test / Humidity test / Temperature rise test on power circuits / short time current test on power circuits.
	Type test: Annealing test / Test for insulation and sheath / Flame retardency test - a) Oxygen index, b) Flammability / Test for acid gas generation / test for water absorption / wet dielectric test
39	Marshalling / System cabinets
	Verification of degree of protection / Electrical tests as detailed under wiring Termination & accessories / Type test and routine test as per relevant Indian standards.
	Notes:
	1. Test Certificates in addition to inspection at manufacturers works shall be furnished for all the instruments for Owner's review. 2. Above Test to be witnessed shall be finalized by Owner. 3. In addition to above test, test as per approved QAP shall also be witnessed by owner

i) Testing Types

The BIDDER shall furnish the Type test reports of all type tests as per relevant standards and codes. As well as other specifics test indicated in the specification. A list of such test are given for various equipment in table titled, Type Test Requirement for C&I System and under the item special requirement for solid state requirements/systems. For the balance equipments/instruments type test may be conducted as per manufacturer standards or if required by relevant standards.

1) Out of these test listed, the bidder / sub vendor / manufacturer is required to conduct certain type test specifically for this contract (and witnessed by employer or his authorized representative). Even if the same have been conducted earlier as clearly indicated subsequently such tests.

2) For the rest, submission of type test, results, and certificates shall be acceptable provided following points

   a) The same have been carried out by the bidder/ sub vendor on exactly the same model/rating of equipment. (For control valves this shall be same size, type & design).
   b) There has been no change in the components from the offered equipments and tested equipments.
   c) The test has been carried out as per the latest standards along with amendments as on the date of bid opening.

3) In case the approved equipment is different from the one on which the type test had been conducted earlier or any of the above grounds, then the tests have to be repeated and the cost of such tests shall be borne by the bidder/sub-vendor within the quoted price and no extra cost will be payable by the owner on this account.

As mentioned against certain items, the test certificates for some of the items shall be reviewed and approved by the main bidder or his authorized representative and balanced have to be approved by the employer. The schedule of conduction of type test/submission of reports shall be submitted and finalized during preaward discussion.

For the type test to be conducted, bidder shall submit detailed test procedure for approval by owner. This shall clearly specify test setup, instruments to be used, procedure, and acceptance norms (wherever applicable). , recording of different parameters, intervals of recording precaution to be taken etc. for the test to be carried out.

ii) Special Requirements for Solid State Equipments /Systems

The minimum type test report, over and above the requirements of above clause which are to be submitted for each of the major C&I systems like DDCMIS, DCS etc. shall be as indicated below:

Surge Withstand Capability (SWC) for solid state equipments/equipments

1. All solid state systems/equipments shall be able to withstand the electrical noise and the surges as encountered in actual service conditions and inherent in the power plant. All the solid states systems /equipments shall be provided with all required protection that needs the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Hence, all front end cards which receive external signals like analog input and output modules, Binary input and output modules etc. including power supply, data highway, data links shall be provided with protection that meets the surge withstand capability as defined in ANSI 37.90.1/IEEE 472. Complete details of the features incorporated in the electronic system to meet this requirement the relevant test carried out, the test certificates, etc. shall be submitted along with the proposal. As an alternative to the above, suitable class of EN 61000-4-12 which is equivalent to ANSI 37.90.1/IEEE 472 may also be adapted for SWC test.
2. The dry heat test as per IEC-68-2-2 or equivalent
3. Damp heat test as per IEC 68-2-3 or equivalent
4. Vibration test as per IEC 68-2-6 or equivalent
5. Electrostatic Discharge test as per EN 61000-4-2 or equivalent
6. Radio frequency immunity test as per EN 61000-4-6 or equivalent
7. Electromagnetic Field Immunity test as per EN 61000-4-3 or equivalent

Test listed at Item no 5, 6, 7 above are applicable for electronic cards only as defined under item no. 1 Above

iii) Type Test Requirements for C&I Systems

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate

S.No	Item	Test Requirement	Standard	Test to be specifically conducted	Owners approval required on test certificate
1	Electrical metering instruments	As per standards	IS 1248	No	Yes
2	Thermocouple	Degree of Protection Test	IS - 13947	No	No.
3	Junction Box	Degree of Protection Test	IS - 13947	Yes	Yes
4	RTD	As per standards	IEC-60751	No	No
5	Electronic Transmitter	As per standards	BS 6447 / IEC 60770	No	Yes
6	E / P convertor	As per standards	Manufacturing standard	No	Yes
7	Instrumentation cable (Twisted and shielded) (Refer Vol. II, Chapter 8)				
8	Battery	As per standard	IS 10918	Yes	YES
9.	Voltage stabiliser	Over load test	Approved procedure	No	YES
		Temp. rise test without redundant fans	Approved procedure	No	YES
		Input voltage variation test	Approved procedure	No	YES
10	**DDCMIS**				
	CLCS system	Model Test	Approved procedure	No	No
	BMS & MFT	Safety requirement	VDE0116, SEC 8.7	No	YES
11	Conductivity type level switch	Degree of protection test	IS 13947	No	No
12	Local gauges	Degree of protection test	IS 13947	No	No
13	Process actuated switches	Degree of protection test	IS 13947	No	No
14	Control valves	CV test	ISA 75.02	No	YES
15	LIE / LIR	Degree of	IS 13947	YES	YES
16	Flue gas O2 analyser, other Flue	Degree of protection test	IS 13947	No	YES
17	Flow nozzles & Orifice plates	calibration	ASMEPTC BS 1042	YES	YES

Note:

