2.6.4 Analyser Monitor/Controller

2.6.4.1 The analyser monitor/controller shall be microprocessor based and shall be programmable type.

2.6.4.2 The monitor/controller shall be remote mounted type with built-in display with keyboard for data display. The cable between analyser and monitor/controller shall be supplied by the vendor.

2.6.4.3 The monitor/controller shall be able to provide sequential display for various parameters and shall be selectable from the display keyboard.

2.6.4.4 A local display unit in the field shall also be provided in the Field Rack for each probe/measurement point. Local display unit shall be intrinsically safe and loop powered type. The required active barrier (with three port isolation) for the local indicator shall be provided by vendor in the analyzer cabinet at control room. Dual power supply required for the barrier shall be provided by vendor. All field mounted instrumentation items shall be weather proof to IP 65.

2.6.5 Moisture Analyzer shall preferably be provided with integral temperature (for liquid service)/ pressure (for gas service) sensor for compensation to enhance accuracy.

2.6.6 Probes are to be shipped adequately encapsulated to maximize shelf life without loss of calibrated accuracy.

2.6.7 Filter assembly shall be with three spare filter elements with filter choke indication sensor. Assembly type and filter mesh (Micron) size shall be per vendor's recommendation.

2.6.8 In addition to the Moisture data, Pressure (for gas service), Temperature (for liquid service) and Flow (all services) indications shall also be provided.

2.6.9 A suitable purging arrangement shall be provided so that, during idling condition i.e. when the moisture probe is not in use during plant shut down or during long isolation condition, the probe can be kept in dry purged atmosphere

2.7 Oxygen Analyser

2.7.1 The type of oxygen analyser shall be offered as specified in the purchaser's data sheet. Where purchaser's data sheet does not specify the type of oxygen analyser, vendor shall select the type meeting all functional and performance requirements indicated in purchaser's data sheets.

2.7.2 The analyser design shall ensure that the analysis is not affected by other sample constituents present in the sample.

2.7.3 **Paramagnetic Type Oxygen Analyser.**

2.7.3.1 Unless otherwise specified, the principle of operation for paramagnetic type of oxygen analyser shall be magnetodynamic type or thermomagnetic type.

2.7.3.2 The analyser shall either have integral or split transducer unit containing the measuring cell and control unit containing the analyser electronics. The control unit facia shall have with LCD/LED display.

2.7.3.3 Whenever the control unit is remote mounted, cable between control unit and measuring cell shall be supplied by vendor.

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2.7.3.4 Whenever paramagnetic type analyser is specified for pressurised or variable pressure application, the offered analyser shall have required pressure compensation to ensure that the measurement is not affected by changes in sample pressure and sample vent pressure.

The analyser design shall be such that the measurement shall not be affected by changes in ambient temperature and sample flow rate.

2.7.3.5 Paramagnetic analyser shall meet the following performance characteristics as a minimum:

Accuracy	:	±1% of full scale.
Repeatability	:	<1% of Span .
Response time	:	Less than 15 seconds for 90% response.

2.7.4 **Electrochemical (Electrolytic) Type Oxygen Analyser.**

2.7.4.1 The electrochemical type of oxygen analyser shall have either aqueous or non-aqueous measuring cell and shall meet the following requirement;

a) The analyser shall be self or auto-calibrating type. The calibration cycle shall be initiated either after a pre-defined time or whenever analyser senses excessive drop/drift in the output.

b) Analyser shall provide a suitable alarm for excessive drift. This information may be available as part of HART/ separate 4-20 mA/ MODBUS output signal.

2.7.4.2 In case, in those analysers where cell need to be replaced after the depletion of electrolyte, the analyser shall, in addition, meet the following requirements;

a) The electro-chemical cell shall be easily replaceable.

b) The analyser shall provide a warning for maintenance i.e. expiration of sensor well in advance (Typically 2 weeks). In addition analyser shall also provide an alarm in case output drops below the minimum reliable calibration level.

c) One spare cell shall be supplied as part of consumable spare.

2.7.4.3 The analyser shall have integral electronics with built in LCD/LED display.

2.7.4.4 Electrochemical analyser shall meet the following performance characteristics as a minimum:

Accuracy	:	±1% of full scale.
Repeatability	:	±1% of full scale.
Response time	:	Less than 15 seconds for 90% response.

2.7.5 **Zirconia Type Oxygen Analyser**

2.7.5.1 The Zirconia type oxygen analyser shall be either in-situ type or extractive type as specified in the purchaser's data sheet.

2.7.5.2 In case of in-situ type of analyser, vendor shall ensure that the analyser as offered is suitable for the pressure-temperature specified in the data sheet and the measurement shall not be effected by changes in sample pressure and flow rate. In case of variable pressure

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application, vendor shall ensure that offered analyser has the provision for pressure compensation and/or pressure balancing arrangement.

2.7.5.3 Zirconia type of oxygen analyser shall be provided with auto-calibration facility to take care of zero-drift of cell.

2.7.5.4 The zirconia analyser shall consist of the following sub-assemblies;

2.7.5.4.1 Sensor Assembly

a) The sensor assembly shall consist of the measuring cell, heater assembly, temperature sensor and connections for reference and calibration gases.

b) The measuring cell shall be a zirconia sensor specific for oxygen measurement.

c) The sensor shall be suitable for operating sample temperature up to 700°C.

2.7.5.4.2 Control Electronics

a) The control electronics shall have capability to execute all required controls, indications, temperature control for normal operation and output signals as specified in purchaser's data sheet.

b) Sensor temperature shall be maintained through temperature controller. Temperature sensor shall preferably be ISA type K thermocouple.

c) Temperature controller shall cut-off power to heater in case of thermocouple burns out.

d) Control electronics shall preferably be remote mounted type. Cable between control electronics and sensor assembly shall be supplied by vendor.

2.7.5.4.3 Reference Gas Control

Reference gas shall be flow and pressure controlled. Flow shall be controlled by variable area flowmeter with needle valve while pressure shall be controlled by self-actuated pressure control valve provided with pressure gauge.

2.7.5.5 Zirconia type oxygen analyzer shall meet the following performance characteristics as a minimum:

Accuracy	:	± 2% of measured value.
Repeatability	:	± 1.0% of full scale.
Response time	:	Less than 10 seconds for 90% response.

2.8 Tunable Diode Laser Spectroscopy (TDLS) Analyser

2.8.1 The Tunable Diode Laser Spectroscopy (TDLS) Analyser shall be cross pipe (in situ) type flanged nozzles unless specified otherwise in the purchaser datasheet. TDLS Analyser shall be a Non-contact type measurement device and shall be suitable for temperatures up to 1500°C.

2.8.2 TDLS Analyser shall have Semi-conductor Laser Diode source in accordance with IEC 60825-1.

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2.8.3 There shall be no routine maintenance required on the TDLS purged optical windows, or field calibration requirement. Validation shall be done with a sealed gas cell of the gas to be measured or with a built-in flow-through cell on the analyser using cylindered standard gases. Validation shall be initiated manually, or on pre-determined schedule as defined by purchaser.

2.8.4 In case of variable pressure/ temperature applications, vendor shall ensure that offered analyser has the provision for pressure/ temperature compensation.

2.8.5 In case of oxygen measurement in heaters stacks & furnaces, external temperature sensing is required and transmitted to TDLS controller for temperature compensation in oxygen measurement.

2.8.6 Isolation valves for mounting the TDLS analyser shall be supplied by vendor.

2.8.7 TDLS analyzer shall meet the following performance characteristics:

Accuracy	:	± 2% of full scale.
Repeatability	:	± 1% of full scale.
Response time	:	less than 10 seconds depending on integration time.

2.9 **Viscosity Analyser**

2.9.1 Viscosity Analyser shall be Vibrating element type.

2.9.2 Sensor shall have built in Temperature detector for optimised performance over wide process temperature range.

2.9.3 The analyser shall have integral electronics with built in LCD/LED display.

2.9.4 It shall be possible to make configuration changes by an inbuilt keypad or through external configurator.

2.9.5 Viscosity analyzer shall meet the following performance characteristics

Repeatability	:	±0.5% of reading.

2.10 **Specific Gravity/ Density/ Molecular Weight Analyser**

2.10.1 Specific Gravity/ Density/ Molecular Weight Analyser Analyser shall be Vibrating cylinder (tube/ spool) or Coriolis type with Field/ Control Room mounted Signal Converter.

2.10.2 Sensor shall have built in Temperature sensor for temperature compensation.

2.10.3 Strainers shall be offered to eliminate higher particle size. Mesh size shall be as per vendor recommendation.

2.10.4 Analyzer shall meet the following performance characteristics

Repeatability	:	±0.02% of reading.

2.11 **Total Sulphur Analyser**

2.11.1 Principle of operation of Total Sulphur Analyser shall be based on Ultra-Violet (UV) spectroscopy.

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2.11.2 The Analyzer shall be microprocessor based with state-of-the-art technology and shall be capable of being configured from analyzer front panel locally using built-in keyboard.

2.11.3 Analyzer shall meet the following performance characteristics

Repeatability	:	± 1% of full scale.
Response time	:	3-5 minutes for 90% response

2.12 **Wobbe Index Analyser**

2.12.1 Unless otherwise specified, principle of Wobbe Index analyser shall be Airflow type or Residual Oxygen type.

2.12.2 Analyser shall provide 4-20 mA DC isolated linear with Stoichiometric Air/Fuel Gas ratio. Specific gravity cell along with Wobbe meter shall also be provided for giving 4 to 20mA output for molecular weight. Additionally common analyser malfunction alarm (potential free contact) shall also be provided.

2.12.3 The analyser shall have integral electronics with built in LCD/LED display.

2.12.3 It shall be possible to make configuration changes by an inbuilt keypad or through external configurator.

2.12.4 Wobbe Index analyzer shall meet the following performance characteristics:

Repeatibility	:	±0.5% of measured value
Response time	:	≤ 5 seconds for full response.

3.0 NAMEPLATE

3.1 Each analyser and its accessory shall have a stainless steel nameplate firmly attached to it at a visible place, furnishing the following information as applicable:

a) Tag number as per purchaser's data sheets.

b) Manufacturer's serial number and model number.

c) Manufacturer's name/trade mark.

d) Component being analysed and its range.

e) Area classification in which the equipment can be used.

f) Power supply requirements.

g) Analyser Outputs

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing of all the items at vendor's works as per Inspection Test Plan and approved quality documents for Process Stream Analysers.

Detailed Inspection Test Plan in line with the Standard Inspection Test Plan attached with Purchaser's specification, incorporating job-specific requirements to be submitted for Purchaser review prior to manufacturing.

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All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably covered to prevent entry of foreign material.

5.2 Each major part shall be sealed in thick plastic bag. Suitable moisture absorbent shall be provided for electronic components.

