9.00.00 **CONTROL AND INSTRUMENTATION FOR PLANT AUXILIARY SYSTEMS**

9.01.00 Instrumentation and Control System with interlocks, protection and annunciation of the mechanical common auxiliary systems as mentioned below shall be provided. All necessary equipments/system for control, monitoring and operations of the plants as well as the incomers and bus couplers shall be provided.

9.02.00 For certain plants, facility for control from DDCMIS shall be provided as mentioned below:

Sl No	Auxiliary Plant	Control System	Connectivity/operation
01	Auxiliary Boiler (if applicable)	Independent control system in SG-C&I hardware	Dual two way Ethernet connectivity to Station LAN for information
02	Fuel Oil Pressurization/ Heating System (FOPH) & Fuel oil unloading system	Independent control system in SG-C&I based Hardware. I/O count for Fuel oil unloading system is 200 binary and 20 analogs.	Dual two way Ethernet connectivity to station LAN for information and control. Local operation of Fuel oil Handling System through GIU.
03	Mill Reject System (Unitised System)	SG C&I Based Control System from Control Room	Graphical interface unit (GIU) based local operation apart from CCR.
04	Air Compressor System including Air-Compressors of Mill Reject System	If the controller is integral to compressor, then Microprocessor/ PLC based control system along with suitable operator interface as per vendor's practice for individual Air compressors control. If the controller for individual compressors is not integral to compressor then control shall be through SG-C&I For both the cases, over all Control shall be through SG-C&I	Two way Ethernet Connectivity to SG-C&I for information and overall Control of Air Compressors. (Applicable only for compressors with integral controllers)
05	LP Dosing and Oxy-genated treatment	Control from BOP-C&I under Station C&I package(in Employer's scope).	
06	Equipment Cooling Water System	Control from BOP-C&I under Station C&I Package	

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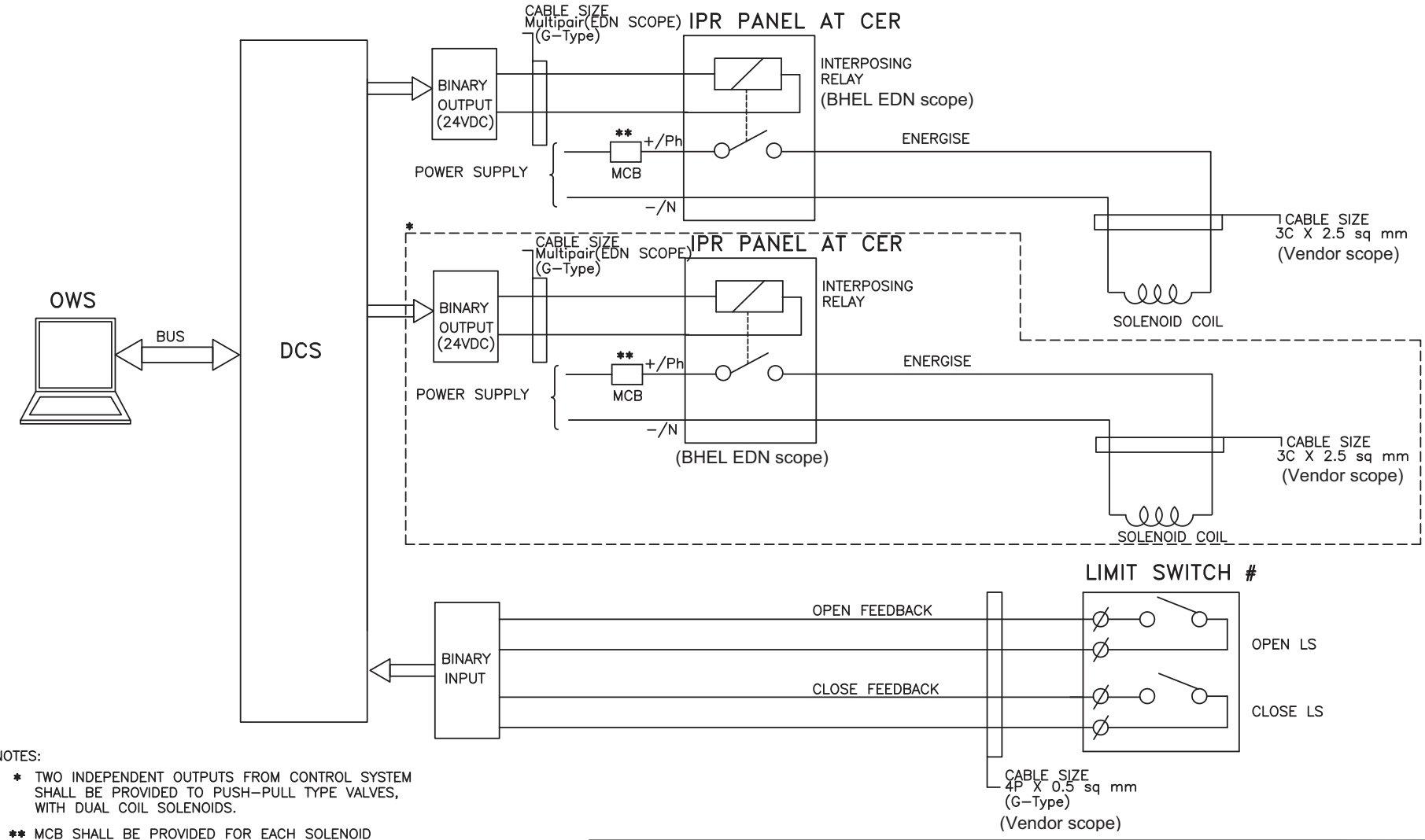
DRIVE CONTROL PHILOSOPHY
(FOR PNEUMATICALLY OPERATED SOLENOID VALVE)

DCS INTERFACE FOR SOLENOID DRIVE
(24V DC / 240V AC UPS)



NOTES:

* TWO INDEPENDENT OUTPUTS FROM CONTROL SYSTEM SHALL BE PROVIDED TO PUSH–PULL TYPE VALVES, WITH DUAL COIL SOLENOIDS.