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR ANALYTICAL INSTRUMENTS

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	V	V	
	VISUAL						
	MAKE, MODEL No.						
	POWER SUPPLY						
	TYPE						
2	DIMENSIONS CHECK			P	V	V	
3	FUNCTIONAL CHECK			P	V	V	
4	LEAKAGE TEST			P	V	V	
5	HV / IR TEST			P	V	V	
6	LINEARITY			P	V	V	
7	RESPONSE TIME			P	V	V	
8	ENCLOSURE CLASS			P	V	V	
9	ACCESSORIES, AS APPLICABLE			P	V	V	
10	ACCURACY / CALIBRATION			P	V	V	
11	ALARM CONTACT TEST			P	V	V	
12	ANALOG OUTPUT CHECK			P	V	V	
13	BURN-IN TEST OF ELECTRONIC PARTS	1/LOT		P	V	V	
14	IN-BUILT INDICATOR, ZERO, SPAN, RANGE SCALE SELECTION ETC	SEE NOTE-1 BELOW		P	V	V	

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TRANSMITTER

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECKS FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	VISUAL.						
	MODEL/TAG No						
2	PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	REPEATABILITY			P	W	V	
5	HYSTERESIS			P	W	V	
6	EFFECT OF TEMP VARIATION ON ACCURACY			P	W	V	
7	SPAN / ZERO ADJUSTMENT	ONE / TYPE		P	W	V	
8	EFFECT OF SUPPLY VOLTAGE VARIATION			P	W	V	
9	EFFECT OF LOADING (500 OHM METERS)			P	W	V	
10	HIGH PRESSURE TEST	SEE NOTE-1 BELOW		P	W	V	
11	BURN-IN TEST	ONE / TYPE		P	W	V	
12	DEGREE OF PROTECTION			P	W	V	
13	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	

Legend :

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Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. When material corelation are not available manufacturer's compliance to be provided.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SOLENOID VALVES

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	TYPE						
	MAKE						
	MODEL No.						
2	MATERIAL (BODY. PLUNGER/TRIM)			P	W	V	
3	PORT SIZE			P	W	V	
4	CABLE CONNECTION SIZE			P	W	V	
5	ENCLOSURE CLASS			P	W	V	TYPE TEST CERTIFICATE TO BE FURNISHED BY VENDOR
6	No. OF COILS & INSULATION CLASS			P	W	V	TEST CERTIFICATE TO BE FURNISHED FOR INSULATION CLASS BY VENDOR
7	POWER SUPPLY CHECK			P	W	V	
8	IR / HV TEST			P	W	V	
9	FUCTIONAL TEST			P	W	V	

Legend :

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P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR TEMPERATURE GAUGE

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	DIAL SIZE						
	MODEL NO./TAG NO./TYPE						
	RANGE/SCALE						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	HYSTERESIS						
3	OVER TEMP. TEST			P	W	V	
4	AMBIENT TEMP. COMPENSATION CHECK	1 OF TYPE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	THERMOWELL						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	THERMOWELL	SEE NOTE-1 BELOW	AS PER APPD DWG		V	V	
	MATERIAL TC & DIMN. CHECK						
	HYD.TEST						
	OVER RANGE TEST						

Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL, P = Perform, W = Witness, V = Verification

Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. IBR certificate to be provided if called for in specn.
5. Contractor to provide compliance certificate for tests/checks verifid by contractor and submit the same alongwith test certificates to be verified by BHEL.

STANDARD CHECK LIST FOR C&I INSTRUMENTS (for Maux Pkgs)

CHECK LIST FOR SIGHT FLOW INDICATOR

Sl. No.	Test / Checks	Quantum of check	Reference Doc. / Acceptance Norms	Agency **			Remarks
				M	C	B	
1	CHECK FOR	SEE NOTE-1 BELOW	APPROVED SPEC./ DATA SHEETS	P	W	V	
	MODEL						
	TAG No.						
	VISUAL						
2	DIMENSIONS,			P	W	V	
3	PROCESS CONNECTION			P	W	V	
4	RANGE / SCALE			P	W	V	
5	ACCURACY			P	W	V	
6	MATERIAL TC FOR METERING TUBE, ORIFICE PLATE, FLANGES AND FASTNER			P	V	V	
7	CALIBRATION REPORT	ONE / SIZE		P	V	V	
8	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		V	V	V	
9	TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	

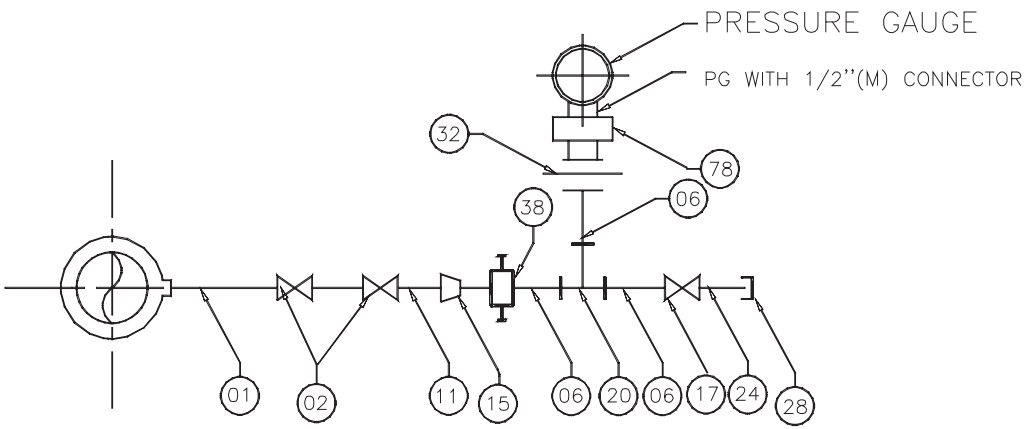
Legend :

** M = Manufacturer / Sub-contractor, C = Contractor / Nominated Inspecting Agency, B = BHEL,
P = Perform, W = Witness, V = Verification