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ऑन–ऑफ वाल्वों के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR ON-OFF VALVES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	11.11.21	Revised and Reissued as Standard Specification	RM/SM	SD/SB	MN	SM
2	27.03.17	Revised and Reissued as Standard Specification	RM	AR	RG	RN
1	11.04.11	Revised and Reissued as Standard Specification	SM	RG	RP/ JMS	DM
0	15.05.07	Issued as Standard Specification	SM	TGM	HCJ	VC

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
AFR	:	Air Filter Regulator
CIMFR	:	Central Institute of Mining and Fuel Research
DD	:	Device Description
DPDT	:	Double Pole Double Throw
ERTL	:	Electronics Regional Testing Laboratory
FLDC	:	Fail Lock Drift Close
FLDO	:	Fail Lock Drift Open
HART	:	Highway Addressable Remote Transducer
MVT	:	Manual Valve Testing
NPS	:	Nominal Pipe Size
NPT	:	National Pipe Thread
PE	:	Plain End
PID	:	Proportional, Integral and Derivative
PFD	:	Probability of Failure on Demand
PST	:	Partial Stroke Testing
PTFE	:	Poly Tetra Fluoro Ethylene
SS	:	Stainless Steel
TSO	:	Tight Shutoff

Instrumentation Standards Committee

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets attached herewith describes the requirement for the design, materials, nameplate marking, inspection, testing and shipping of on-off valves.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ASME American Society of Mechanical Engineers

B 1.20.1	Pipe Threads, General Purpose (Inch)
B 16.5	Pipe Flanges and Flanged Fittings NPS½ through NPS24 Metric/Inch Standard
B 16.10	Face-to-face and End-to-End Dimensions of Valves
B 16.20	Metallic Gaskets for Pipe Flanges
B 16.34	Valves – Flanged, Threaded and Welding End
B 16.47	Large diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard

ANSI American National Standards Institute

FCI 70-2	Control Valve Seat Leakage

API American Petroleum Institute

API 6D	Specification for Pipeline and Piping Valves
API 6 FA	Specification for Fire Test of Valves
API 598	Valve Inspection & Testing
API 607	Fire Test for Quarter-Turn Valves and Valves Equipped with Non-Metallic seats
API 608	Metal Ball Valves – Flanged, Threaded and Welding Ends
API 609	Butterfly Valves: Double-Flanged, Lug- and Wafer-type
API 641	Type testing of Quarter-turn Valves for Fugitive Emissions

AWWA American Water Works Association

C207 CL.D	Steel Pipe Flanges for Water Works Services

BS British Standards

6364	Specification for Valves for Cryogenic Service

EN European Standard

10204	Metallic Products – Types of Inspection Documents
12266-1	Industrial valves. Testing of metallic valves Pressure tests, test procedures and acceptance criteria. Mandatory requirements

EPA United States Environment Protection Agency

Method 21	Volatile Organic Compound Leaks

IBR Indian Boiler Regulation

IS/IEC Indian Standards/International Electro Technical Commission

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	IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
	IS/IEC 60529	Degrees of Protection Provided by Enclosures (IP Code).
	IEC-60534-4	Inspection & Routine Testing
	IEC-61508	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related systems
	IEC-60534-3-2	Face-to-face Dimension for Rotary Control Valves Except Butterfly Valves
	IEC-61511	Functional Safety - Safety Instrumented Systems for the Process Industry Sector
ISA	International Society of Automation	
	75.01.01	Industrial – Process Control Valves – Part 2-1: Flow Capacity – Sizing Equations for Fluid Flow under Installed Conditions
	75.02.01	Control Valve Capacity Test Procedures
	TR75.04	Control Valve Position Stability
	75.05.01	Control Valve Terminology
	75.08.01	Face-to-Face Dimensions for Integral Flanged Globe-style Control Valve Bodies (Classes 125,150,250,300 and 600)
	75.08.02	Face-to-Face Dimensions for Flanged and Flangeless Rotary Control Valves (Classes 150,300 and 600)
	75.08.04	Face-to-Face Dimensions for Buttweld-end Globe-style Control Valves (Class 4500)
	75.08.05	Face-to-Face Dimensions for Buttweld-end Globe-style Control Valves (Classes 150,300,600,900,1500 and 2500)
	75.08.06	Face-to-Face Dimensions for Flanged Globe-style Control Valve Bodies (Classes 900,1500 and 2500)
	75.11.01	Inherent Flow Characteristic and Rangeability of Control Valves.
	75.19.01	Hydrostatic Testing of Control Valves
	75.08.08	Face-to-centreline Dimensions for Flanged Globe-style Angle Control Valve Bodies (Classes 150,300 and 600)
	75.25.01	Test Procedure for Control from Step Inputs
	TR 75.25.02	Control Valve Response Measurement from Step Inputs
	75.13.01	Method of Evaluating the Performance of Positioners with Analog Input Signals and Pneumatic Output
ISO	International Organization for Standardization	
	10497	Testing of valves — Fire type-testing requirements
	15848-1	Industrial valves — Measurement, test and qualification procedures for fugitive emissions
	5208	Industrial valves — Pressure Testing of Metallic Valves
	17292	Metal ball valves for petroleum, petrochemical and allied industries
MSS	Manufacturers Standardization Society	
	SP 25	Standard Marking System for Valves, Fittings, Flanges and Unions
	SP 61	Pressure Testing of Valves
	SP 67	Butterfly Valves
NACE	National Association of Corrosion Engineers	

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	MR0103	Petroleum, Petrochemical and Natural Gas Industries – Metallic Materials Resistant to Sulphide stress Cracking in Corrosive Petroleum Refining Environments.
OSHA	Occupational Safety and Health Authority	
UL	Underwriter Laboratories	
	1709	Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

a) Statutory regulations

b) Job specification/data sheets

c) Standard specification

d) Codes and standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

a) Purchaser's data sheets specify the minimum acceptable materials for the on-off valve body and trim. Alternate superior materials of construction shall also be acceptable, with the consent of purchaser, provided vendor assumes complete responsibility for proper selection of material for these parts for their compatibility with the process fluid and its operating conditions

b) Purchaser's data sheets specify the on-off valve size and open / close operation time. Vendor shall be responsible for selecting their standard valve suitable for the specified service and process conditions and operation time specified in the purchaser's data sheets.

c) Purchaser's datasheet specify the shut-off differential pressure and fire safe requirements. Vendor shall be responsible for correct selection of Actuator for the offered valves.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications. Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

b) Whenever the requirements of a detailed specification sheet for each on-off valve is specifically indicated, the specification sheet shall provide information regarding type, material of construction, capacity, open/close operation time etc. of the on-off valve and its accessories. The material specifications and units of measurement

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indicated in the specification sheet shall be to the same standards as those in purchaser's data sheet.

c) Proven references for each offered model, in line with clause no. 1.2.4 of this specification, specifically for valves with ANSI rating 600# and above, temperature more than 250°C and below -29°C , special applications like hydrogen, NACE, cryogenic, fire safe and metal seated valves with leakage rate as per API 598 or Rate A of ISO 5208.

d) A copy of approval for items such as limit switches, solenoid valves, PST positioner, whenever specified from local statutory authority, as applicable, such as Petroleum & Explosives Safety Organisation (PESO) in India, along with:

i) Test certificate from recognised test house like Central Institute of Mining and Fuel Research (CIMFR) / Electronics Regional Testing Laboratory (ERTL) etc. for flameproof enclosure and/ or intrinsic safety, as specified in the data sheet, as per relevant Indian Standard for all Indian manufactured equipments.

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Physikalisch-Technische Bundesanstalt (PTB) , Canadian Standards Association (CSA), Underwriters Laboratories (UL) etc. for compliance to ATEX directives or equivalent recognised standards for all equipments manufactured outside India.

e) Type test certificate for fire safety and fugitive emissions for on-off valve, wherever applicable.

f) Limitation, if any, in changing actuator orientation at site.

g) Catalogues giving detailed technical specifications, model decoding details and other technical information for each type of on-off valve and accessories covered in the bid.

1.2.3 For valves in cryogenic service, vendor shall meet the following acceptance criteria:

a) Vendor shall furnish, along with the offer, type test certificate, duly witnessed and certified by any one of Third Party Inspection agency like M/S Lloyds Register, DNV, BV, TUV or CEIL of having successfully conducted the cryogenic test as per BS 6364, subject to below mentioned conditions, on the offered valves (same model, size, rating and material) in cryogenic service.

i) Test temperature, unless otherwise specified, shall be -45°C for LTCS and -196°C for all grades of austenitic stainless steel.

ii) Test pressure, unless otherwise specified, shall be the maximum operating pressure.

iii) Seat pressure tests shall be conducted for the normal flow direction, unless the valves are specifically indicated as Bi-directional in Purchaser's datasheets.

iv) For valves requiring Tight Shut-off as per Purchaser's datasheets, acceptable leakage rate shall be as per class VI of ANSI FCI 70-2.

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b) Tests carried out on a particular size of one type of valve, pressure rating and material shall qualify all sizes equal to and below the test valve size for the same type, pressure rating and material. In case of austenitic SS any one grade would qualify for all other grades of austenitic SS.

c) In case vendor does not have cryogenic type test certificate for the offered valves as mentioned above, vendor shall meet one of the following requirements:

i) Vendor shall successfully carry out the cryogenic type testing as per BS 6364 on the same series (model) of the valves and type test certificate duly witnessed by any one of Third Party Inspection agency as per cl no. 1.2.3 a) for same shall be furnished for purchaser's review as part of vendor document submission after order.

ii) Vendor has proven references as per clause 1.2.4 of this specification for each of the offered valves (the same model, size, rating and material) in cryogenic service.

1.2.4 All items, as offered, shall be field proven and should have been operating individually for a period of minimum 6 months on the bid due date in the process conditions similar to those as specified in the purchaser's data sheets. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.5 Whenever specified, vendor must furnish certified values of failure rates, probability of failure on demand (PFD) and test intervals for valve and its accessories for the safety integrity level analysis.

1.2.6 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals etc., shall be in English language only.

1.2.7 Vendor's quote shall include the following:

a) Partial Stroke Testing positioner with license software for loading in purchaser's IAMS, when specified.

b) Two years' operational spares for each on-off valve and its accessories, which shall include plug, seat ring, gasket set, packing set, diaphragm, o-ring set etc. as a minimum.

1.2.7.1 Each valve quoted shall include the following:

a) One extra set of packing and bonnet gasket with each tag.

b) One extra set of stem seal o-rings for each actuator and piston o-rings additionally for each piston actuator.

c) Seat insert (soft part) for each ball valve.

d) Line bolting (set of long studs and nuts) and set of gasket, in case of flangeless valves as per material given in Annexure-1 and Annexure-2 with each such tag number

e) Line bolting (set of studs and nuts) with suitable spares in case of valves with tapped holes

1.3 Drawing and Data

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1.3.1 Detailed drawings, data, catalogues and manuals required shall be submitted by the vendor as per vendor data requirements attached with the requisition.

1.3.2 Final documentation consisting of design data, installation manual/procedure, operation and maintenance manual/calibration procedure etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each on-off valve and its accessories.

b) Certified drawings for each on-off valve and its accessories, which shall provide dimensional details (face-to-face and height of completely assembled valve), hook-up and wiring details, dimensions of clearance space for maintenance work, weight of completely assembled valve, internal constructional details, materials of construction, fire box/jacket dimensions and actuator orientation with respect to flow direction marked on the body.

c) Copy of the type test certificates.

d) Copy of the test certificates for all tests indicated in Inspection Test Plan.

e) Device Description (DD) Files for configuring PST positioner parameters.

2.0 DESIGN AND CONSTRUCTION

2.1 Body

2.1.1 On-off valves shall have flanged end connections integral to the valve body. Whenever flangeless on-off valve body design is specified in the purchaser's data sheet, following shall apply:

a) Wafer type or lug type body design for on-off valves body size up to 6 inches.

b) Lug type body design for butterfly type of on-off valve body size more than 6 inches.

However, for on-off valves with fire safe design, flanged body construction shall only be acceptable.

2.1.2 Top entry valve design shall not be offered unless specifically indicated in the purchaser's data sheets. However, for valves with butt-weld ends required as per purchaser's datasheets, top entry design shall be provided to facilitate maintenance without cutting the valve out of the pipe.

2.1.3 Unless specifically indicated otherwise, the minimum on-off valve body size shall be 1 inch.

2.1.4 The valve body rating shall be equal to or higher than the flange rating specified in the data sheets.

2.1.5 Whenever flanged body is mentioned in the purchaser's datasheet, the same shall be double-flanged and suitable for connecting to Purchaser's flanges on both sides through standard length stud bolts & nuts.

2.1.6 Unless otherwise specified, the on-off valves shall be suitable for horizontal pipe installation. When vertical pipe installation is found necessary at site, it shall be possible to suitably modify the valve assembly at site for vertical mounting. The weight of actuators and supporting of actuator should be considered in the vendor design.

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2.1.7 Unless otherwise specified, the on-off valves shall be of full-port design and the following shall apply:

a) Port size shall be equal to line size for rating up to ASME Class 1500.

b) Port size shall not be less than one size than the line size for rating ASME Class 2500 and above.