** MCB SHALL BE PROVIDED FOR EACH SOLENOID

\# FOR ON/OFF TYPE, SOLENOID ACTUATED CONTROL VALVE.

BHEL	PROJECT: STANDARD	DRG.NO.	PE–SD–999–145–I002
		DATE	12.02.2013
	TITLE: DDCMIS INTERFACE FOR SOLENOID DRIVE	REV.NO.	03

INSTRUMENTS DATA SHEET

MEASURING INSTRUMENTS

1.00.00 **MEASURING INSTRUMENTS**

1.01.00 Measuring instruments/equipment and subsystems offered by the Bidder shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Refer Sub-section-IV:I1(Basic Design Criteria). Further, all instruments shall be of proven reliability, accuracy, and repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Employer's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical specifications, ranges, makes/numbers as approved by the Employer during detailed engineering.

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

1.03.00 All local gauges as well as transmitters, sensors, and switches for parameters like pressure, temperature, level, flow etc. as required for the safe and efficient operation and maintenance as well as for operator and management information (including all computation) of equipment under the scope of specification shall be provided on as required basis within the quoted lump sum price. For bidding purpose, tentative minimum instruments have been indicated on the P&IDs. However, contractor shall supply any additional local gauges/ switches/ transmitters/sensors for reasons mentioned above without any additional cost to the Employer.

1.04.00 The necessary root valves, impulse piping, drain cocks, gauge-zeroing cocks, valve manifolds and all the other accessories required for mounting/erection of these local instruments shall be furnished, even if not specifically asked for, on as required basis. The contacts of equipment mounted instruments, sensors; switches etc. for external connection including spare contacts shall be wired out in flexible/rigid conduits, independently to suitably located common junction boxes. The proposal shall include the necessary cables, flexible conduits, junction boxes and accessories for the above purpose. Double root valves shall be provided for all pressure tapping where the pressure exceeds 40 Kg./sq.cm.

1.05.00 For all instruments envisaged for sea water applications, they shall be provided with wetted parts made of monel/Hastelloy C or any other material (if provenness experience of the proposed material for such applications is established by Contractor).

1.06.00 All instruments shall be provided with durable epoxy coating for housings and all exposed surfaces of the instruments.

2.00.01 **SPECIFICATION FOR ELECTRONIC TRANSMITTER FOR PRESSURE, D.P., FLOW AND LEVEL**

ELECTRONIC TRANSMITTERS		
Sl.No.	**Features**	**Essential/Minimum Requirements**
1.	Type of Transmitter	Microprocessor based 2 wire type, Hart protocol compatible.
2.	Accuracy	± 0.1% of calibrated span (minimum)

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3.	Output signal range	4-20 mA DC (Analog) along with superimposed digital signal (based on HART protocol)
4.	Turn down ratio	10:1 for vacuum/very low pressure applications.
		30:1 for other applications.
5.	Stability	± 0.1% of calibrated span for six months for Ranges up to and including70 Kg/cm².
		± 0.25% of calibrated span for six months for Ranges more than 70 Kg/cm² (g).
6.	Zero and span drift	+/- 0.015% per deg. C at maximum span.
		+/-0.11% per deg. C at minimum span.
7.	Load impedance	500 ohm (min.)
8.	Housing	Weather proof as per IP-55 with durable corrosion resistant epoxy coating.
9.	Over Pressure	150% of maximum operating pressure
10.	Connection (Electrical)	Plug and socket type
11.	Process connection	1/2 inch NPT (F)
12.	Span and Zero	Continuous, tamper proof, Remote as well as adjustability manual from instrument with zero suppression and elevation facility.
13.	Accessories	-Diaphragm seal, pulsation dampeners, syphon etc. as required by service and operating condition.
		-2 valve manifold for absolute pressure transmitters (3-valve manifold for gauge/ vacuum pressure transmitters) and 5 valve manifold for DP/level/flow transmitters.
		-For hazardous area, explosions proof enclosure as described in NEC article 500.
14.	Diagnostics	Self Indicating feature
15.	Power supply	24V DC ± 10%.
16.	Adjustment/calibration/maintenance	Centralised PC based system (In Employer's Scope). In addition total two (2) no. of hand- held type universal calibrators per unit, compatible with HART protocol, shall be provided.

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Notes	
In case it becomes necessary to use a DP transmitter for pressure measurement, then a 3-valve manifold should be used in place of 2-valve manifold.	
LVDT type is not acceptable.	
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.	