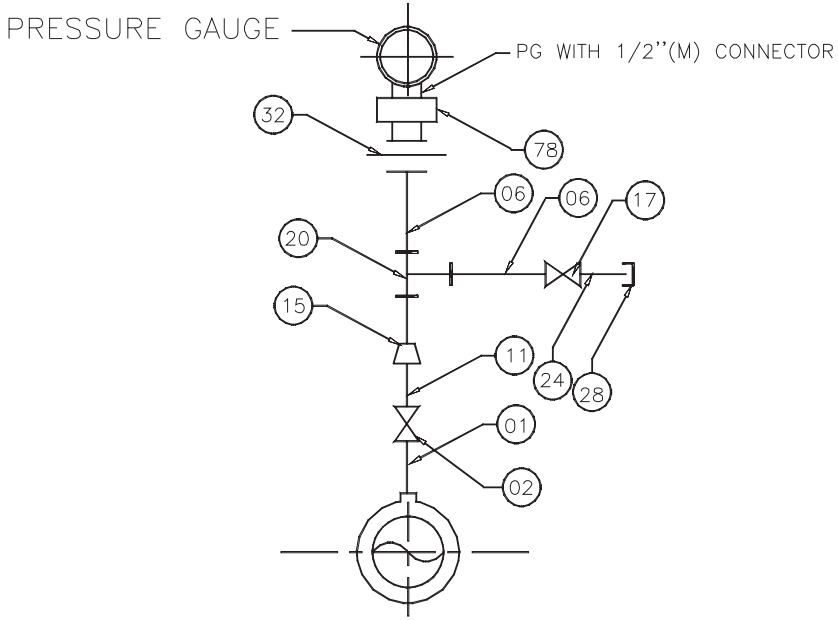
Note :

1. Quantum of check shall be as below :
   100 % - By Manufacturer
2. Manufacturer to maintain calibrated instrument having better accuracy than the item under test. Inspecting engineer shall check the same.
3. Manufacturer to carry out ROUTINE TEST on 100 %.
4. Contractor to provide compliance certificate for tests/checks verifid by contractor and the same alongwith test certificates to be verified by BHEL

INSTRUMENT INSTALLATION DIAGRAM



FIG–A STEAM/LIQUID SERVICE



FIG–B AIR SERVICE

NOTE

TAG NO.	DESCRIPTION	QTY. A	QTY. B
78	1/2''NPT(F)X1/2"NPT(M) SNUBBER/ PULSATION DAMPER	1	1
38	3–WAY GAUGE VALVE WITH 1/2" NB SW	1	–
32	1/2"NPS, 3 PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	1
28	1/2"NPT (f) CS CAP	1	1
24	1/2"NPS, SCH–80/160 X 1/2"NPT(MO CS/AS NIPPLE	1	1
20	1/2"SW EQUAL TEE, CS/AS	2	1
17	1/2"SW CS/AS GLOBE VALVE	1	1
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
15	1"TO 1/2"SW REDUCER	1	1
11	1"NPS SCH–80/160 CS/AS PIPE	1	1
6	1/2"NPS. SCH–80/160 CS/AS PIPE	AS REQ.	
2	1/2"/3/4"/1"ROOT VALVE – SW GLOBE VALVE	2	1

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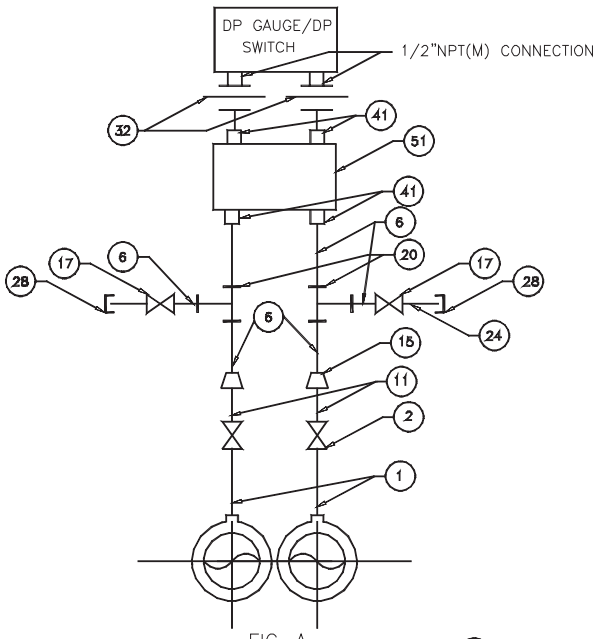
SCALE	1:1	

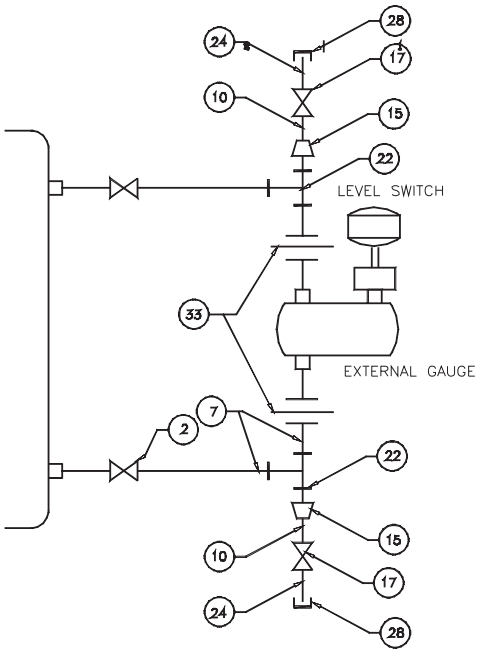
PROJECT : 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE : INSTRUMENT DRAWING FOR PRESSURE GAUGE FOR STEAM/LIQUID/AIR SERVICE