2.1.8 For steam jacketed valves, the body size and jacket line size shall be as per individual valve datasheets.

2.1.9 Flow Direction

2.1.9.1 Flow direction shall be clearly marked on the on-off valve body, preferably either stamped or cast on the valve body for uni-direction valves and 3-way valves. For Bi-directional valves, marking of flow direction on the valve is not required.

2.1.9.2 3-way on-off valves shall be clearly identified with inlet and outlet end connection.

2.1.10 End Connections

2.1.10.1 Unless otherwise specified, the following shall govern:

a) Threaded end connections shall be to NPT as per ASME B1.20.1.

b) Flanged end connections shall be as per ASME B 16.5 for sizes up to 24". For sizes 26" and above AWWA-C207 CL.D shall be followed for water applications & ASME B-16.47B for all other applications.

c) Flange face finish shall be as per ASME B16.5. The face finish shall be as follows:

125 AARH : 125 to 250 micro inch AARH

63 AARH : 32 to 63 micro inch AARH

d) Grooves of ring type joint flanges shall be octagonal as per ASME B 16.20

2.1.10.2 Face-to-face dimensions of on-off valves shall be in accordance with the relevant standard indicated in clause 1.1.2 of this standard specification.

2.1.10.3 Where provided, on-off valve bottom drains shall be blind flanged only with dimensions and rating corresponding to ASME B 16.5. Material of blind flanges shall be same as valve body material.

2.1.11 Material of Construction

2.1.11.1 The material of construction of on-off valves shall be as specified in the data sheet. Alternate superior materials of construction shall also be acceptable, with the consent of purchaser, provided vendor assumes complete responsibility for proper selection of material for the internal parts of on-off valve and compatible with the process fluid and conditions specified in the purchaser's data sheets.

2.1.11.2 On-off valve body, bonnet, bottom flange, line flanges and other pressure containing assemblies shall be of the same material of construction as specified for valve body in the purchaser's data sheets.

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2.1.11.3 The bonnet flange and bottom flange shall have metallic spiral wound gaskets suitable for the specified service. The gaskets with asbestos bearing fillers shall not be used.

2.2 Trim

2.2.1 The term 'trim' covers those parts of valve assembly (excluding the body, bonnet and bottom flange) which are exposed to and are in contact with the line medium consisting of but not limited to the seat ring, valve stem, valve plug/disc/ball, valve plug guide, cage guide bushing etc.

2.2.2 In case of ball-type of on-off valves;

a) The valve design shall ensure valve seat and body protection against thermal expansion of the entrapped fluid when the on-off valve is fully close.

b) Ball valves shall be of floating ball/trunnion mounted type as per following:

150#	6" & below	Floating ball
	8" & above	Trunnion mounted
300#	4" & below	Floating ball
	6" & above	Trunnion mounted
600#	1.5" & below	Floating ball
	2" & above	Trunnion mounted

2.2.3 Guiding

2.2.3.1 Single seated globe (unbalanced) and angle type on-off valves shall have heavy top plug guiding. Stem guided on-off valve design shall not be acceptable.

2.2.3.2 Rotary type on-off valves like Ball valves, butterfly valves etc. shall have blow out proof shaft guiding design.

2.2.3.3 Guide bushing shall be of a sufficiently hard material to resist side thrust on the plug or shaft.

2.2.4 Trim Design

2.2.4.1 Vendor shall be responsible for trim design and selection of the on-off valve. However, it must meet the following minimum requirements:

a) On-off valve trim design shall suit the type of guiding specified in the data sheet.

b) Unless specifically indicated otherwise in purchaser's data sheets, the valve characteristics shall be quick-opening (on-off) type.

c) Vendor shall select proper material pairs, surface finish, hardness and clearances to avoid galling.

d) For on-off valves operating under extreme temperature conditions, vendor shall consider increased clearances at room temperature and seal welding of threaded seat rings etc whenever required. Hard facing of trim including guide bushing shall be considered for all on-off valves operating at high temperatures (i.e. temperature more than 200°C). For very low temperature application, material used shall have adequate cold impact strength.

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e) For all on-off valves including 3-way type of valves, stem and plug shall be detachable and shall be attached together by suitable threaded design secured with a pin to avoid plug rotation during operation.

2.2.4.2 For valves in bi-directional service as per purchaser's datasheets, the valve seat design shall provide tight shut off for flow in either directions meeting the leakage requirement as per clause 2.2.5.4.

2.2.5 Trim Material

2.2.5.1 Whenever stellited trim is specified in the data sheets following material of construction for the trim parts shall also be acceptable.

a)	Ball/Disc/Plug and seat	Stellite sheathing/Chromium Carbide/Tungsten Carbide/Alloy 6 coating or solid stellite
b)	Guide	Stellite sheathing/Chromium Carbide/Tungsten Carbide/Alloy 6 coating, solid stellite or SS 440C
c)	Stem/Shaft	17-4 PHSS, Hastelloy

2.2.5.2 Minimum acceptable hardness in case of stellited or hardened trim shall be of the order of RC38 (BHN 352) to RC45 (BHN 429).

2.2.5.3 In case of rotary valves, vendor shall select the stem bearing type and material as per the process conditions. Material of construction shall be as per the wetted part material specified in the purchaser's data sheet, as a minimum.

2.2.5.4 Unless otherwise specified in Purchaser's datasheet, Leakage rate of non-cryogenic on-off valves shall be as per API 598 or Rate A of ISO 5208.

2.2.5.5. For on-off valves specified with leakage rate as per API 598, the valves should have undergone both low pressure closure test and high pressure closure test as a minimum.

2.3 Sizing

2.3.1 Unless specifically indicated otherwise in purchaser's data sheet, no sizing shall be carried out for the on-off valve, body size of on-off valve shall be same as the line size. Valve sizing shall be carried out only for those on-off valves where purchaser data sheet specify the same.

2.3.2 Vendor shall indicate the offered on-off valve flow coefficient i.e. Cv . Wherever the requirement of valve sizing is indicated, the valve capacities in terms of Cv when shown in the purchaser's data sheets have been arrived at using the formulae given in the standard ISA S 75.01.01-"Control valve sizing equations". In case vendor's sizing formulae differ from above, purchaser shall be provided with the details.

2.3.3 Rangeability of valves shall be as per manufacturers' standard. However, where purchaser's data sheet indicate the sizing requirement, the rangeability of the offered valves shall be suitable to meet specified rangeability.

2.4 Packing Box, Bonnet and Stem

2.4.1 Packing Box

2.4.1.1 The packing box shall be flanged bolted to the bonnet and shall meet the requirements specified in purchaser's data sheet.

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2.4.1.2 Generally low friction type packing like braided PTFE is preferred wherever operating conditions permit. For high temperature application (Design Temperature>200°C) and fire safe valves, Grafoil or equivalent gasket suitable for the specified service shall be selected. Asbestos based packing material shall not be used. Selected packing design shall also meet fugitive emission requirements as per clause 2.9.3.

2.4.1.3 For application in vacuum service, vendor to provide inverted packing design suitable for vacuum service. For pressure-cum-vacuum service, the on-off valve shall have dual packing design suitable for the application and Fugitive emission requirement is not mandatory for such application. Dual packing / Live loaded design shall also be provided for on-off valves in toxic service, with a facility to connect inert fluid between the packings.

2.4.1.4 3-way on-off valves of either diverting or mixing type shall have PTFE box rings, unless otherwise specified.

2.4.2 Bonnet

2.4.2.1 The bonnet shall be flanged bolted to the body. Threaded bonnets are not permitted.

2.4.2.2 Wherever the operating temperature of the fluid is above 200°C, extension or radiation finned bonnet shall be provided. Vendor standard bonnet design shall also be acceptable if these are suitable for higher temperatures.

2.4.2.3 For temperature below 0°C, vendor shall provide extended bonnet design. For valves in cryogenic application bonnet extension shall be as per BS-6364 as a minimum.

2.4.3 Stem

2.4.3.1 The stem surface finish shall be fine. Extra fine surface finish shall be provided wherever the packing material is PTFE.

2.4.3.2 The stem/shaft shall be designed for the maximum thrust of the actuator without any measurable deflection.

2.4.3.3 The valve stem/shaft shall be connected to the actuator stem/shaft by suitable arrangement to avoid backlash problem.

2.5 Pneumatic Actuator

2.5.1 Actuator shall be sized for the shut-off differential pressure indicated in purchaser's data sheets. However, for 3-way type on-off valve, the actuator shall be sized for maximum differential pressure, unless specifically indicated otherwise.

2.5.2 The actuator shall be designed to move the valve to the failure position specified in the purchaser's data sheet. For failure position specified as 'fail-last', unless vendor's actuator design has this feature in-built, vendor shall provide air reservoir as per clause 2.7.5 with all required accessories to meet the fail last position of the valve. All accessories shall be SS316 as a minimum and tubing shall be SS 316L as a minimum.

2.5.3 Actuator casing shall be made of pressed steel or anodised aluminium. Non-metallic actuator casings shall not be offered.

2.5.4 Springs shall be corrosion-resistant and shall preferably be cadmium or nickel-plated. These shall be of the enclosed type. The compression of the springs / number of springs shall be adjustable to get the desired output torque.

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2.5.5 In general, actuator operating range shall be 0.2 to 1.0 kg/cm²g, higher actuator operating range shall be acceptable provided vendor standard actuator model fails to meet specified shutoff pressure.

2.5.6 In general, spring return piston actuators shall be used for On-Off valves. Only when this type of actuator becomes extremely unwieldy, based on the data specified in the purchaser's data sheet, should a double acting piston type of actuator be considered.

2.5.7 Whenever piston and cylinder actuator is considered, single acting spring return type is preferred.

2.5.8 Whenever double acting springless type of actuator is unavoidable, all accessories like pilot valves, booster relays, non-return valve, pressure gauge, volume bottle etc. shall be provided to ensure desired action on air failure. All accessories shall be SS316 as a minimum and tubing shall be SS 316L as a minimum. Volume Bottle is not required when failure position in Purchaser's data sheet is specified as 'Fail lock'/'Fail Last' only.

2.5.9 For actuator casing design, vendor shall consider at least any one of the following:

a) Actuator casing shall be suitable for 1.5 times the maximum pneumatic operating pressure

b) Actuator provided with upstream safety valve set at "Actuator Casing suitable pressure less 0.2 kg/sq.cm.g"

c) Actuator provided with PST Positioner having Overpressure Limit feature and set for the "Actuator Casing suitable pressure less 0.2 kg/sq.cm.g"

2.5.10 Valve stem position indicator shall be provided for every on-off valve, when specified. The position indicator scale shall be calibrated from 0 to 100%.

2.5.11 In general, side-mounted handwheels are preferred when specified. Hand wheels shall provide manual on-off in both opening and closing directions independent of spring action. Hand wheels shall be of non-rising type suitable for accurate valve positioning .The hand wheel actuator shall be sized to provide the required thrust for valve positioning with 178N force applied to the hand wheel.

2.5.12 Actuator orientation shall be as per purchaser's requirements, in general. When, no requirements are indicated by purchaser, vendor shall provide recommended actuator orientation. It shall be possible to change this orientation at site for the offered valve-actuator combination in case it is found necessary.

2.5.13 For the on-off valves where operating times are specified in the purchaser's data sheets, vendor shall design the actuator and its accessories to meet these requirements. Whenever no operating time is specified, the same shall not exceed 1 second per inch of valve.

2.5.14 Actuator Sizing

a) Vendor shall be fully responsible for sizing and selection of correct actuator for the specified on-off valve. While sizing the actuator, vendor shall ensure that the actuator is able to develop sufficient thrust to properly seat the on-off valve at an air pressure which is at least 0.5 units less than the minimum air supply pressure specified in purchaser's datasheet and the specified shut-off conditions.

b) While sizing the actuator vendor shall consider actuator thrust at least 1.5 times the total force induced by shut off condition specified in purchaser's data sheet and the force required to overcome packing friction.