2.01.00 **Ultrasonic Type level Transmitter**

Sl. No	Features	Essential/Minimum requirements
1.	Type of Transmitter	Non contact Microprocessor based 2 wire type, HART protocol compatible Ultrasonic transmitter.
2.	Output signal	Galvanically isolated 4-20mA DC (Analog) along with superimposed digital signal (based on HART protocol).
3.	Sensor Accuracy	+/- 0.5% of calibrated span.
4.	Sensor Repeatability	3 mm or better.
5.	Power supply	24 V DC +/- 10%
6.	Temperature compensation	To be provided within transducer.
7.	Configuration	Sensor unit and Electronic units are to be separate. It shall be possible to mount the Electronic unit at a remote accessible location from the transducer. All cables and weather proof fittings to interconnect transducer to electronic unit shall be provided by Bidder.
8.	Housing	Weather proof as per IP-55 with durable corrosion resistant epoxy coating.
9.	Calibration	Through HART Communicator.
10.	Zero and Span adjustment	Continuous, tamper proof, remote as well as manual adjustability from instrument. It shall be possible to calibrate the instrument without any level in the tank/sump etc
11.	Sensor Material	Corrosion resistant material to suit individual application requirement.

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12.	False signal tolerance	Transmitter shall be capable of ignoring false echoes from internal tank/sumps obstructions such as pipes, heating coils or agitator blades. Also transmitter shall have adjustable damping circuitry
13.	Range	Range of transmitter shall be capable of covering the complete level span of tank taking care of blocking distance, frequency attenuation due to surface, obstructions, vapors etc
14.	Display	Minimum 4 character display with integral keypad, access protected by user code.
15.	Diagnostics	Loss of echo alarm etc
16.	Load Impedance	500 ohms minimum
17.	Electrical Connection	Plug and socket
18.	Accessories	• All weather canopy for protection from direct sunlight and direct rain. • All mounting hardware and accessories required for erection and commissioning mounting fittings material shall be SS 316. • For hazardous areas, explosion proof enclosure as described in NEC article 500.

3.00.00 TEMPERATURE ELEMENTS

3.01.00 **Thermocouple**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of Thermocouple.	:	16 AWG wire of Chromel-Alumel (Type K) or 24 AWG wire Pt-Rhodium Pt (Type R) depending on operating temperature Range (ungrounded type).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-55/Diecast Aluminium. Plug in connectors are to be provided for external signal cable connection.
4	Sheathing of Thermocouple	:	Swaged type magnesium oxide insulation.
5	Calibration and accuracy	:	As per IEC-751/ANSI-C-96.1(special class) for T/C.
6	Characteristic	:	Linear with respect to temp, within ±1/2 percent of top range value.

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	7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
	8	Standard	:	ANSI C 96.1 for Thermocouple and ASME PTC-19.3 for Thermo-well.

3.02.00 **Resistance Temperature Detector (RTD)**

Sr. No.	Features		Essential/Minimum Requirements
1	Type of RTD.	:	Four wire, Pt-100 (100 Ohms resistance at zero degree Centigrade).
2	No. of element	:	Duplex
3	Housing/Head	:	IP-55/Diecast Aluminium. Plug in connectors are to be provided for external signal cable connection.
4	Sheathing of RTD	:	Metal sheathed, ceramic packed
5	Calibration and accuracy	:	As per DIN-43760 Class-A for RTD
6	Characteristic	:	Linear with respect to temp, within ±1/2 percent of top range value.
7	Accessories	:	Thermo well (as specified below) and shall be spring loaded for positive contacts with the well.
8	Standard	:	DIN-43760 for RTD and ASME PTC-19.3 for Thermo-well.

3.03.00 **Metal Temperature Thermocouples**

Measuring Medium	Metal Temperature
Material of Thermocouple.	Chromel Alumel Type K
Type of Thermocouple	Duplex with separate hot junctions, ungrounded
Insulation	Mineral Insulation Magnesium Oxide.
Thermocouple wire gauge	16 AWG
Protective sheath	SS 321
Protective sheath dia	8 mm O.D
Characteristics of Thermocouple	Special limits of error as in ANSI thermocouple MC 96.01.1975
Mounting accessories	1/2" BSP SS sliding end connector, weld pad, clamps of heat resistant steel SS310.

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	Cold end sealing	SS pot weal with colour coded PTFE headed sleeve Insulated flexible tails. Sealing compound- Epoxy resin.
	Minimum bending radius	30 mm
	Length of T/C	30 Mtr. (minimum)

3.04.00 **Thermo well (for all process temp. elements)**

(a) Shall be one piece solid bored type of 315 SS of step-less tapered design. (As per ASME PTC 19.3 1974)

(b) For Mill classifier outlet long life solid sintered tungsten carbide material of high abrasion resistance shall be provided.

(c) For Air & Flue gas 316 SS protecting tube with welded cap. (However contractor shall provide better material for Flue gas service if require based on the specify boiler design parameters).

(d) For furnace zone, impervious ceramic protecting tube of suitable material along with Incoloy supporting tubes and adjustable flanges.

4.00.00 TEMPERATURE TRANSMITTER

Following types of 2-wire temperature transmitter (directly powered from 4-20mA input cards of DDCMIS) shall be provided. The temperature transmitter shall be fully compatible with thermocouples and RTDs being provided by the contractor. Temperature compensation of the thermocouples shall be performed in the temperature transmitter itself.

a. Single Input Head mounted Temperature Transmitter

These shall be suitable for mounting in the head of temperature element itself. The protection class of head of thermo well along with its plug-in connector shall be min. IP65.

b. Single Input DIN-rail mounted Temperature Transmitter

These shall be especially designed for DIN-rail mounting in JBs. The specifications of the JBs shall be same as indicated in Subsection-IV:I7(INST CABLE) with additional DIN-rails and IP 65 Protection class. This temperature transmitter shall be the ones which are specially designed for DIN-rail mounting with IP 20 protection class. These shall have terminals for input/output provided on front side when mounted on DIN-rail. Head mounted temperature transmitter with clamps to make it suitable for DIN-rail mounting shall not be acceptable under this category.