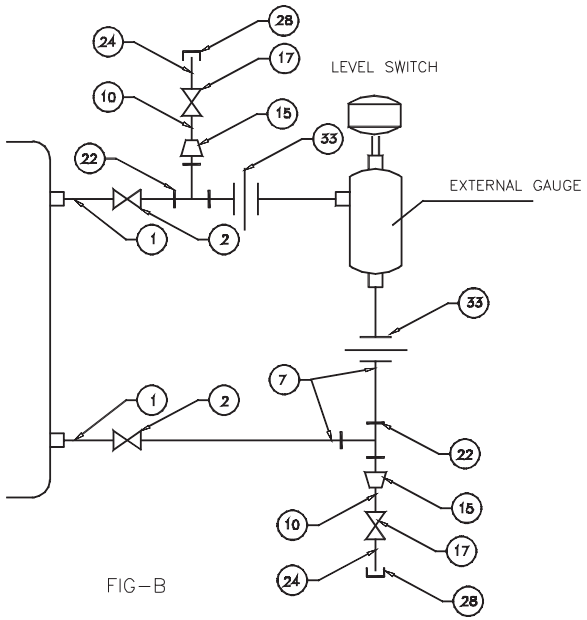
DRAWING NO : LII–GEOE15066–I–45786–004 | REV. 00 | SHEET 1 OF 1



FIG–A



FIG–C



FIG–B

NOTE

TAG NO.	DESCRIPTION	QTY. A	B	C
78	1/2"NPT(F)X1/2"NPT(M) SNUBBER/ PULSATION DAMPER	1	–	–
38	3–WAY GAUGE VALVE WITH 1/2" NB SW	1	–	–
32	1/2"NPS, 3 PIECE PIPE UNION WITH 1/2"NPT(F) SCREWED	1	–	–
28	1/2"NPT (f) CS CAP	1	2	2
24	1/2"NPS, SCH–80/160 X 1/2"NPT(MO CS/AS NIPPLE	1	2	2
20	1/2"SW EQUAL TEE, CS/AS	1	–	–
17	1/2"SW CS/AS GLOBE VALVE	1	2	2
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.		
15	1"TO 1/2"SW REDUCER	1	2	2
11	1"NPS SCH–80/160 CS/AS PIPE	1	–	–
6	1/2"NPS, SCH–80/160 CS/AS PIPE	AS REQ.		
2	1/2"/3/4"/1"ROOT VALVE – SW GLOBE VALVE	2	2	2
33	1"SW EQUAL PIPE UNION	–	2	2
22	1"SW EQUAL TEE CS/AS	–	1	2
10	1/2"NPS, SCH 80/160 CS/AS NIPPLE	–	2	2
7	1"NPS, SCH 80/160 CS / AS PIPE	AS REQ.		
33	1"SW EQUAL PIPE UNION	2	2	2

NOTE:–
WITH VALVE SIZE 1/2"SW NIPPLE PIECE IS NOT REQUIRED

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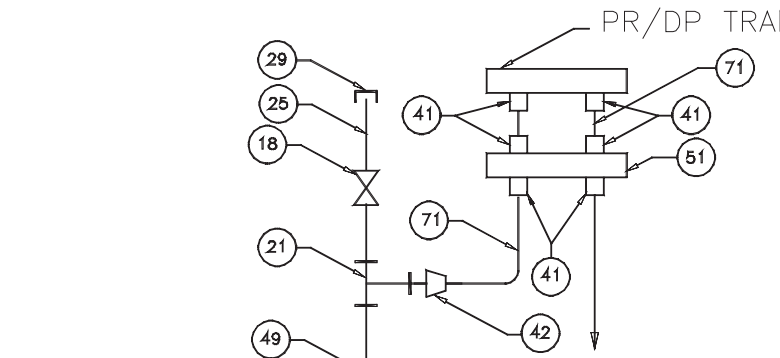
SCALE	1:1	

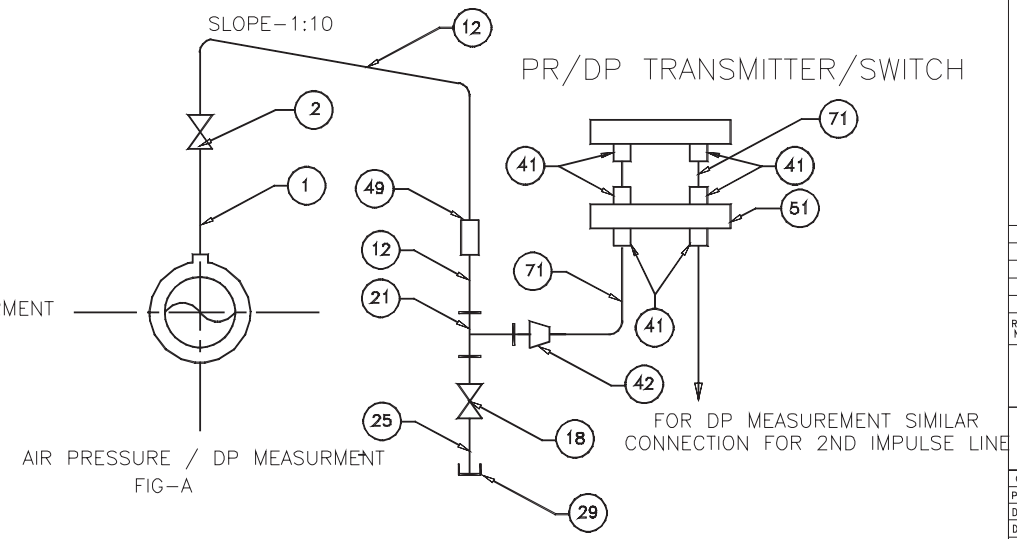
PROJECT : 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE : INSTRUMENT DRAWING FOR DP GAUGE/ SWITCH & LEVEL SWITCH