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2.6 Valve Jacketing

2.6.1 The jacketed valves shall have steam inlet/outlet connections as flanged.

2.6.2 The valve end connections shall be same as the jacket line size which shall be higher than the normal valve size. Body size and end connection sizes of jacketed valves shall be as per individual valve datasheets.

2.7 Accessories

2.7.1 Partial Stroke Testing(PST) Positioners

Partial stroke testing positioners with HART Protocol shall be supplied whenever specified in purchaser's datasheet. These shall meet the following minimum requirements:

a) Every positioner shall have two pressure gauges mounted on it, one each for air supply and for positioner output to actuator.

b) Cable entry shall be ½" NPTF to ASME B1.20.1. If connection for cable entry is different than that specified, suitable adapters shall be provided.

c) Positioners shall be side-mounted on the ON-OFF valve and shall have corrosion resistant linkages and rugged brackets.

d) The positioner sensor and sensing mechanism shall be rugged and shall not be affected by the line / valve vibration. The performance of the positioners shall be immune to above vibration.

e) The positioner's output and input range shall be field adjustable without any hardware modification. The output from the positioners shall be available for both single acting as well as double acting actuator.

f) Each positioner shall be operable, configurable and accessible through HART compatible hand held configurator.

g) The positioner shall be a two-wire device with HART protocol of latest version and shall be capable of implementing commands from Instrument Asset Management system/hand-held HART configurator.

h) The positioners shall be suitable to operate with commercially available asset management softwares and shall support the following features, as a minimum:

   i) It shall allow multimaster for configuration, calibration, diagnosis and maintenance. The primary could be a host computer and secondary could be a hand held communicator.

   ii) It shall be capable of implementing universal commands. It shall be possible to communicate all commands of commercially available asset management system to/ from smart positioner.

i) The offered positioners shall meet the following performance characteristics: -

   i) Overall accuracy shall be better that ±0.5% of span.

   ii) Repeatability shall be less than ± 0.25% of span.

   iii) Hysteresis shall be less than ± 0.5% of span.

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j) All positioners shall have metallic casing and cover either of stainless steel or of anodized aluminum.

k) The PST Positioner model shall be suitably selected to ensure that failure or closure of PST positioner does not result in the valve going to its fail safe position.

2.7.2 Air Filter Regulator

2.7.2.1 Vendor shall supply air filter regulator with each ON-OFF valve complete with an integral output gauge. Air filter regulator shall be downstream regulator type, in general.

2.7.2.2 Air filter regulator shall be sized considering the minimum air supply pressure and flow required to meet requirements specified in the purchaser's data sheets.

2.7.2.3 Filter material shall be sintered bronze or polypropylene. Filter size shall be maximum 5 microns.

2.7.3 Limit Switches

2.7.3.1 Unless otherwise specified, limit switches shall be proximity type and shall meet NAMUR standard. Mechanical type limit switches shall only be used when specifically indicated.

2.7.3.2 The limit switches shall be Weather proof to IP 65 and intrinsically safe. Certificates to this effect indicating the entity parameters shall be furnished from statutory body.

2.7.3.3 Suitable terminal blocks shall be provided for cable termination. Flying leads shall not be acceptable.

2.7.4 Solenoid Valves

2.7.4.1 Solenoid valves provided with all On-Off valves shall be direct acting type only. Pilot operated solenoid valves shall not be acceptable unless specifically indicated in the job specifications / data sheets.

2.7.4.2 Wherever solenoid valves are 24V DC Intrinsically safe, Solenoid Valves shall be low power consumption type, suitable for voltage available as per Safety Certification of 3-port isolation type active IS Barrier and considering a cable resistance of 12.3 ohms/km.

2.7.5 Volume Bottle / Air Reservoir

Whenever Volume Bottle / Air Reservoir is specified in purchaser's datasheets or required as per the actuator design:

2.7.5.1 Backup volume bottles for the valve operation shall be of SS304 construction and shall be designed in line with ASME Sec. VIII Div. 1 and suitable for the design pressure of 10.5 kg/cm2(G). Volume bottle thickness shall be 6 mm as a minimum.

2.7.5.2 Volume bottles shall be provided with all required accessories including PG, PSV, NRV, etc. in 316 Stainless steel construction as a minimum.

2.7.5.3 Volume Bottle shall be sized at the minimum air supply pressure for a minimum of three full strokes.

2.7.5.4 Volume Bottle shall be mounted separate from the actuator assembly as a free standing item. Minimum tubing length of 10 meters shall be considered between the volume bottle and the actuator assembly.

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2.7.5.5 Volume bottle shall be tagged with the associated on-off valve tag number by the vendor

2.7.6 On-Off valve accessories like Air Filter Regulators (AFR), PST Positioners, Solenoid valves, Limit switches, handwheel, Pneumatic lock relay etc. (wherever applicable) shall be supplied in fully assembled conditions with minimum of ¼" / 6.0mm or 8.0mm OD with 0.04"/ 1 mm wall thickness SS316L air tubing. Material for mounting part/bracket shall be SS as minimum. Tube fittings shall be of flareless compression type of SS316 material. The fitting/ ferrule hardness shall be in the range of RB 85-90 so as to ensure a minimum difference of RB 5 to 10 between tube and fitting. The ferrule shall also be made of stainless steel (SS 316). If required, tubing of higher size like ½" / 12.0mm OD or higher, min 0.049"/ 1.2mm thick for proper actuation of On-Off valve shall be provided by vendor. Accessories like AFR shall be selected to match the air tubing requirements

2.7.7 Loose Supplied Items

2.7.7.1 Whenever tube size of more than ½" is considered for any valve to meet stroke time, additional material for interface with purchaser's 1" Air piping shall be loose supplied by vendor for each valve. The items shall include isolation ball valve with required tubing (3 meters of single length) and end connectors/ adapters / swage nipple etc. as a minimum to connect the AFR's inlet port with the 1" PE Air pipe. Material of construction of all loose supplied items shall be SS316 as a minimum.

2.7.7.2 Vendor shall furnish a table of valve tags which require air supply tubing greater than ½" and detail out the items being loose supplied after order.

2.7.8 All accessories in the pneumatic scheme shall be full ported with port size same as the tube size.

2.8 Finish

2.8.1 The body shall be painted as below:

Carbon steel body	-	Light Grey (RAL 7035)
Alloy steel body	-	Yellow (RAL 1003)
Stainless steel body	-	Natural
Above 150°C	-	Aluminium White (RAL 9006)

2.8.2 The actuator shall be painted as below:

Direct action (open on air failure including FLDO) valves	-	Green (RAL 6024)
Reverse acting (close on air failure including FLDC) valves	-	Red (RAL 3001)
Fail Lock / Fail Last (Stay-put on air failure) valve	-	Yellow (RAL 1004)

Items like air volume bottle etc., supplied as an accessory along with the actuators, shall be painted as per corresponding actuator.

2.8.3 Valve Body, Actuator and accessory Paint colours complying to equivalent BIS Standard IS-5 in place of specified RAL Codes mentioned above are also acceptable.

2.9 Special Requirements:

2.9.1 Fire Safe Design Requirements

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2.9.1.1 Whenever the valves are indicated as fire safe in purchaser's datasheets:

2.9.1.1.1 All Soft seated valves in downstream Oil & Gas applications such as Refineries / Petrochemicals etc. shall be tested for fire safe requirements as per latest edition of API 607 or ISO 10497. Also, vendor's fire safe design shall be such that soft seat is not damaged while closing/opening of the valve.

2.9.1.1.2 All Metal seated valves in downstream Oil & Gas applications and all valves in Offshore and pipeline applications shall be tested for fire safe requirements as per latest edition of API 6FA or API 607 or ISO 10497.

2.9.1.1.3 In case ISO 10497 is referred for testing of valves mentioned in clauses 2.9.1.1.1 & 2.9.1.1.2, only API 607 shall be considered as 'similar internationally recognized fire test standards' mentioned in ISO 10497.

2.9.1.2 Wherever fire safe actuator and controls have been asked for, volume bottle shall be provided, unless otherwise specified in individual datasheets. Actuators and all accessories such as solenoid valves, air volume bottles etc. shall meet the fire proof requirement to ensure normal valve operation even during and after exposure to fire. Vendor shall clearly define the schemes they propose to achieve the above requirements and ensure that the proposed schemes shall meet the requirement in terms of type of exposure and exposure time of the testing procedure given in ISO10497 / API 607 / API 6FA.

2.9.1.3 Vendor must note that all items i.e. actuators, its accessories and interconnecting tubing including Volume bottles is required to be protected under fire exposure conditions. The fire protection methodologies like fully enclosed fireboxes or special material coverage are acceptable provided fire safe certification is provided for complete assembly as indicated above.

2.9.1.4 Vendor shall furnish type test certificate duly witnessed by third party inspection agency like M/S Lloyds Register, BV, DNV, TUV or CEIL . for fire safe testing of valve, actuator and controls for the offered models along with the offer. When fire safe box is offered, vendor to note that fire safe box up to maximum twice the surface area of fire box already satisfactorily fire safe type tested is acceptable provided the clearance inside the fire box with all accessories duly mounted are maintained equal to or greater than those maintained in fire safe box successfully type tested. In case, earlier fire safe test carried out by vendor is not applicable for quoted size/rating of the valve, fire safe box, then vendor shall carry out the test for fire safe design for the offered valves / actuators & controls.

2.9.2 Special Service Valves

All on-off valves in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or equivalent non-toxic reagents. End connections shall be blinded / plugged after this degreasing process in order to avoid entrance of grease and oil particles.

2.9.3 Fugitive Emission Requirements

2.9.3.1 Unless otherwise specified, all ON-OFF valves shall comply with the following performance class requirement as per ISO-15848-1:

Service	Tightness Class	Endurance Class	Temperature Class
H2, H2S and Benzene	AH / AM	CO1	t200 °C
All other services	CH / CM	CO1	t200 °C

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2.9.3.2 Type test certificates shall be provided by vendor with the offer clearly indicating the extension of qualification to untested valves. All valves supplied by vendor shall fall within this extended qualification criteria.

2.9.3.3 In case any valve supplied by vendor is not covered under the extended qualification criteria of type test certificates, vendor shall test the valve as per ISO-15848-1, prove compliance to performance class requirement as per clause 2.9.3.1, furnish the test reports for purchaser's review as part of vendor document submission before inspection and only then proceed for dispatching the valve to site.

2.9.3.4 Alternatively, On-Off valves with type test qualification as per API 641 are also acceptable in place of Class CH / CM of ISO-15848-1.

3.0 NAMEPLATE

Each on-off valve shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's data sheet.

b) Body and port sizes in inches.

c) Stem travel in millimetres.

d) Action on air failure.

e) Spring range.

f) Air supply pressure.

g) Manufacturer's model number for the valve body, actuator and positioner.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan and approved quality documents. All these tests shall be completed by the vendor and test reports shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 The on-off valve and its accessories shall be supplied pre-assembled and pre-tubed.

5.2 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.3 Valves with external lubricators shall be lubricated prior to shipment.

5.4 Valves in oxygen and chlorine service shall be packed separately along with a certificate indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE', as applicable.