c. Dual-input Temperature Transmitter With Indicator:

The dual-input TTs shall be suitable for mounting in enclosures/racks and shall be provided with clamps. Indicator shall be provided with these transmitters. These transmitters shall have bump less change over facility to second sensor in case first sensor fails .This change-over is to be alarmed. Protection class shall be IP65 minimum.

d. Common requirements for each of the above type of temperature transmitters

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Output	:	2-wire (power supply from input card of Control System) with 4-20mA output with superimposed HART protocol signal.
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)
Isolation	:	min. 500 V AC
EMC compatibility	:	as per EN 61326
Operating ambient temperature	:	0 to 85 deg C (without indicator) 0 to 70 deg C (with indicator)
Power supply		compatible with input module of Control System
Accessories		Mounting arrangements including clamps etc.
Composite Accuracy (Refer note 2)		(a) For head mounted and DIN-rail mounted types: RTD =<0.4% of 0-250 deg C span T/C-K type =<0.4% of 0-600 deg C span T/C-R type =<0.4% of 0-1000 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C (b) For dual-input type: RTD =<0.25% of 0-250 deg C span T/C-K type =<0.2% of 0-600 deg C span CJC accuracy (for thermocouples) shall be =< 1 deg C

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e. Field bus compatible temperature Transmitters (For Boiler Metal Temperature measurement applications)

Temperature transmitters *of this category shall be field mounting type & shall be capable of withstanding operating ambient temperature upto 85 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.

[redacted] [redacted] 564

Notes:-*(Common for a to e above):-*

1. In case of failure (open or burn-out) of RTD/thermocouple, temp. Transmitter shall provide low temperature output.

2. Composite Accuracy is to be calculated as summation of all applicable accuracies of temp transmitter, for converting sensor input to output in 4-20 mA (e.g., basic accuracy, digital accuracy, D/A accuracy, etc.) and temperature effect on these accuracies at ambient temperature of 50 deg C, based on the figure/ formula given in the standard product catalogue for span as specified above for various types of Temperature Elements specified. All such accuracy/ temp effect figures in catalogue shall be first converted to deg C, and then percentage of this converted accuracy in specified span shall be calculated to compare with the specified composite accuracy figures.

5.00.00 SPECIFICATION FOR FLOW ELEMENTS

5.01.00 **Orifice Plate**

Features	Essential/Minimum Requirements
Type	Concentric as per ASME PTC-19.5 (Part-II), ISA RP-3.2, 1960 or BS-1042
Material	316 SS
Thickness	3 mm for main pipe diameter up to 300 mm and 6 mm for main pipe dia above300 mm.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tappings	Flanged weld neck. 3 pairs. of tapping.
Beta Ratio	0.34 to 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, flanges, Vent/drain hole (As required)

Contractor shall submit certified flow calculation and differential pressure vs. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of computated flow calculations.

5.02.00 **Flow Nozzle**

Features	Essential/Minimum Requirements
Type	Long radius, welded type as per ASME PTC-19.5 (Part-III) or BS-1042
Material	316 SS
Thickness	Suitable for intended application.
Material of branch pipe	Same as main pipe
Root valve type	Globe
Root valve material	316 SS
Root valve size	1 inch
Impulse pipe of same material up to root valve	Required
Tapping	D and D/2 (3 Nos. of tappings)
Beta Ratio	Around 0.7
Beta Ratio calculation to be submitted	Yes
Assembly drg. and flow Vs DP Curves	Yes
Accessories	Root valves, vent and drain hole.

Contractor shall submit certified flow calculation and differential pressure vs. flow curves for each element for Employer's approval. Sizing calculation, precise flow calculation for all the flow elements, fabrication and assembly drawings and installation drawings shall be submitted for Employer's approval. One Flow element of each type shall be calibrated in the test laboratory for validation of computed flow calculations.

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6.00.00

SPECIFICATIONS FOR PR. GAUGE, D.P. GAUGE, TEMP. GAUGE AND LEVEL GAUGE.

Sl.No	FEATURES	ESSENTIAL/MINIMUM REQUIREMENTS		
		Pr. Gauge/ DP Gauge/ Draught gauges	**Temperature Gauge**	**Level Gauge**
1	Sensing Element and material	Bourdon for high pressure, Diaphragm/ Bellow for low pr. Of 316 SS	Mercury in steel for below 450°C and inert gas actuated for above 450°C of SS bulb and capillary.	Tempered *toughened Borosilicate gauge glass steel armoured reflex or transparent type.
2	Body material	Die-cast aluminium	Die-cast aluminium	Forged carbon steel/304 SS
3	Dial size	150mm	150 mm	Tubular covering entire range
4	End connection	1/2 inch NPT (M)	3/4" NPT (M)	Process connection as per ASME PTC and drain/vent 15 NB
5	Accuracy	±1% of span	± 1% of span	± 2%
6	Scale	Linear, 270° arc graduated in metric units	Linear, 270° arc graduated in °C	Linear vertical
7	Range selection	Cover 125% of max. of scale	Cover 125% of max. of scale	Cover 125% of max. of scale
8	Over range test	Test pr. for the assembly shall be1.5 to the max. Design pr. at 38°C.		
9	Housing	Weather and per IP-55	Weather and dust proof as per IP-55	CS/304 SS leak dust proof as proof
10	Zero/span adjustment	Provided	Provided	--
11	Identification	Engraved with service legend or laminated phenolic name plate		
12	Accessories	Blow out disc, siphon, snubber, pulsation dampener, chemical seal (if required by process) gauge isolation valve	SS Thermowell	Gasket for all KEL-F shield for transparent type vent and drain valves of Steel/SS as per CS/ Alloy process Requirement.