DRAWING NO : LII-GEOE15066-I-45786-013 | REV. 00 | SHEET 1 OF 1



AIR PRESSURE / DP MEASURMENT
FIG-B



AIR PRESSURE / DP MEASURMENT
FIG-A

NOTE

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE, SS-316	AS REQ.	
51	5/3/2 - VALVE MANIFOLDS, SS-316	1	1
49	3/4"SW, CS/AS BULK HEAD PIPE UNION	1	1
42	3/4"BW X1/2"OD TUBE FITTINGS, SS-316	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTINGS, SS-316	6	6
29	3/4"NPT (F) CS CAP	1	1
21	3/4" EQUAL UNION TEE, CS	1	1
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
18	3/4"SW, CS GLOBE VALVE	-	1
12	3/4"NPS, SCH-80 CARBON STEEL PIPE	AS REQ.	
2	1/2"/3/4"/1"ROOT VALVE - SW GLOBE VALVE	1	1
25	3/4"NPS, SCH-80 X 3/4"NPS(M)CS NIPPLE	1	1

NOTE:-
QTY. TO DOUBLED FOR DP TAPPING EXCEPT ITEM NO:51

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PROJECT : 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUZHUDHIVAKKAM VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE :
INSTRUMENT DRAWING FOR PRESSURE/DP TRANSMITTER/SWITCH IN AIR SERVICE

DRAWING NO : LII-GEOE15066-I-45786-016 | REV. 00 | SHEET 1 OF 1

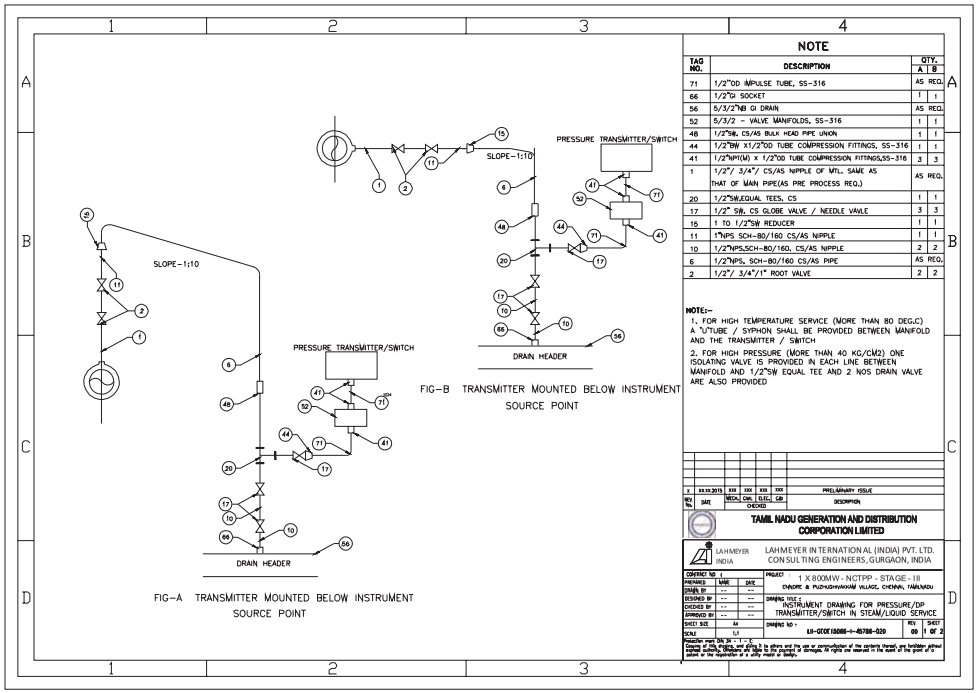

FIG-A TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT

FIG-B TRANSMITTER MOUNTED BELOW INSTRUMENT SOURCE POINT

NOTE

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE, SS-316	AS REQ.	
66	1/2"GI SOCKET	1	1
56	5/3/2"NB GI DRAIN	AS REQ.	
52	5/3/2 - VALVE MANIFOLDS, SS-316	1	1
48	1/2"SW, CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X1/2"OD TUBE COMPRESSION FITTINGS, SS-316	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTINGS,SS-316	3	3
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
20	1/2"SW,EQUAL TEES, CS	1	1
17	1/2" SW, CS GLOBE VALVE / NEEDLE VAVLE	3	3
15	1 TO 1/2"SW REDUCER	1	1
11	1"NPS SCH-80/160 CS/AS NIPPLE	1	1
10	1/2"NPS,SCH-80/160, CS/AS NIPPLE	2	2
6	1/2"NPS, SCH-80/160 CS/AS PIPE	AS REQ.	
2	1/2"/ 3/4"/1" ROOT VALVE	2	2

NOTE:-

1. FOR HIGH TEMPERATURE SERVICE (MORE THAN 80 DEG.C) A 'U'TUBE / SYPHON SHALL BE PROVIDED BETWEEN MANIFOLD AND THE TRANSMITTER / SWITCH
2. FOR HIGH PRESSURE (MORE THAN 40 KG/CM2) ONE ISOLATING VALVE IS PROVIDED IN EACH LINE BETWEEN MANIFOLD AND 1/2"SW EQUAL TEE AND 2 NOS DRAIN VALVE ARE ALSO PROVIDED

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APPROVED BY	--	--
SHEET SIZE	A4	
SCALE	N.T.	