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Sr. No.	Piping Classes	Nut and Bolt Material
1	A1A, A2A, A5A, A6A, A7A, A8A, A9A, A10A, A11A, A13A, A14A, A15A, A19A, A20A, A32A, A33A, A1K, A6K, A1M, A1N, B1A, B2A, B5A, B6A, B9A, B13A, B18A, B19A, B32A, B1K, B6K, B18K, B1M, B3M, B5M, B1N, B6N, D1A, D2A, D5A, D18A, D1K, D18K, D18P, E1A, E2A, E5A, E5E, F5A	A-193 Gr. B7 A-194 Gr. 2H
2	A16A, B16A	A-193 Gr. B7M A-194 Gr. 2HM
3	A1B, A1D, A4F, A4G, B1B, B1D, B5D, B1E, B3F, B4F, B4G, D1B, D2B, D1D, D2D, D5D, D5E, F2D	A1-193 Gr. B16 A-194 GR. 4
4	A2K, B2K, D2K	A-320 Gr. B8 CL.2 A-194 Gr. 8
5	A4A, A1H, B4A, B1H, D4A, D1H	A-320 Gr. L7 A-194 Gr. 4
6	A3Y	A-307 Gr. B A-563 Gr. B
7	A3A, A3K, A3Y, A4Y, J3A	A-307 Gr. B A-563 Gr. B
8	A1Z, A4Z, A5Y, A5Z, J2A, J5A	A-307 Gr. B (Galv) A-563 Gr. B (Galv)
9	B4K, B5K	A-193 Gr. B8 M Cl1 A-194 Gr. 8 MA
10	A32Y	A-193 Gr. B (Galv) A-194 Gr. 2H (Galv)
11	B3M, B4K, B5K, B5M	A-453 Gr. 660 CL.A A-453 Gr. 660 CL.A

1. The nuts and bolt material shall be applicable for loose supply of nuts and bolts.

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Sr. No.	Piping Classes	Gasket Material
1	A1A, A6A, A9A, A10A, A11A, A13A, A14A, , A19A, A1B, A1D, A1H, A1K, A1M, A4A, A4F, A4G, B1A, B1H, B2A, B4A, B6A, B9A, B13A, B18A, B19A, B32A, B18K, D1A, D2A, D1H, D1K, D4A, D18A, D18K, D18P	SP.WND SS316+GRAFIL+ I Ring
2	B5M	SP WND SS316H+ GRAFIL + I RING
3	A2K, B2K, D2K	SP WND SS 316+GRAFIL+SS 316 I/O RING
4	B1N	SP WND SS 316L+GRAFIL + I RING
5	B6N	SP WND SS 316L + GRAFIL
6	A1Z, A3Y, A4Y, A4Z, J2A	BUTYL RUBBER
7	E1A, E2A, E5A, F5A	SOFT IRON
8	E5E, F2D	5% CR, 0.5% MO
9	B4K, B5K	SS 316H+GRAFIL+I RING SS 316 O RING
10	A5Z	BS 7531 GR X (PTFE JACKETED)
11	A5Y, A8A, A15A, A32Y, A33Y	IS 2712 Gr. A/1
12	B3M	SP WND SS 321+GRAFIL+I RING
13	A1N, A6K, A16A, B16A	SP.WND SS316L+GRAFIL+ I Ring
14	A3A, A3K, A33A, J3A, J5A, A32A, A20A	NON ASBESTOS BS 7531 GR X
15	A2A	SP.WND SS316L+GRAFIL+ I Ring
16	B5A, D5A	SP.WND SS316L+GRAFIL+ I Ring
17	A7A, B1B, B1D, B1E, B1K, B3F, B4F, B4G,B5D, D1B, D1K, D2B, D1D, D2D, D5D, D5E	SP WND SS 316 + GRAFIL + I RING
18	B6K, B1M	SS 316 + GRAFIL

1. The gaskets material shall be applicable for loose supply of gaskets.

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डीसुपरहीटरों और पी.आर.डी.एस के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR DESUPERHEATERS AND PRDS.

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
3	02.09.22	Revised and Re-issued as Standard Specification	MK	KR	MN	SM
2	21.11.17	Revised and Re-issued as Standard Specification	SM	SB	RG	RN
1	22.03.12	Revised and Re-issued as Standard Specification	SC	RG	RP/JMS	DM
0	05.05.06	Issued as Standard Specification	RG	HCJ	PM	VJN

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Abbreviations:

AARH	Arithmetic Average Roughness Height
BFW	Boiler Feed Water
DS	Desuperheater
FISCO	Fieldbus Intrinsic Safety Concept
HART	Highway Addressable Remote Transducer
NPT	National Pipe Thread
NPS	Nominal Pipe Size
OSHA	Occupational Safety and Health Authority
PID	Proportional, Integral and Derivative
PRDS	Pressure Reduction and Desuperheater
PTFE	Poly Tetra Fluoro Ethylene
TSO	Tight Shutoff
SS	Stainless Steel

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets, covers the requirements for the design, materials, assembly, painting, nameplate marking, inspection, testing and shipping of desuperheaters and PRDS.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest edition prior to the date of purchaser's enquiry;

ASME	American Society of Mechanical Engineers	
	B 1.20.1	Pipe Threads, General Purpose (Inch)
	B 16.5	Pipe Flanges and Flanged Fittings
	B 16.20	Metallic Gaskets for Pipe flanges
	B 16.47-B	Large Diameter Steel Flanges
ANSI/FCI	American National Standard Institute/Fluid Control Institute	
	FCI 70-2	Control Valve Seat Leakage
ASTM	American Society for Testing and Materials	
EN	European Standards	
	10204	Inspection documents for Metallic Products
IBR	Indian Boiler Regulation	
ISA	International Society of Automation	
	S 75.01.01	Flow equation for sizing control valves.
	S 75.02	Control valve capacity test procedure.
	S75.13	Method of evaluating the performance of positioners with analog input signals and pneumatic output.
	S75.17	Control valve aerodynamic noise prediction
	S75.25.01	Test Procedure for Control valve response measurement for step inputs
IS/IEC	Indian Standards/International Electro-Technical Commission	
	IS/IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere
	IS/IEC-60529	Degree of Protection Provided by Enclosures
	IEC 60534-8.3	Industrial process control valves, noise consideration, control valve aerodynamic noise prediction method
	IEC 60534-8.4	Industrial process control valves, noise consideration, prediction of noise generated by hydrodynamic flow
	IS/IEC-61158	Fieldbus Standard for use in Industrial Control System
	IEC-61158-2	Physical layer specification and Service definition for Fieldbus
	IEC-61804	Function Blocks (FB) for Process Control: Electronic Device Description
ITK	Interoperability Test kit (Latest version)	
MSS	Manufacturer's Standardisation Society	
	SP25	Standard Markings system for Valves, Fittings, Flanges and Unions
OSHA	Occupational Safety and Health Authority	

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1.1.3 In the event of any conflict between this standard specification, job specifications/data sheets, statutory regulations, related standards and codes. the following order of priority shall govern:

a) Statutory Regulations

b) Job Specifications/Data Sheets

c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendors' extent of responsibility shall include the following:

a) Sizing and selection of desuperheater, pressure reduction and desuperheating station and temperature control (coolant) valve as per purchaser's datasheets.

b) Detailed design of desuperheater and PRDS including mechanical design of its components and internals like stem, plug assembly, atomising nozzle, sleeve, seat assembly, bonnet, packing etc.

c) Purchaser's data sheets indicate the minimum requirements of material of construction for the body, trim (i.e. stem, plug and seat), atomising nozzles, sleeve, packing, gasket etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for all the parts of the desuperheater/ PRDS so as to be compatible with the process fluid and its operating conditions.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) A detailed specification sheet for each item shall be furnished, which shall provide information regarding type, principle of operation, material of construction, flow co-efficient (C_V) data, % opening, rangeability, leakage class, capacity and end connection etc. of the desuperheater and its accessories for each desuperheater. The material specification and the units of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) A detailed sizing sheet for each desuperheater / PRDS including pressure reduction control valve and coolant control valve, as required shall be submitted. The sizing sheet shall also include the following information for each desuperheater/PRDS;

i) Minimum Velocity Requirement

ii) Maximum Turndown

iii) Minimum coolant pressure, flow and temperature requirement

iv) Maximum coolant pressure requirement

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v) % opening of desuperheater, temperature control valve and pressure control valve at minimum/maximum condition

vi) Expected Outlet steam temperature with respect to saturation temperature.

vii) Full open flows for pressure reducing valve and temperature control valve considering maximum inlet pressure/temperature.

d) Proven references for each offered model of desuperheater/ PRDS in line with clause 1.2.3 of this specification.

e) Vendor to indicate minimum upstream and downstream pipe straight length requirements and location of temperature sensor downstream of desuperheater. For the straight-lengths, vendor shall clearly indicate the reference point of straight length measurement w.r.t water injection point.

f) A copy of approval from local statutory authority, as applicable, such as Petroleum and Explosives Safety Organization (PESO) in India, for the electronic instruments installed in electrically hazardous area along with:

i) Test certificate from recognised test house like Central Institute of Mining and Fuel Research (CIMFR) / Electronics Regional Testing Laboratory (ERTL) etc. for flameproof enclosure and / or intrinsic safety, as specified in the data sheets, as per relevant Indian standard for all Indian manufactured equipments.

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Physikalisch-Technische Bundesanstalt (PTB), Canadian Standards Association (CSA), Underwriters Laboratories (UL) etc. for compliance to ATEX directives or other equivalent standards for all equipments manufactured outside India.

g) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason, they must include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with the technical reasons for each of these deviations.

h) Catalogues giving detailed technical specifications, model decoding details and other related information for each model of desuperheater / PRDS covered in the bid.

i) Schematic drawing indicating scope of supply of desuperheaters/ PRDS, coolant control valves, pressure reducing valves, strainers etc. as applicable alongwith end connections and ratings shall be furnished.

j) Bidder to indicate recommended desuperheater / PRDS orientation along with all other allowed orientations with bid.

1.2.3 All items, as offered, shall be field proven and should have been operating individually for a period of minimum six (6) months on the bid due date in the similar application with the process conditions / applications similar to those as specified in the purchaser's data sheets. Items with prototype design or items not meeting provenness criteria specified above shall not be offered.

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1.2.4 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals, etc shall be in English language only.

1.2.5 Vendor shall also quote for the following:

a) Two years operational spares for each desuperheater, PRDS, control valves and its accessories, which shall include plug, nozzle, seat, stem, cage packing, gaskets, actuator diaphragm, positioner, air filter regulator etc. as a minimum.

b) One extra set of packing along with each desuperheater, PRDS, pressure-reducing valve and temperature control valve, as applicable.

c) Two nos. of strainers.

d) Loose supply of suitable nut bolt and gasket wherever valve and desuperheater assembly is supplied by vendor and for flangeless desuperheaters.

e) Any special tools needed for maintenance work. In case no special tools are necessary for the offered desuperheater / PRDS or their accessories, vendor must clarify the same in their offer.

1.3 Drawings and Data

1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints and soft copies should be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operational and maintenance manual etc. shall be submitted by the vendor after placement of purchase order. Vendor shall include the following, as a minimum:

a) Specification sheets for desuperheaters, PRDS, related control valves and their accessories, as applicable.

b) Certified drawing sheets for each desuperheater, PRDS, related control valves and their accessories, tag number wise, as applicable, which shall provide the following information:

i) Overall dimensions in millimetres.
ii) Clearance space required for maintenance work in millimetres.
iii) Material of construction.
iv) Weight of complete assembly.

c) Sizing sheet for each desuperheater / PRDS / control valve.

d) Copy of type test certificate, as applicable.

e) Copy of test certificates for all the tests indicated in clause 4.0 of this specification.

f) Installation procedure for desuperheater / PRDS / Control valves.

g) Calibration and maintenance procedure for desuperheater / PRDS / positioner / control valves including replacement of parts, as applicable.

h) Device Descriptor (DD) Files for configuring Smart positioner/ Fieldbus parameters.

i) Common File Formats (CFF) for integrating the fieldbus positioner into the control system.

2.0 DESIGN AND CONSTRUCTION

2.1 General

2.1.1 Vendor shall offer type of desuperheater/PRDS as per the type specified in the purchaser's data sheets, ensuring that the selected desuperheater meets the process requirements

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specified in data sheets, particularly the pressure and temperature characteristics of the process fluid at the outlet of the desuperheater. In case, vendor offers desuperheater of a type other than that specified, they must indicate the specific technical reason along with their offer.

2.1.2 The coolant injection of desuperheater/PRDS shall be solely responsible for coolant atomisation and shall ensure uniform atomisation of the coolant fluid without requiring separate atomising fluid.