13	Material of Bourdon/ movement	316 SS / 304 SS	316 SS / 304 SS

Notes:-

* Bicolour type level gauges will be provided for applications involving steam and water except for condensate and feed water services.

Length of gauge glass shall not be more than 1400 mm. If the vessel is higher, multiple gauge glasses with 50 mm overlapping shall be provided.

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.

7.00.00 PROCESS ACTUATED SWITCHES

FEATURES	ESSENTIAL / MINIMUM REQUIREMENTS		
1	2	3	4
	Pressure/ Draft Switches/ DP Switches	Temperature switches	Level switches
Sensing Element	Piston actuated for high pressure and diaphragm or bellows for low pr./ vacuum	Vapor pressure sensing, liquid filled bellow type with SS bulb and capillary (10 m minimum)	Capacitance types for oil and dirty medium, water, condensate application. Float type switches for applications as decided by Employer during detailed engineering. Capacitance/ Conductivity/ Ultrasonic type for acid and alkali application. Radio-frequency/ Ultrasonic type for ash hopper, ash slurry application.
Material	316 SS	Bulb 316 SS/ capillary 304 SS	316 SS
End connection	½ inch NPT (F)	½ inch NPT (F)	Manufacturer standard

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	Over range proof pressure	150% of max. design pr.	-	150% of max. design pressure
	Repeatability	+ 0.5% of full range		
	No. of contacts	2 No.+2NC. SPDT snap action dry contact		
	Rating of contacts	60 V DC, 6 VA- (or more if required by DDCMIS)		
	Elect. Connection	Plug-in socket.		
	Set point/ dead band adjustment	Provided over full range.		
	Enclosure	Weather and dust proof as per IP-55		
	Accessories	Siphon, snubber, chemical seal, pulsation dampeners as required by process	Thermo well of 316 SS and packing glands	All mounting accessories
	Mounting	Suitable for enclosure/ rack mounting or direct mounting	Suitable for rack mounting or direct mounting	-
	Power Supply (wherever required)	24 V DC, to be arranged by Contractor except for Ash Level Switches, where the same shall be as per Contractor's Standard practice.		

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.

8.00.00 POSITIVE DISPLACEMENT TYPE FLOW TRANSMITTERS

The Bidder shall provide positive displacement type flow transmitters for fuel oil flow measurement, suitable for the fuel oil being used for the project, i.e., keeping in view the pressure, temperature and viscosity of the fuel oil.

The meter shall be a volumetric meter type consisting of two meshing oval wheels driven by the fluid. Each revolution of the oval wheels shall displace a precisely known volume of the fluid from inlet to outlet. The housing/measuring chamber and oval wheels shall be of 316 SS.

The measurement accuracy of the transmitter shall be better than +0.2%.

The transmitter shall provide suitable 4-20mA dc output signal for control and indication/recording. Converters if necessary shall be provided to generate the 4-20mA signal.

A local indicator of fuel oil flow shall also be provided. The instrument shall be calibrated in Tons/hr.

Suitable strainer shall be provided before the transmitter for the protection of oval wheel meters against foreign matter contained in the fuel oil.

The exact model no. and type of material being used, etc., shall be subject to Employer's approval during detailed engineering without any price repercussion to Employer.

9.00.00 OXYGEN ANALYSER INSTRUMENTS

Sl No	Specification Requirements system	Oxygen Analyser cum monitor (High temp.)	Low Temp. O2 Analyser cum monitor
1	Output signals a) Analog	4-20 mA DC galvanically isolated. If analyser provides superimposed HART signal on 4-20 mA DC output, It shall also be connected to PC based station.	
	b) Binary	2 NO + 2 NC for high alarm	
2	Zero & span Adjustment	To be provided with range selection facility.	
3	Ambient temp.	50°C	
4	Indication	Digital Alphanumeric Display. Display of reading in engineering units shall be provided	
5	Enclosure Type/Material	Weather & Dust proof (IP 55) Die cast Aluminium/SS.	
6	Type of Electronics	Microprocessor based with self diagnostic.	
7	Digital Signal transmission	HART / RS 485 Port Modbus Protocol / Ethernet TCP/IP protocol for communication with plant control system.	
8	Calibration	Auto & Manual (from Remote)	
9	Power Supply	To be arranged by Contractor subject to Employer's approval.	
10	Others	All interconnection tubing and cabling between probe and analyser / analyser panel and cabling from analyser/ analyser panel to local junction box are to be provided. All the calibration gases required for one year continuous operation shall be provided. The calibration gas container material shall not contaminate the calibration gas. The construction of the sensor shall be such that joints between dissimilar materials are avoided to prevent formation of cracks.	
11	Type of Instrument	Non-heated in-situ dry type	Heated type in-situ
12	Principle of Measurement	Partial-pressure using Zirconium Oxide Cell	Partial-pressure using zirconium oxide cell

13	Measurement Range	0.01% to 10% oxygen	0 to 25% oxygen programmable upto min 0.5% of O_2
14	Accuracy	+/-1% of F.S. or 0.5 % O_2, whichever is more	+/-1% of Full Scale
15	Linearity	+/- 1% of F.S.	+/- 1% of F.S.
16	Repeatability	≤ 0.5% of Span	≤ 0.5% of Span
17	Response time(up to 90% of full scale)	≤ 5 secs	≤ 5 secs
18	a) Temperature Drift	-	-
19	b) Zero Drift	-	< 1% span/week
20	c) Span Drift	Stability:- 1% deviation through out life of sensor	< 1% measured value/week
21	Operating Temperature Range	600-1600 deg.C	0-450 deg.C
22	Filter	Cell shall be protected using ceramic boot	Suitable filter to be provided
23	Accessories purging system	Not applicable	Not applicable
24	Temperature	Yes With R/B type thermocouples (to be finalised during detailed Engineering) required.	Automatic temperature control of heating circuit through thermostat.
25	Location	SH Zone	Air heater inlet

10.00.00 DEW POINT METER

Sensor

Type : Capacitance type with change in output proportional to moisture present.