PROJECT: 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUDHUVAYAVAI VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE: INSTRUMENT DRAWING FOR PRESSURE/DP TRANSMITTER/SWITCH IN STEAM/LIQUID SERVICE

DRAWING NO: LH-CCOC15088-I-45788-020 | REV: 00 | SHEET: 1 OF 2

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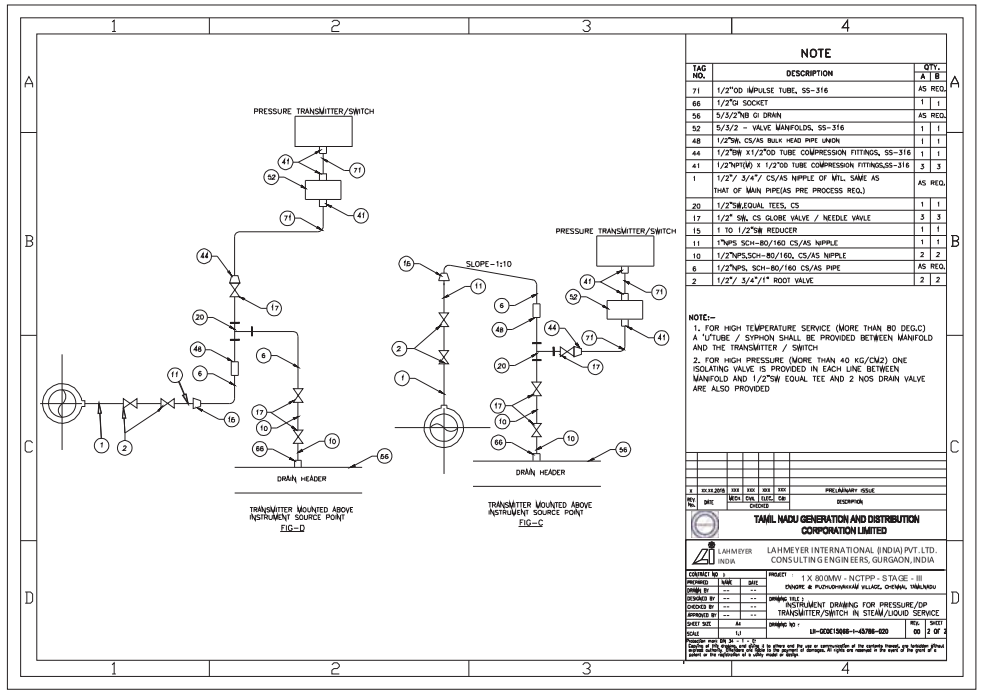

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT FIG-D

TRANSMITTER MOUNTED ABOVE INSTRUMENT SOURCE POINT FIG-C

NOTE

TAG NO.	DESCRIPTION	QTY. A	QTY. B
71	1/2"OD IMPULSE TUBE, SS-316	AS REQ.	
66	1/2"GI SOCKET	1	1
56	5/3/2"NB GI DRAIN	AS REQ.	
52	5/3/2 - VALVE MANIFOLDS, SS-316	1	1
48	1/2"SW, CS/AS BULK HEAD PIPE UNION	1	1
44	1/2"BW X1/2"OD TUBE COMPRESSION FITTINGS, SS-316	1	1
41	1/2"NPT(M) X 1/2"OD TUBE COMPRESSION FITTINGS,SS-316	3	3
1	1/2"/ 3/4"/ CS/AS NIPPLE OF MTL. SAME AS THAT OF MAIN PIPE(AS PRE PROCESS REQ.)	AS REQ.	
20	1/2"SW,EQUAL TEES, CS	1	1
17	1/2" SW, CS GLOBE VALVE / NEEDLE VAVLE	3	3
15	1 TO 1/2"SW REDUCER	1	1
11	1"NPS SCH-80/160 CS/AS NIPPLE	1	1
10	1/2"NPS,SCH-80/160, CS/AS NIPPLE	2	2
6	1/2"NPS, SCH-80/160 CS/AS PIPE	AS REQ.	
2	1/2"/ 3/4"/1" ROOT VALVE	2	2

NOTE:-

1. FOR HIGH TEMPERATURE SERVICE (MORE THAN 80 DEG.C) A 'U'TUBE / SYPHON SHALL BE PROVIDED BETWEEN MANIFOLD AND THE TRANSMITTER / SWITCH
2. FOR HIGH PRESSURE (MORE THAN 40 KG/CM2) ONE ISOLATING VALVE IS PROVIDED IN EACH LINE BETWEEN MANIFOLD AND 1/2"SW EQUAL TEE AND 2 NOS DRAIN VALVE ARE ALSO PROVIDED

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SCALE	N.T.	

PROJECT: 1 X 800MW - NCTPP - STAGE - III
ENNORE & PUDHUVAYAVAI VILLAGE, CHENNAI, TAMILNADU

DRAWING TITLE: INSTRUMENT DRAWING FOR PRESSURE/DP TRANSMITTER/SWITCH IN STEAM/LIQUID SERVICE

DRAWING NO: LH-CCOC15088-I-45788-020 | REV: 00 | SHEET: 2 OF 2

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APPLICABLE CODES AND STANDARDS

2.3.1.6 Codes and Standards

All equipments, system and service covered under this specification shall comply with the requirements of the latest statutes regulations and safety codes as applicable in the locality where the equipments / systems will be installed. The Bidder shall fully acquaint himself with these requirements and shall ensure compliance with them.

The equipments, systems and services furnished as per this specification shall conform to the codes and standards mentioned in Cl. no. 2.3.1.7 of this Section. However in the event of any conflict between the requirements of two standards or between the requirements of any standard and this specification, the more stringent requirements shall apply unless confirmed otherwise by the Owner in writing. The decision of the Owner shall be final and binding in all such cases.

The Bidder's scope of supply shall include some items such as thermo wells, and other in-line devices for main steam, hot reheat, cold reheat, feed water system falling under the purview of Indian Boiler Regulation (IBR) Act. It shall be the responsibility of the Bidder to obtain the necessary approval of the concerned Inspecting Authority / Chief Inspector of Boilers for the design and design calculations and manufacturing and erection procedures as called for under the IBR act for all items requiring such certifications.

The requirements of statutory authorities (e.g. MOEF, Inspectors of factories, IBR, TAC, BEE, CPCB / TNPCB etc.) with regards to various plants areas like Main plant, Fuel oil plant / system, Chlorination Plant, Emission Measurement, Ambient Air Monitoring system etc. shall be complied, even if not actually spelt out.