2.1.3 Liner

a) Vendor must review the design of desuperheater / PRDS with respect to the specified process conditions and ensure that steam velocity does not fall below the allowable minimum fluid velocity for the selected desuperheater. Vendor shall supply a velocity liner, if required, to ensure a reduction in the pipe diameter to achieve the minimum required steam velocity for proper desuperheater functioning. However, vendor shall ensure that the pressure drop stays within the allowable pressure drop specified in the purchaser's data sheet.

b) Vendor shall review and provide thermal liner, if necessary, for the protection of steam line, particularly where the difference between the operating temperature of the coolant temperature and process fluid temperature exceeds 250 °C and/or where pipe thickness exceeds 12mm.

c) The diameter, length, material and design of the liner shall be decided by the vendor. The liner material as selected shall be suitable for the process conditions specified in the purchaser's data sheets.

d) The liners shall be pre-installed inside vendor supplied flanged spool pieces, along with the main desuperheater / PRDS. Material, size and rating of the flanged spool piece shall be same as that of the corresponding desuperheater / PRDS body material.

2.1.4 The flow direction of the process fluid shall be clearly marked preferably stamped or cast on the desuperheater/ PRDS/ control valve body. In case where direction is stamped on the body, vendor must ensure that stamped portion is unambiguously clear and visible.

2.1.5 The desuperheater, PRDS, pressure reducing valve and coolant valve body rating shall be equal to or better than the flange rating specified in the data sheet (purchaser specifications). The desuperheater / PRDS rating (body and end connections) shall be higher of the rating required to meet design conditions of both steam (process fluid) and coolant liquid.

2.1.6 Material of construction

a) The material of construction of body and trim of desuperheater, PRDS and control valves shall be as specified in the purchaser's data sheet.

The term trim covers those parts of desuperheater, PRDS and control valve assembly, excluding the body, which are exposed to and are in contact with the line fluid consisting of but not limited to the seat ring, plug, stem, atomising nozzles, coolant sleeve, plug guide, guide bush and cage.

b) For the internals where no material of construction is explicitly indicated in the purchaser's data sheet, vendor shall select the material based on their standard design but ensuring suitability of the material for the specified process conditions.

c) Whenever purchaser's data sheet specify trim material as hardened SS or stellited SS, vendor may select alternate material as Nitrided plated SS / solid stellite / 440C / 17-4 PH SS, provided the selected material is compatible with the specified process conditions.

d) Vendor shall ensure that selected material, surface finish, hardness and clearances for the parts, which slide against each other, shall avoid galling effect.

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In addition, valve stem surface finish shall be selected considering type of packing used.

e) Unless specified otherwise in purchaser's data sheet, the material of construction of desuperheater and BFW control valve trim / internals shall be as follows:

Seat	-	Stellite
Plug	-	Nitrided SS / Stellited SS / Solid Stellite
Desuperheater Nozzles	-	Stellite
Desuperheater Internals	-	SS316
Cage	-	SS Nitrided / 17-4 PH SS

f) Unless otherwise specified, the Nut-bolt and gasket material shall be as follows:
i. Nut & Bolt: For pressure rating up to 1500#, stud bolt & nut shall be ASTM A193 gr. B7 & ASTM A194 gr. 2H respectively. For pressure rating of 2500#, bolt & nut shall be as per ASTM A194 gr. 4 & ASTM A193 gr. B16 respectively.
ii. Gasket: For line rating up to 600#. gasket shall be sp. wnd. + SS316 + grafil. + I-ring. For line pressure rating of 900# and 1500#, gasket shall be octagonal ring of rating 900# or 1500# respectively of MOC soft iron. For line pressure of 2500#, gasket shall be 5% Cr, 0.5% Mo, 130 BHN max, oct-ring, 2500#.

g) The body and trim design and material of construction shall be such that the unit is capable of withstanding excessive stresses produced due to pressure reduction and thermal quenching because of coolant.

h) The plug and seat assembly shall be of sufficient hardness to avoid any wear and tear of these components

2.1.7 End Connection:

a) Unless otherwise mentioned, end connection details shall be as below:

i) Threaded end connections shall be to NPT as per ASME B 1.20.1.
ii) Flanged end connections shall be as per ASME B 16.5.
iii) Grooves of ring type joint flanges shall be octagonal as per ASME B16.20.
iv) Flanged face finish shall be as per ANSI B 16.5. The face finish shall be as follows:

125 AARH	:	125 to 250 microinch AARH
63 AARH	:	32 to 63 microinch AARH

2.1.8 Vendor shall supply two (2) numbers of strainers for installation in coolant line. Unless specified otherwise, these strainers shall be installed in 1:1 (one main and one standby) configuration by purchaser in coolant line.

2.1.9 The coolant control valve shall be of leakage class V as per ANSI/ FCI 70-2.

2.1.10 Where provided, desuperheater, PRDS and control valves bottom drains shall be blind flanged only, with dimensions and rating corresponding to ASME B 16.5. Material of blind flanges shall be same as main body material. No threaded or welded plugs shall be provided.

2.1.11 Radiography of desuperheaters, PRDS and control valves shall be carried out, for all applicable tags as per datasheets and other purchaser specifications, and for all castings of pressure class ANSI 600# and above.

2.2 Desuperheaters

2.2.1 Atomising Spray Nozzle Type Desuperheater

2.2.1.1 Atomising spray nozzle type of desuperheater shall have insertion type of design and shall consist of a coolant injection assembly with nozzle / nozzles inserted perpendicular to the process line. The length of insertion shall be such that the uniform vaporisation of coolant

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shall take place throughout the cross section of the desuperheater internally avoiding impingement of cooling media on pipe walls.

2.2.1.2 The desuperheater shall be either single nozzle or multi nozzle design as per the vendor standard design. However, vendor shall ensure that design of offered type of desuperheater shall avoid problems related to larger coolant droplet size and poor atomisation.

2.2.1.3 In case of multi nozzle desuperheater design, the number of nozzles required in the atomiser shall be decided based on the process requirements specified in purchaser's data sheets.

2.2.1.4 The desuperheater shall have an integral control valve, which shall regulate amount of coolant in to the desuperheater. This valve along with a temperature transmitter and temperature controller shall form part of the temperature control loop, which shall be able to control the temperature within 6 to 7°C of the saturation temperature. Unless otherwise specified, temperature element / transmitter and temperature controller are beyond vendor's scope of supply.

2.2.1.5 Whenever specified or necessitated by the desuperheater design, a separate temperature control valve shall be used.

2.2.1.6 The inherent characteristics of the integral coolant control valve shall be equal percentage / modified linear.

2.2.1.7 Integral coolant control valve shall have leakage class V as per ANSI / FCI 70-2, as a minimum.

2.2.1.8 End connections:

a) Unless specified otherwise in purchaser's data sheet, the desuperheater shall be supplied with following end connections;
Body connection - 3" flanged
Coolant connection - 1" flanged

b) The rating and facing of end connection flanges shall be as specified in purchaser's data sheet.

c) Nut-bolt & gasket shall be as per 2.1.6f.

2.2.1.9 Material of Construction: The material of construction shall be as per 2.1.6.

2.2.2 Venturi Type Desuperheater

2.2.2.1 Venturi type of desuperheater shall be a line-mounted desuperheater wherein coolant is preheated in the circulating chamber around the water diffuser tube and is introduced in many small jets to achieve atomisation. Such a desuperheater shall be capable of installation in horizontal as well as in vertical line.

2.2.2.2 This type of desuperheater shall be provided with a separate temperature control valve, which along with temperature controller shall form part of temperature control loop. This desuperheater shall be able to control the outlet temperature within 5°C to 6°C of the saturation temperature of the line fluid. Unless specified otherwise, temperature element / transmitter and temperature controller are beyond the vendor's scope of supply.

2.2.2.3 End connection:

a) Venturi type desuperheater shall generally be offered with wafer type of design suitable for mounting in between line flanges. The line reducers / expanders if required shall not be in vendor scope of supply. Long stud-bolts and set of gaskets required for the installation of desuperheater shall be supplied by the vendor.

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b) Unless otherwise specified in purchaser's data sheets, the end connections for the coolant shall be 1" flanged.

c) Nut-bolt and gasket shall be as per clause 2.1.6f.

2.2.2.4 Material of Construction: The material of construction shall be as per clause 2.1.6.

2.2.3 Lifting plug (variable orifice) type desuperheater

2.2.3.1 Lifting type of desuperheater shall be in-line mounted desuperheater, which shall desuperheat the process fluid flowing through it by the coolant, which is injected into the low-pressure area created by a lifting plug in the direction of flow over the seat area. The design shall ensure that the injection of the coolant into a low-pressure area and the subsequent turbulence in the process stream shall result in complete atomisation and vaporisation of the coolant by the superheated line fluid, which shall subsequently desuperheat.

2.2.3.2 This desuperheater shall require a separate control valve, which along with temperature controller shall form part of temperature control loop. This desuperheater shall be capable of controlling outlet temperature within 5°C to 6°C of the saturation temperature of the line fluid.

2.2.3.3 Vendor to ensure that the maximum pressure drop across the desuperheater shall be less than allowable pressure drop indicated in data sheets.

2.2.3.4 The desuperheater body shall be flanged and shall be mounted in the line always in vertical position.

2.2.3.5 Unless specified otherwise, the material of construction of plug shall be SS316 while plug seating and seat shall be SS 316 stellited.

2.3 Pressure Reduction and Desuperheating Station (PRDS)

2.3.1 Whenever specified, PRDS shall have pressure reduction along with the desuperheating of process fluid as a complete assembly. Type of PRDS (as per clause 2.3.2 and 2.3.3 of this specification) shall be offered as per purchaser's datasheet.

2.3.2 Combined pressure reduction and desuperheating unit (CPRDS):

2.3.2.1 Combined pressure reduction and desuperheating unit shall reduce pressure and temperature of the process fluid simultaneously in one common unit. The design shall ensure that desuperheating is achieved by injecting coolant in the centre of the line flow i.e. in an area of high velocity, minimum pressure and very high turbulence through a coolant sleeve and atomising injection nozzles thus contributing to very efficient mixing and very high evaporation of the coolant. The pressure reduction shall be achieved by multipath / multistage trim assembly design.

2.3.2.2 In case noise level is higher than 85 dBA, vendor shall consider special PRDS design with source treatment of noise, i.e. low noise trims. When source treatment for noise is not sufficient to reduce the noise level below 85 dBA, vendor shall provide path treatment like diffuser plates (baffles, silencer, etc), in addition to source treatment, at the outlet of PRDS to limit the noise level below 85 dBA.
For low noise trims, the no. of stages shall be decided by vendor ensuring that the selected number of stages can sufficiently withstand the dynamic fluid forces to avoid vibration of stem and plug during normal continuous operation. Vendor shall ensure trim design to account for worst case dynamic force / power generated by the process fluid under maximum operating conditions with a 10% safety margin.

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The maximum differential pressure across the path treatment shall not exceed 20% of the specified differential pressure.
The path treatment shall be installed within expander assembly with flanged end connections.
Vendor shall also furnish noise calculations with and without the use of these devices and the noise abatement achieved in individual components.
The stud-bolts, nuts and gasket material shall be as per section 2.1.6f. Design shall ensure that the performance of PRDS is insensitive to the negative effect of coolant evaporation because of presence of path treatment.

2.3.2.3 The rangeability of PRDS shall be atleast 50 to 1 even when diffuser plates or silencer is provided to reduce the noise level.

2.3.2.4 Unless otherwise specified, the PRDS shall have leakage class IV as per ANSI/ FCI 70-2.

2.3.2.5 Inherent flow characterisation of PRDS shall be modified linear, in general.

2.3.2.6 The unit shall be capable of controlling temperature within 6° C of saturation temperature of process fluid. A separate control valve shall form part of temperature control loop consisting of temperature transmitter and temperature controller. Unless otherwise specified, temperature element/transmitter and temperature controller shall be beyond vendor's scope of supply.

2.3.2.7 The pressure control shall be achieved by a downstream pressure sensor/transmitter and pressure controller, which regulates the pressure regulator of PRDS through its integral actuator. Unless specified otherwise, pressure transmitter and pressure controller shall be beyond vendor's scope of supply.