Service : Dry Air

Range : -50 to 0 Degree Centigrade Dew-Point

Sensor Accuracy : Better than +/-0.5^

Operating Temperature : 0 to 50 degree C.

Operating Pressure : 0-10 Kg./Cm2, suitable for process application.

Analyser

Input : Change in capacitance from dew point sensor.

Display	:	Combined enclosure with two three-digit seven segments LED display with decimal point after two digits. LED height shall be 4 inches, clearly legible from a distance of atleast 10 meters.
Range	:	-50 to 0 Degree Centigrade Dew-Point
Display Accuracy	:	Better than =/-2 Degree C.
Mounting	:	Table top/Flush mounting, to be finalised during detailed engineering.
Power supply	:	240V AC, 50 Hz to be arranged by the contractor.
Output	:	4-20 mA DC capable of driving a load impedance of 500 ohms minimum.

4-20 mA DC Output signal is to be connected to control system in Contractor's Scope (Interconnection cables are to be provided by the Contractor).

In case the system is not suitable for Direct online mounting, then all the required sampling system is to be provided by the contractor.

All required accessories including cables, sensor holder, desiccant chambers, mounting fixtures etc. are to be supplied by the Contractor within his quoted lumpsum price.

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INSTRUMENTS CHECK LIST

CHECK LIST FOR PRESSURE SWITCH

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	
	1.1 MODEL NO/TAG NO						
	1.2 RANGE						
	1.3 END CONN						
	1.4 NO. OF CONTACT						
2	CALIBRATION			P	V	V	
	2.1 REPEATABILITY						
	2.2 SET POINT ADJUSTMENT						
	2.3 DIFFERENTIAL						
3	OVER PR & LEAK TEST			P	V	V	
4	ELECT. INSULATION/HV TEST	ONE		P	V	V	
5	REVIEW OF TC FOR MATERIALS OF	FOR LOT		V	V	V	
	5.1 SENSOR						
	5.2 MOVEMENT						
	5.3 PROCESS CONNECTION						
	5.4 HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	REVIEW OF TC OF MICROSWITCH	FOR LOT		V	V	V	

** 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 carry out ROUTINE TEST on 100 %.
3. Contractor to provide compliance certificate for tests/checks verifid by contractor and 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 :

** 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. 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 PRESSURE & DP 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	
	SENSOR TYPE						
	DIAL SIZE						
	MODEL NO/TAG NO						
	RANGE/SCALE						
	SWITCH CONTACT RATING & NOS.						
	END CONNECTION						
2	CALIBRATION			P	W	V	
	ACCURACY						
	REPEATABILITY						
	SET POINT ADJUSTMENT						
3	OVER PRESSURE & LEAK TEST			P	W	V	
4	OPERATION OF PRESSURE. RELIEF DEVICE	ONE		P	W	V	
5	REVIEW OF TC FOR	FOR LOT		V	V	V	
	MATERIALS OF SENSOR						
	MOVEMENT						
	PROCESS CONNECTION						
	HOUSING						
6	REVIEW OF TC FOR DEGREE OF PROTECTION	TYPE TEST		V	V	V	
7	ACCESSORIES AS APPLICABLE	SEE NOTE-1 BELOW		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. When material corelation is not available, MFR's compliance to be provided
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 LEVEL 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 / DRWGS	P	W	V	
	TYPE						
	MODEL/ TAG NO.						
	DAIL SIZE						
	RANGE/SCALE						
	END CONNECTION						
2	DIMENSIONS, PROCESS CONNECTION			P	W	V	
3	ACCURACY			P	W	V	
4	MATERIAL TC FOR	ONE / LOT		P	V	V	
	BODY ISO.						
	VALVE						
	GAUGE GLASS						
5	HYD. TEST	SEE NOTE-1 BELOW		P	W	V	
6	ACCESSORIES AS APPLICABLE			P	W	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 submit the same alongwith test certificates to be verified by BHEL.

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

CHECK LIST FOR ANNUNCIATORS

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/ MODEL						
	DIMENSIONS OF HARDWARE						
	MODULARITY						
	SEQUENCE						
	FACIA DETAILS						
2	FUNCTIONAL TEST	100%		P	W	V	
3	IMMUNE TO STEP VARIATIONS IN THE POWER SUPPLY	SEE NOTE-1 BELOW		P	W	V	
4	DEGREE OF PROTECTION FOR ENCLOSURE	TYPE TEST		P	W	V	
5	I/R CHECK	SEE NOTE-1 BELOW		P	W	V	
6	RESPONSE			P	W	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 submit the same alongwith test certificates to be verified by BHEL.

PROCESS CONNECTION & PIPING

PROCESS CONNECTION AND PIPING

1.00.00 **PROCESS CONNECTION PIPING**

1.01.00 The Contractor shall provide, install and test all required material for completeness of Impulse Piping System and Air Piping System as per the requirements of this Sub-section enclosed installation drawings and source connection drawings on as required basis for the connection of instruments and control equipment to the process and make the system complete. The installation & source connection of various items shall generally as per installation drawings (drawing no. 0000-999-POI-A-022 to 034) and source correction drawings (drawing nos. 0000-999-POI-A-035), however, the Contractor shall furnish during detailed engineering all relevant drawings, material and tech. specifications of various items service wise for Employer's approval.