Reference Codes and Standards

The design, manufacture, inspection, testing, site calibration and installation of all equipment and systems covered under this specification shall conform to the latest editions of codes and standards mentioned below and all other applicable ANSI, ASME, IEEE, NEC, NEMA, ISA, DIN, VDE, NFPA, IEC, EIA, TIA and Indian Standards and their equivalents.

a. American National Standards Institute (ANSI).
b. American Society of Mechanical Engineers (ASME).
c. The Institute of Electrical and Electronics Engineers (IEEE).
d. Deutsche Industries Norman (DIN)
e. Instrumentation Systems and Automation Society (ISA).
f. National Electrical Manufacturers Association (NEMA).
g. National Fire Protection Association (NFPA)
h. Scientific Apparatus Makers Association (SAMA).
i. Indian Standards (IS)
j. International Standards Organization (ISO)
k. British standards (BS)
l. International electro technical committee (IEC)
m. American petroleum Institute (API)
n. Tariff Advisory Committee (TAC)
o. Japanese Industrial Standards (JIS)
p. American Society of Testing and Materials (ASTM)
q. Standards of the Hydraulic Institute, U.S.A.
r. Tubular Exchanger Manufacturer's Association (TEMA)
s. American Welding Society (AWS)
t. Expansion Joint Manufacturers Association (EJMA)
u. Heat Exchange Institute (HEI)

Other recognized equivalent international standards will be utilized as required to serve design, fabrication, and construction guidelines when not in conflict with the above listed standards.

1) Temperature Measurement

a. Performance Test Code for temperature measurement ASME PTC 19.3 as per latest edition.
b. Temperature measurement - Thermocouples ANSI-MC 96.1 as per latest edition, IEC 584
c. Temperature measurement by electrical resistance thermometers - IS-2806.
d. Thermometer-element-platinum resistance-IS-2848, IEC 751 / DIN 43760
e. RTD Design Code – DIN EN 60751:1996, BS EN 60751: 2008
f. Thermo well Design Code – ASME PTC 19.3 TW – 2010

2) Pressure Measurement

a. Performance Test Code for pressure measurement - ASME PTC 19.2 as per latest edition

b. Bourdon tube pressure and vacuum gauges - IS 3624, IS 3602, ASME B 40.1
c. Electronic transmitters BS: 6447
d. Process operated switch devices (Pr. Switch) BS-6134.

3) Electronic measuring Instruments & Control hardware

a. Automatic null balancing electrical measuring instruments - ANSI C 39.4 as per latest edition, IS 9319
b. Safety requirements for electrical and electronic measuring and controlling instrumentation - ANSI C 39.5 as per latest edition.
c. Compatibility of analog signals for electronic industrial process instruments - ISA-S 50.1: ANSI MC 12.1 as per latest edition.
d. Dynamic response testing of process control instrumentation - ANSI MC 4.1 as per latest edition: ISA-S26 as per latest edition.
e. Surge withstand capability (SWC) tests - ANSI C 37.90A (1974) IEEE Std. 472 as per latest edition, IEC – 255.4.
f. Printed circuit boards - IPC TM-650, IEC 326 C
g. General requirements and tests for printed wiring boards - IS 7405 (Part-I) - as per latest edition
h. Edge socket connectors - IEC 130-11.
i. Requirements and methods of testing of wire wrap terminations DIN 41611, Part-2.
j. Dimensions of attachment plugs & receptacles ANSI C73 as per latest edition.
k. Direct acting Electrical Indicating Instruments: IS-1248 as per latest edition.
l. Standard Digital Interface for Programmable Instrumentation - IEEE-488.2 as per latest edition.
m. Information Processing Systems - Local Area Networks - Part 2: Logical Link Control - IEEE- 802.2 as per latest edition.
n. Standard for Local Area Networks: Carrier Sense Multiple Access with Collision Detection – IEEE-802.3 as per latest edition.
o. Supplements A, B, C and E to Carrier Sense Multiple Access with Collision Detection - IEEE- 802.3 as per latest edition.
p. Standard for Local Area Networks: Token - Passing Bus Access Method - IEEE- 802.4 – as per latest edition.
q. Standard for Local Area Networks: Token - Ring Access Method and Physical Layer Specification - IEEE- 802.5 - as per latest edition.
r. IEEE Guide to Software Requirements Specifications - IEEE-830 as per latest edition.
s. Hardware Testing of Digital Process Computers - ISA RP55.1 as per latest edition.
t. Electromagnetic Susceptibility of Process Control Instrumentation - SAMA PMC 33.1 as per latest edition.
u. Interface between the Data Terminal Equipment and Data Circuit – Terminating Equipment Employing Serial Binary Data Interchange - EIA-232- D- as per latest edition.

4) Instrument Switches and Contacts

a. Contact rating - AC services NEMA ICS Part-2-125, A600
b. Contact rating - DC services NEMA ICS Part-2-125, N600.

6) Electronic Cards, Subassemblies and Components

a) Unpackaged

S.No	Parameter	Codes
i.	Vibration	IEC-68.2.6
ii.	Shock	IEC-68.2.27
iii.	Drop & Topple	IEC-68.2.31

b) Packaged

S.No	Parameter	Codes
i.	Vibration, Drop & Static Compression	NSTA

c) Electromagnetic compatibility

S.No	Parameter	Codes
i.	Electrical Fast Transient	IEC-801.4
ii.	Surge Withstand	IEC-255.4
iii.	Radiated Electromagnetic Field	IEC-801.3
iv.	Electrostatic Discharge	IEC-801.2
v.	Electromagnetic Emission	VDE 0871, Class B
vi.	Electromagnetic compatibility (EMC / EMI)	EN 50081 / 82