2.3.2.8 Material of Construction: The material of construction shall be as per section 2.1.6.

2.3.2.9 End Connection:

a) PRDS shall have flanged end connections and shall be installed directly in the line.
b) Unless otherwise specified, coolant connection shall be 1" flanged.

2.3.3 Separate Pressure Reduction and Desuperheating unit (SPRDS)

2.3.3.1 PRDS with separate pressure reduction and desuperheater assembly construction shall be offered when specifically indicated in the Purchaser's datasheet. Such a unit shall be supplied as a complete assembly along with line reducers/expanders and interconnecting piping. The pipe section between pressure reducing valve and desuperheater (material same or different than that is indicated in purchaser's specifications) shall also be supplied by vendor.

2.3.3.2 Complete assembly shall be supplied with flanged end connection including control valve and desuperheater, which shall also have flanged end connections. The type and rating of flanged ends shall be as specified in purchaser's data sheets. The stud-bolts, nuts and gasket materials shall be as per clause 2.1.6f.

2.3.3.3 In the pressure reducing and desuperheating assembly dedicated pressure reduction control valve shall be located upstream of the desuperheater and shall form part of pressure control loop. Unless specified otherwise, pressure transmitter and pressure controller shall be beyond the vendor's scope of supply.

2.3.3.4 PRDS assembly shall be sized as per the process conditions specified in the purchaser's data sheet. However, the pressure drop indicated in purchaser's data sheet may be readjusted across desuperheater and control valve keeping battery limit pressure drop unchanged.

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Desuperheater end connection rating if required to be upgraded because of pressure drop readjustment shall be taken care of by vendor.

2.3.3.5 The pressure reducing control valve trim design shall be special low noise type. Control valve with external diffuser may be offered along with the special trim when special trim alone is not sufficient to reduce the noise level below the specified limits and the pressure drop across the diffuser does not affect the pressure control loop sensitivity/controllability. Diffuser shall be suitable for design condition.

2.3.3.6 All other desuperheater requirements shall be similar to the type of desuperheater selected alongside the pressure-reducing valve.

2.4 Sizing criteria

2.4.1 The sizing of the desuperheater / PRDS shall be carried out as per the process conditions specified in the purchaser's data sheets.

2.4.2 Vendor shall consider the following points while sizing the desuperheater, unless specifically indicated otherwise in purchaser's datasheets:

a) Coolant flow shall be calculated for the worst conditions specified as tabulated below.

Required cooling water / BFW / coolant flow (F_W) is	When the following conditions are present *maintaining outlet enthalpy, H_D (and temperature) as constant*		
	Steam / process fluid flow (F_S) is	Inlet (superheated) steam / process fluid enthalpy (Hs) / temperature is	Cooling water / BFW / coolant enthalpy (H_W) / temperature is
Minimum	Minimum	Minimum	Minimum
Maximum	Maximum	Maximum	Maximum

b) Highest and lowest available pressure difference between steam pressure and coolant pressure for minimum flow and maximum flow respectively.

c) Required turndown ratios including coolant turndown ratio (minimum to maximum coolant flow, i.e. nozzle turndown) and turndown ratio of the desuperheated fluid (system turndown).

d) Required coolant flow to fluid to be desuperheated.

e) For temperature control valves in cooling water / BFW / coolant liquid lines of the desuperheater / PRDS, unless specified otherwise, the control valve shall be supplied with a multistage trim if the differential pressure between liquid coolant inlet and steam / process fluid outlet is 20 kg/cm^2g or greater. The no. of stages shall be decided by vendor ensuring that the selected number of stages can sufficiently withstand the dynamic fluid forces to avoid vibration of stem and plug during normal continuous operation. Vendor shall ensure trim design to account for worst case dynamic force / power generated by the process fluid under maximum operating conditions with a 10% safety margin.

2.4.3 The flow coefficient (Cv) of the desuperheater shall be selected such that preferably it operates between 20% to 80% of the lift under minimum and maximum conditions. However, the desuperheater with lift less than 10% and/or higher than 90% shall not be selected even under worst operating conditions.

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2.5 Actuator

a) The actuator of the desuperheater and control valves shall be sized for the shutoff differential pressure indicated in the data sheet.

b) The actuator shall be pneumatically operated with its casing made up of pressed steel or anodised aluminium. Non-metallic actuator casing shall not be offered. The actuator operating range shall be 0.2 to 1.0 kg/cm^2 preferably.

c) In general, spring opposed diaphragm type of actuators are preferred. Only when this type of actuator becomes extremely unwieldy, piston and cylinder type with single acting spring return can be considered.
For actuator casing design, vendor shall consider at least any one of the following:
- Actuator casing shall be suitable for 1.5 times the maximum pneumatic operating pressure
- Actuator provided with upstream safety valve set at 'actuator casing suitable pressure less 0.2 kg/cm^{2}g'.
- Positioner's overpressure limit feature set for 'actuator casing suitable pressure less 0.2 kg/cm^{2}g'.

d) Whenever double acting springless type of actuator is unavoidable, all accessories like pilot valves, booster relays, non-return valve, pressure gauge, volume tank etc (volume bottle / air reservoir), shall be provided to achieve desired failure action on air failure.
The volume tank shall be free standing equipment and not mounted on actuator. The volume tank shall be sized considering the minimum air supply pressure and considering full stroking of the desuperheater PRDS / valve for three full strokes. The volume tank shall be of SS316 construction as a minimum, and sized as per ASME section VIII with design pressure of 10.5 kg/cm^{2}G with a minimum thickness of 6mm. Accessories like pressure relief valves and tubing shall be of SS316 construction. Vendor shall supply minimum 10m of interconnecting tubing between volume bottles / volume tanks and actuator assembly. Volume bottle shall be tagged with the associated desuperheater / PRDS / control valve tag number by the vendor.

e) Actuator spring shall be manufactured out of corrosion resistant steel and shall be nickel-plated. Alternately vendor standard coating is also acceptable. The spring shall be enclosed in the actuator casing.

f) Each desuperheater actuator and valve actuator shall be provided with stem position indicator with scale calibrated from 0 to 100% in steps of 10%.

g) While sizing the actuator, vendor must ensure that the sizing factors indicated below are fully complied. Higher sizing factor may be considered if found necessary by vendor.

i. For leakage class IV and below, the actuator shall be sized considering actuator thrust more than 1.3 times the total force induced by shut-off conditions specified in the data sheet and the force required to overcome packing friction. Vendor shall utilize this factor as 1.5 in case the desuperheater/PRDS is operating between 80% to 90% or 10% to 20% in any of the specified conditions.

ii. For leakage class V and above, the actuator shall be sized considering actual thrust atleast 1.5 times the total force induced by specified shut-off conditions in the purchaser's data sheet and the force required to overcome packing friction.

2.6 Bonnet and Packing

a) The desuperheater valve bonnet shall be flanged bolted to the body. Bonnet with threaded connections is not permitted. Extended or finned bonnet shall be provided for low temperature or high temperature applications.

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b) Generally low friction type of packing is preferred. Wherever external lubrication is required for gland packing lubrication isolation valve shall be provided along with the lubricator. Vendor shall indicate the lubricator stick material and supply the same for one year of continuous operational use.

c) The desuperheater / valve shall have its gland packing box drilled and tapped to ¼" NPTF for connecting external lubricator, when external lubricator is not provided, the hole shall be plugged.

d) Asbestos or asbestos bearing material gaskets shall not be used.

2.7 Accessories

2.7.1 Positioners

2.7.1.1 Positioners shall be of smart type (HART / FF) as specified in the purchaser's datasheet. They shall be direct acting, with an adjustable gain unless otherwise specified. The positioner shall be a two-wire device, which shall operate on two-way digital communication mode. All engineering, configuration, diagnostic and maintenance related data shall be provided by the positioner.

2.7.1.2 Every positioner shall have two pressure gauges mounted on it, one each for air supply and for positioner output to actuator.

2.7.1.3 Pneumatic connections shall be 1/4" NPT (F) and cable entry shall be ½" NPTF. If connection for cable entry is different than that specified, suitable adapters shall be provided.

2.7.1.4 Positioners shall be side-mounted on desuperheaters, PRDS and control valves and shall be linkage-less / contact less type. Alternatively, positioners with SS linkages are also acceptable. Any applicable links shall be of corrosion resistant stainless-steel linkages and with rugged brackets.

2.7.1.5 All positioners shall have metallic casing and cover either of stainless steel or of anodized aluminium.

2.7.1.6 Unless otherwise specified, the SMART positioner shall be intrinsically safe type.

All positioners in electrical gas group IIC area as specified in purchaser's datasheet shall be dual certified. i.e. certified intrinsically safe Ex'i' and Flameproof Ex'd'.

2.7.1.7 Unless otherwise specified, the enclosure shall confirm to the following standards:

Weather proof housing:	IP-65 as per IS/ IEC 60529
Flameproof housing:	Flameproof i.e. Ex (d) as per IS/ IEC 60079

2.7.1.8 Flameproof housing shall also be made weather proof.

2.7.1.9 The offered positioners shall meet the following performance characteristics:

i) Overall control accuracy shall be better that ± 0.5% of span.
ii) Repeatability shall be less than ± 0.25% of span.
iii) Hysteresis shall be less than ± 0.5% of span.
iv) Vendor shall supply the valve / desuperheater's operating signatures in the form of hardcopy and soft copy for each valve / desuperheater supplied with smart positioners. The necessary software for advanced control valve / desuperheater diagnostics like seat ring condition, gland packing condition, actuator leakage etc. shall also be included.

2.7.1.10 The positioner sensor and sensing mechanism shall be rugged and shall not be affected by the line/valve vibration. The performance of the positioner shall be immune to such vibration.

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2.7.1.11 The positioner's output and input range shall be field adjustable without any hardware modification. The output from the positioners shall be available for both single acting as well as double acting actuator. Positioners shall be provided with 4-20mA hardwired output signal for position transmission if specifically indicated in Purchaser's data sheet.

2.7.1.12 The positioner shall be operable, configurable and accessible through HART compatible hand held HART configurator/ Fieldbus configurator as applicable.

2.7.1.13 HART positioners

HART positioner with diagnostic capabilities shall be supplied whenever specified in the purchaser's data sheets. The positioner shall provide HART protocol of latest version and shall be capable of implementing commands from Instrument Asset Management System / hand-held configurator.

2.7.1.14 Fieldbus Positioners

Positioners with Fieldbus output shall also meet the following requirements:

a) All positioners must satisfy the requirements of the fieldbus registration laboratory with applicable checkmark like Fieldbus foundation, Profibus Nutzerorganisation e.v (PNO) or as specified in the purchaser's data sheets.

b) All positioners shall have analog output (AO) and controller blocks (PID).

c) All positioner must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation fieldbus or equivalent for profibus PA, as applicable.

d) The fieldbus positioners shall support peer-to-peer communication with two wire communicator and bus powered supply.

e) Fieldbus positioner as offered shall not be polarity sensitive.

f) The fieldbus positioners in hazardous area shall be certified as per entity concept or shall be FISCO approved as per the requirements specified in the purchaser's specification.

g) Internal software shall be configured by the vendor including the following information:
- Serial Number
- Device tag (Tag No.)
- Process Description/service

h) Positioner shall be capable of supporting incremental Device Description (DD) for extra functionality and/or software revisions in Device memory.

i) The positioner shall be suitable to operate with commercially available Instrument asset management software and shall support the following features, as a minimum:

i) It shall allow multi-master for configuration, calibration, diagnosis and maintenance. The primary could be a host computer and secondary could be a hand held communicator.

ii) It shall be capable of implementing universal commands. It shall be possible to communicate all commands of commercially available instrument asset management system to/ from smart positioner.

j) Fieldbus positioners shall support EDDL requirements as per IEC61804/ FDT/ DTM requirements, as specified in job specifications.