1.01.01 All materials supplied under this Sub-section shall be suitable for intended service, process, operating conditions and type of instruments used and shall fully conform to the requirements of this specification. The material offered by the Bidder shall be from reputed, experienced manufacturer whose guaranteed and trouble free operation has been proven at least for two years in not less than two pulverized coal fired utility stations.

1.02.00 IMPULSE PIPING, TUBING, FITTINGS, VALVES AND VALVE MANIFOLDS

1.02.01 All impulse pipe shall be of seamless type conforming to ANSI B36.10 for schedule numbers, sizes and dimensions etc. The material of the impulse pipe shall be same as that of main process pipe. For various applications specification of associated fittings and valves shall be as given in Table PCP. For protection against sea environment all impulse pipes fittings etc. shall be provided with durable epoxy coating with poly urethane finish.

1.02.02 Stainless steel tube shall be provided inside enclosures & racks from tee connection to valve manifold and then to instrument. For high pressure/temperature applications (piping class A, B, C &D of the table no. PCP) the material shall be ASTM A 213 TP 316H and for other applications material shall be ASTM A 213 TP 316L. The wall thickness of the tube shall be in accordance with the ANSI B31.1 standard.

1.02.03 All fittings shall be forged steel and shall conform to ANSI B16.11. The material of forged tube fittings for shaped application (e.g. Tee, elbow etc.) shall be ASTMA 182 Gr. 316 H for high pressure/ temperature applications (as defined above) and ASTMA 182 Gr. 316L for other applications. The material for bar stock tube fitting (for straight application) shall be 316 SS. Metal thickness in the fittings shall be adequate to provide actual bursting strength equal to or greater than those of the impulse pipe or SS tube, with which they are to be used.

1.02.04 The source shut-off (primary process root valve) and blow down valve shall be of 1/2 inch size globe valve type for all applications except for air and flue gas service wherein no source shut-off valves are to be provided. The disc and seat ring materials of carbon steel and alloy steel valves be ASTM A-105 and ASTM A-182, Gr. F22, hard faced with stellite (minimum hardness - 350 BHN.) The surface finish of 16 RMS or greater is required in the area of stem packing. The valve design shall be such that the seats can be reconditioned and stem and disc may be replaced without removing the valve body from the line.

1.02.05 The valve manifolds shall be of 316 stainless steel with pressure rating suitable for intended application. 2 valve manifold and 3 valve manifold shall be used for pressure measurements using pressure transmitters/ pressure switches and diff. pressure transmitter/ switches respectively. 5-valve manifold shall be used for remaining applications like DP, flow and level measurements.

1.02.06 For Pr./D.P gauges in fluid application two-way globe valve on each impulse line to the instrument and in A/F application two-way gate valve on each impulse line to the instrument

	shall be provided near the instrument. These shall be in addition to the three ways gauge cock provided along with the pressure /D.P gauges.
2.00.00	**AIR SUPPLY PIPING**
2.01.00	All pneumatic piping, fittings, valves, air filter cum regulator and other accessories required for instrument air for the various pneumatic devices/ instruments shall be provided.
2.01.01	This will include as a minimum air supply to pneumatically operated control valves, actuators, instruments, continuous and intermittent purging requirements of etc.
2.02.00	For individual supply line and control signal line to control valve, 1/4-inch size light drawn tempered copper tubing conforming to ASTM B75 shall be used. The thickness of cu-tubing shall not be less than 0.065 inch and shall be PVC coated. The fittings to be used with copper tubes shall be of cast brass, screwed type.
2.03.00	All other air supply lines of 1/2 inch to 2 inch shall be of mild steel hot dipped galvanized inside and outside as per IS-1239, heavy duty with threaded ends. The threads shall be as per ASA B.2.1. Fittings material shall be of forged carbon steel A234 Gr. WPB galvanized inside and outside, screwed as per ASA B2.1. Dimensions of fittings shall be as per ASA B16.11 of rating 3000 lbs.
2.04.00	For air supply to various devices mentioned above, the bidder shall provide 2 inch size GI pipe header with isolation valve from the instrument air and service air terminal points. In the boiler area the 2 inch head shall be provided upto top most elevation of boiler floor and from this 2 inch header, 1 inch sub-header shall be branched off at each floor with isolation valve. From this 1 inch sub-header, branch line of 1/2 inch, with isolation valve shall be provided upto various devices. Similar system is to be followed for service air required for intermittent purging in the Local Instrument Enclosures (LIEs) etc.
2.05.00	All instrument air filters cum regulator set with mounting accessories shall be provided for each pneumatic device requiring air supply. The filter regulators shall be suitable for 10-kg/ sq.cm max. Inlet pressure. The filter shall be of size 5 microns and of material sintered bronze. The air set shall have 2-inch size pressure gauge and built in filter housing blowdown valve. The end connection shall be as per the requirement to be finalized during detailed engineering.
2.06.00	All the isolation valves in the air supply line shall be gate valves as per ASTM B62 inside screw rising stem, screwed female ends as per ASA B2.1. Valve bonnet shall be union type & trim material shall be stainless steel, body rating 150 pounds ASA. The valve sizes shall be ½ inch to 2 inch.
2.07.00	Purge Air Connection for Air and Flue gas Applications The continuous purging with instrument air shall be done, for all air and flue gas measurements excepting instrument air and service air instruments, at the process source connection end. Necessary arrangements required for continuous purging shall be provided inside all the Air and Flue gas enclosures as per enclosed drawing no. 0000-999-POI-A-034. For intermittent purging with service air, necessary arrangements inside all the air and Flue gas enclosures shall be provided. The SS three way valve provided in the SS tubing shall be used for isolating the transmitter & connecting the service air quick disconnect line.