7) Control Valves

a. Control Valve sizing - Incompressible fluids - ISA S39.2 - as per latest edition.
b. Control valve sizing - Compressible fluids - ISA S39.3 - as per latest edition, ISA S39.4 - as per latest edition.
c. Face to face dimensions of control valves - ANSI B16.10
d. ISA Hand book of control valves - ISBN B1047-087664-234-2.
e. Valves - flanged, threaded and welding end : ANSI B 16.34(as per latest edition)
f. Casting : ASTM A 216 / A 351 (as per latest edition)
g. Welded end connection: As per ASME boiler and pressure vessel code / ANSI.B 16.34(as per latest edition), B16.25 (as per latest edition), B 16.11(as per latest edition).
h. Defect removal: ANSI B 16.34 as per latest edition.
i. Cleaning: ASTM A 380 as per latest edition.
j. CV test: As per ISA procedure S 75.02 (as per latest edition).
k. Control Valve seat leakage : ANSI / FCI 70.2

8) Enclosures

a. Types of enclosures - NEMA Std. ICS-6-110.15 through 110.22 (Type 4 to 13).
b. Racks, panels, and associated equipment - EIA: RS-310-B (ANSI C83.9 - as per latest edition)
c. Protection Class for Enclosure, Cabinets, Control Panels and Desks - IS-13947- as per

latest edition.

d. Classification of hazardous area – IEC 79
e. Degree of protection for enclosures – IEC 60529.
f. Electrical Instruments in Hazardous Area – ISA RP 12.11
g. Environmental conditions for process measurement and control systems – ISA S71.04
h. Purged and pressurized enclosure for electrical equipment in hazardous location –NFPA Article 496 Volume-4, as per latest edition.

9) **Apparatus, enclosures and installation practices in hazardous areas**

a. Classification of hazardous area - NFPA Art. 500, Vol.70- as per latest edition.
b. Electrical Instruments in hazardous dust locations - ISA-RP 12.11
c. Intrinsically safe apparatus - NFPA Art.493 Vol.4. as per latest edition
d. Purged and pressurized enclosure for electrical equipment in hazardous location - NFPA Art. 496 as per latest edition.
e. Enclosures for Industrial Controls and Systems - NEMA IS 1.1 - as per latest edition.

10) Sampling System

a. Stainless steel material of tubing and valves for sampling system - ASTM A269-82 Gr TP316.
b. Submerged helical coil heat exchangers for sample coolers ASTM D 11- as per latest edition.
c. Water and Steam in power cycle - ASME PTC 19.11(as per latest edition).
d. Standard methods of sampling system - ASTM D 1066-69.

11) Annunciators

a. Specifications and guides for the use of general purpose annunciators - ISA RP 18.1- as per latest edition.
b. Surge withstand capability tests - ANSI C.37.90a - 1974 and IEEE std. 472- as per latest edition.
c. Alarm Management System – ISA 18.2 – 2009 or latest edition.

12) Interlocks, Protections

a. Relays and relay system associated with electric power apparatus – IEEE std.3.13.
b. Surge withstand capability tests - ANSI C.37.90a - as per latest edition and IEEE Std. 472 - as per latest edition.
c. General requirements & tests for switching devices for control and auxiliary circuits including contactor relays - IS-6875 (Part-I) as per latest edition.
d. Turbine water damage prevention - ASME - TDP- as per latest edition.
e. Boiler safety interlocks - NFPA Section 85B, 85D, 85E, 85F,85G.
f. Turbine safety interlocks - IEC 61508 and IEC 61511 or VDE 0116, Section 8.7, VDE 0160.

13) Process Connection and Piping:

a. Codes for pressure piping power piping ANSI B31.1
b. Seamless carbon steel pipe ASTM A-106.
c. Forged and Rolled Alloy steel pipe flanges, forged fittings, valves and parts - ASTM A-182.
d. Material for socket welded fittings - ASTM A-105.
e. Seamless ferrite alloy steel pipe - ASTM A-335.
f. Pipe fittings of wrought carbon steel and alloy steel - ASTM A-234.
g. Composition bronze or metal castings - ASTM B-62.
h. Seamless copper tube, bright annealed ASTM B-168.
i. Seamless copper tube - ASTM B-75.
j. Dimensions of fittings - ANSI B-16.11
k. Valves flanged and butt welding ends - ANSI B16.34.
l. Nomenclature for Instrument tube fittings ISA-RP-42.1 - as per latest edition.
m. Hydrogen Piping and Pipelines: piping in gaseous and liquid hydrogen service and pipelines in gaseous hydrogen service – ASME B31.12.

14) Instrument Tubing

a. Seamless carbon steel pipe - ASTM - A106.
b. Material for socket weld fittings - ASTM - A105.
c. Dimensions of fittings - ANSI B16.11
d. Code for pressure piping, welding, hydrostatic testing - ANSI B31.1.

15) Cables

a. Thermocouple extension wires / cables - ANSI C 96.1 - as per latest edition.
b. Colour coding of single or multi-pair cables – VDE 0815
c. Guide for design and installation of cable systems in power generating stations (insulation, jacket materials) - IEEE Std. 422 - as per latest edition.
d. Requirements of vertical tray flame test - IEEE 383 - as per latest edition.
e. Standard specification for tinned soft or annealed copper wire for electrical purpose - ASTM B-33 - 81.
f. Oxygen index and temperature index test - ASTM D-2863.
g. Smoke generation test - ASTMD-2843 and ASTME-662.
a. Acid gas generation test - IEC-754-1.
b. Swedish chimney test - SEN - 4241475 (F3)
c. Instrumentation cables and internal wiring IS-1554 (Part-I, 1976) and IS-5831(as per latest edition).
d. Standard for Control, Thermocouple Extension and Instrumentation cable- NEMA WC57- as per latest edition, ICEA S-73-532, Rev. 2, as per latest edition)
e. PVC insulated (heavy duty) Electric cables for working voltages up to and including 1100V - IS:1554 (Part-I)
f. Conductors for insulated electric cables and flexible cords. - IS: 8130
g. PVC insulation and sheath of electric cables - IS:5831

h. Mild steel wires, strips and tapes top armouring cables - IS:3975
i. Water Immersion Test - VDE 0815
j. Drums for electric cables - IS : 1048