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	Purging arrangement is not required for Instrument air and service air measurement applications.
3.00.00	**INSTALLATION AND ROUTING**
3.01.00	Instrument Piping System
3.01.01	For steam and liquid measurements, the impulse pipe should preferably slope downward from source connection to instrument and instrument shall be installed below the source point. If due to any reason instrument is installed above the source point, the impulse pipe should slope upwards continuously and a 'pigtail' should be provided at the instrument to assure water seal for temperature protection. For vacuum measurements instrument shall be installed above source point and impulse pipe should slope upwards.
3.01.02	Impulse piping for air and flue gas shall slope upwards and instrument shall be installed above source point. If this requirement cannot be met special venting or drain provision shall be provided with vent & drain lines along with isolation valves and other accessories including drainpipes. This drain is to be connected to plant drain through open funnel also.
3.01.03	All impulse piping shall be installed to permit free movement due to thermal expansion. Wherever required expansion loops shall be provided.
3.01.04	Special accessories such as condensing pots/ reservoirs shall be provided and installed wherever required. In any case condensing pots shall be provided for all level measurements in steam and water services, all flow measurement in steam services and flow measurements water services above 120 Deg.C. For drum/ separator level measurement required balancing chamber shall be provided.
3.01.05	Color coding of all impulse pipes shall be done by the bidder in line with the colour coding being followed for the parent pipes.
3.02.00	Instrument Air & Service Air Piping/ Tubing System
3.02.01	Instrument air & service air headers and their branches with all associated fittings & accessories shall be provided for giving supply to all consumers, as per the requirements. Air piping shall be installed always with a slope of over 1/20 to prevent accumulation of water within the pipe.
3.02.02	Single and multi tubes shall run with the minimum number of changes in direction. Suitable identification tags shall be provided for easy checkup and for connections.
4.00.00	**PIPING/TUBING SUPPORT**
4.01.00	Impulse piping and sample piping shall be supported at an interval not exceeding 1.5 meters. Each pipe shall be supported individually using slotted angle mounted clamps with necessary fixtures. Tubing shall run in proper perforated trays with proper cover. Tubing shall be supported inside the trays by aluminium supports. Hangers and other fixtures required for support of piping and trays shall be provided, either by welding or by bolting on walls, ceilings and structures. Hanger clamps and other fastening hardware shall be of corrosion resistant metals and hot-dip galvanized.

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5.00.00	**SHOP AND SITE TESTS**
5.01.00	General Requirements
5.01.01	The equipment and work performed as per this Sub-section shall be subject to shop and site test as per requirements of Sub-section-Q (Quality Assurance & Inspection) other applicable clauses of this Sub-section and Employer approved quality assurance plan.
5.01.02	Hydrostatic and pneumatic tests shall be performed on all pipes, tubing and systems and shall conform to ANSI B31.1.
5.02.00	Hydrostatic Testing
5.02.01	All instrument piping/ tubing shall be hydrostatically tested upon completion of erection. The test pressure shall be 1.5 times the maximum process pressure. The test shall be performed either with the testing of associated process piping or without the associated process piping (by closing the root valve). In both the cases the instrument shall be isolated by closing the shut-off valve.
5.03.00	Air Testing
5.03.01	All air headers & branch pipes shall be air tested by pressure decay method as per ANSI B31.1. Flexible hoses and short signal tubing shall be tested at normal pressure for leakage. Long signal tubing shall be tested by charging each tube with air at 2 kg/ sq. cm. through a bubbler sight glass. The boiler draft and vacuum piping shall be air tested by the same method as long signal tubing.
6.00.00	**LOCAL INSTRUMENT ENCLOSURE AND RACKS**
	Transmitters, switches, devices ,temperature transmitters etc. (except for all fuel oil applications which shall be mounted close to be tapping points) mounted in the field shall be suitably grouped together and mounted (i) local instruments enclosure in case of open areas of the plant like boiler area, etc. and (ii) In local instrument racks in case of covered areas. Gauges are to be mounted on a channel or a frame or a rack (Gauges shall not be mounted directly on process pipe). These local instrument enclosures and racks shall be furnished as per the actual requirements finalized during detailed engineering stage. The exact grouping of instruments in a particular instrument enclosure/instrument rack shall be as finalized during detailed engineering stage subject to Employer's approval.
	For mounting of PT/DPT/LT/FT, LIEs / LIRs shall be of three types depending on the number of transmitters located in it as elaborated in the typical GA of the LIE/LIR, drawing no. 0000-999-POI-A-064 (Sh Nos. 1 to 3 of 5).
	These dimensions and number of instruments indicated therein are only indicative and the exact dimensions along with the number of instruments shall be as finalized during detailed engineering stage without any price repercussions.
	The internal layout shall be such that the impulse piping/ blow down lines are accessible from back side of the enclosure / rack and the transmitters etc. are accessible from front side for easy maintenance. Bulkheads, especially designed to provide isolation from process line vibration shall be installed on instrument enclosures/racks to meet the process sensing line connection requirement.
	Vibration dampeners shall be installed for each enclosure / rack.