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2.7.2 Line Strainers

2.7.2.1 Vendor shall supply two line strainers per desuperheater / PRDS. The mesh size of the strainer shall be decided by the vendor as per desuperheater nozzle and coolant control valve trim size, as applicable.

2.7.2.2 The material of construction of the strainer shall be as follows;
Mesh Material - SS316
Body Material - Same as control valve body material or desuperheater body material specified in the data sheet.

2.7.2.3 The body size of the strainer shall be of the same size as coolant line size. Unless specified otherwise it shall be 1".

2.7.2.4 Unless specified otherwise in datasheet, the end connection of the strainer shall be flanged only with rating as per the coolant end connection specified in the data sheet.

2.7.2.5 The strainers shall include provisions for maintenance of elements and shall be supplied with block and bypass arrangement.

2.7.3 Air Filter Regulator

2.7.3.1 Vendor shall supply air filter regulator with each positioner complete with an integral output gauge.

2.7.3.2 Air filter regulator shall be sized considering the air supply pressure and flow required to meet requirements specified in the purchaser's datasheet.

2.7.3.3 Filter material shall be sintered bronze. Filter size shall be maximum 5 microns. However, lower filter mesh size shall be considered to suit the positioner's requirement.

2.8 Painting

2.8.1 The external surface of the desuperheater/PRDS being supplied shall first be thoroughly cleaned by sand blasting or other suitable means, before painting.

2.8.2 Carbon steel external surfaces other than flange faces shall be given one coat of red oxide zinc chromate primer of single pack. The composition shall be of modified phenolic alkyd pigmented with red oxide and zinc chromate.

2.8.3 The desuperheater, PRDS and control valves bodies shall be painted as follows:

Carbon steel:	Light grey (RAL-7035)
Alloy steel:	Canary yellow (RAL-1003)
Stainless steel:	Natural
Above 150°C operating temperature:	Aluminium white (RAL-9006)

Actuators shall be painted as follows:

Direct action (open on air failure) valves:	Green (RAL-6024)
Reverse acting (close on air failure) valve:	Red (RAL-3001)
Fail Lock / Fail Last (stay-put on air failure) valve:	Yellow (RAL-1004)

Items like air volume tanks etc., supplied as an accessory along with the actuators, shall be painted as per corresponding actuator.
Body, actuators and accessories paint colours complying to equivalent BIS Standard IS-5 in place of specified RAL codes mentioned above are also acceptable.

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3.0 NAMEPLATE

3.1 Each desuperheater, PRDS and control valve shall have a stainless steel nameplate attached firmly to it at a visible place furnishing the following information:

a) Tag No. as per purchaser's datasheet
b) Body size in inches and ANSI Rating
c) Designed inlet/ outlet conditions of desuperheater
d) Designed inlet/ outlet conditions of coolant
e) Stem travel in mm
f) Action on air failure
g) Spring Range
h) Air supply pressure
i) Manufacturer's model no. for desuperheater, PRDS, control valve, actuator and positioner.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing of all the items at vendor's works as per Inspection Test Plan and approved quality documents. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 The desuperheater / PRDS shall be transported to site by the vendor in fully assembled condition. However, in case some components are liable to be damaged during transit, the same shall be dismantled and supplied separately.

5.2 All parts shall be thoroughly cleaned of loose scale, dirt and other foreign material before packing.

5.3 All flange faces shall be suitably protected to avoid damage to the gasket faces and prevent entry of foreign materials.

5.4 Each item shall be suitably wrapped in polythene sheets, packed in wooden crates, properly tagged and secured before despatch.

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प्रोग्रामेबल लॉजिक कंट्रोलर के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR PROGRAMMABLE LOGIC CONTROLLERS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards committee Convener	Standards Bureau Chairman
					Approved by	
3	02.12.20	Revised and Reissued	SMK/AJS	NK/AR	MN	SM
2	30.06.15	Revised and Reissued	AR	MA	RG	SC
1	24.11.09	Revised and Reissued	MN	RP	TGM	ND
0	22.04.98	ISSUED AS STANDARD SPECIFICATION	PM	RK	BRS	AS

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Abbreviations:

AC	:	Alternating Current
ATEX	:	ATmosphere EXplosible
Baseefa	:	British Approval Service for Electrical Equipment in Flammable Atmospheres
CPU	:	Central Processing Unit
CSA	:	Canadian Standards Association
DC	:	Direct Current
DCS	:	Distributed Control System
DMR	:	Dual Modular Redundant
DPDT	:	Double Pole Double Throw
EMI	:	Electromagnetic Interference
ESD	:	Emergency Shutdown System
EXIDA	:	Excellence in Dependable Automation
FAT	:	Factory Acceptance Test
FMEDA	:	Failure Modes, Effects and Diagnostic Analysis
FSM	:	Functional Safety Management
HART	:	Highway Addressable Remote Transducer
HW	:	Hardware
HRC	:	High Rupture Capacity
HWC	:	Hardwired Console
IEEE	:	Institute of Electrical and Electronic Engineers
I/O	:	Input / Output
LAN	:	Local Area Network
LCD	:	Liquid Crystal Display
LCIE	:	Laboratorie Central Industries Electriques
LED	:	Light Emitting Diode
MIS	:	Management Information System
MOSFET	:	Metal Oxide Semiconductor Field Effect Transistor
MTBF	:	Mean Time Between Failure
MTTR	:	Mean Time to Repair
OPC	:	OLE for Process Control
PC	:	Personal Computer
P&ID	:	Piping and Instrumentation Diagram
PFD	:	Probability of Failure on Demand
PID	:	Proportional, Integral and Derivative
PLC	:	Programmable Logic Controller
PTB	:	Physikalisch Technische Bundersanstalt
RFI	:	Radio Frequency Interference
SIL	:	Safety Integrity Level
SRR	:	Satellite Rack Room
TCP / IP	:	Transmission Control Protocol / Internet Protocol
TFT	:	Thin Film Transistor
TMR	:	Triple Modular Redundant
TUV	:	Technische Uberwachungs Vereine
UHF	:	Ultra High Frequency
UPS	:	Uninterrupted Power Supply
UL	:	Underwriter's Laboratories
VDU	:	Video Display Unit
VHF	:	Very High Frequency

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Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members: Mr. Arupjyoti Saikia
Mr. Sachin Garg
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1.0 GENERAL

1.1 Scope

1.1.1 This specification, defines the minimum functional requirements for the design, hardware, software and firmware specifications, nameplate marking, testing and shipping of Programmable Logic Controllers (PLC) designed for reliable, effective and optimum control and monitoring of a process plant (hydrocarbon and non-hydrocarbon) and captive power plant.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions, unless otherwise specified: -

API	American Petroleum Institute	
	RP 552	Transmission Systems
EEMUA	Engineering Equipment & Material User Association	
	191	Alarm System - A Guide to Design, Management and Procurement
BS EN	British European Standards	
	10204	Inspection Document for Metallic Products
	500820-2	Electromagnetic Compatibility - Generic Immunity Standard Part 2: Industrial Environment
IS/IEC	Indian Standards / International Electrotechnical Commission	
	IS/IEC60079	Electrical Apparatus for Explosive atmospheres
	IS/IEC60529	Classification of Degree of protection provided by enclosures (IP Code).
	IEC 60617	Graphical Symbols for Diagram
	IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
	IEC 61000-4-3	Electromagnetic compatibility (EMC) - Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.
	IEC 61000-4-4	Electromagnetic Compatibility (EMC) –Part 4-4: Testing and Measurement Techniques – Electrical Fast Transients / Burst Immunity Test
	IEC 61000-4-5	Electromagnetic Compatibility (EMC) –Part 4-5: Testing and Measurement Techniques – Surge Immunity Test
	IEC 61000-6-2	Electromagnetic Compatibility (EMC) –Part-6-2: Generic Standards – Immunity for Industrial environments.

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	IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic Safety-related Systems.
	IEC 61131	Programmable Controllers
	IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector
	IEC 61643-21	Low voltage surge protective devices - Part 21: Surge protective devices connected to telecommunications and signaling networks - Performance requirements and testing methods
	IEC 62305-4	Protection against lightning- Part 4: Electrical and Electronics systems within structures
	IEC 62561-3	Lightning protection system components (LPSC) - Part 3: Requirements for isolating spark gaps (ISG)
	IEC 62443	Security for Industrial Automation and Control System
IEEE 802.3	Telecommunication and Information Exchange between Systems – Local and Metropolitan Area Networks – Specific Requirements – Part 3: Carrier Sense Multiple Access with Collisions Detection (CSMA / CD) Access Method and Physical Layer Specifications	
IS	Indian Standards	
	3043	Code of Practice for Earthing
ISA	International Society of Automation	
	5.1	Instrumentation Symbols and Identification
	5.2	Binary Logic Diagrams for Process Operations
	5.3	Graphic Symbols for Distributed Control / Shared Display Instrumentation, Logic and Computer System.
	5.4	Instrument Loop Diagrams
	5.5	Graphic Symbols for Process Displays
	18.1	Annunciator Sequences and Specifications
	71.01	Environmental Conditions for Process Management and Control Systems: Temperature and Humidity
	71.04	Environmental Conditions for Process Measurement and control Systems: Airborne Contaminants
ANSI/ISA	American National Standards Institute/ International Society of Automation	
	TR 99.00.01	Security technologies for Industrial Automation and Control Systems
ISO	International Organization of Standardization	

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	216	Writing Paper and Certain Classes of Printed matter-Trimmed Sizes- A & B Series and indication of machine direction
	9241-5	Ergonomic requirements for office work with visual display terminals (VDTs) -- Part 5: Workstation layout and postural requirements
	9241-302	Ergonomics of human-system interaction: Terminology for electronic visual displays
	9241-303	Ergonomics of human-system interaction: Requirements for electronic visual displays
NFPA	National Fire Protection Association	
	496	Purged and pressurized enclosures for electrical equipment

1.1.3 In the event of any conflict between this specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory regulations

b) Job Specifications/ Data Sheets

c) Standard Specifications

d) Codes and Standards

1.1.4 In addition to meeting purchaser's specifications in totality, vendor's extent of responsibility shall also include the following:

a) Purchaser's data sheets specify the minimum acceptable functional requirements for the programmable logic controllers. It shall be vendor's responsibility to select proper hardware, software and firmware to meet the specified functional requirements, keeping the integrity of functional blocks specified in the configuration diagram attached with the Requisition.

b) Purchaser's data sheets specify the scan time / cycle time and loading requirements. Vendor shall be responsible for sizing and selecting their standard product i.e. hardware, software and firmware to meet the requirements specified in the purchaser's data sheets.

c) Adequacy of Bill of Material selected to meet purchaser's requirements including spares. BOM shall also include mandatory spare as specified in the requisition. Vendor to note that bill of material shall not be verified by the purchaser during evaluation stage. Any hardware, software and firmware required to meet the purchaser's specified requirements shall be provided by the vendor without any implication.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Requisition. Vendor's quotation shall enumerate and include the detailed specification of each subsystem and each module of programmable logic controller, detailed system configuration, hardware and software capabilities, programming aids, display facilities and other relevant information.

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1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Compliance to the specifications.

b) Detailed specification sheet for each sub-system. The specification sheet shall provide information regarding hardware specifications, software specifications, redundancy requirements, capacity, power consumption etc. of the programmable logic controllers and its accessories. The material specifications and unit of measurement for various items in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

c) System security features and design details.

d) Proven references for each offered model in line with clause 1.2.4 of this specification whenever specifically indicated in the purchaser's specifications.

e) A copy of approval for flameproof enclosure, intrinsic safety etc., whenever specified for field mounted PLC Cabinets/components in electrically hazardous area and for intrinsic safe isolators in control room, from local statutory authority, as applicable, like Petroleum and Explosives Safety Organisation (PESO) / Nagpur or Director General of Mines Safety (DGMS) in India along with:

i) Test certificate from recognised house CIMFR (Central Institute of Mines & Fuel Research) / ERTL (Electronics Research and Test Laboratory) etc. for specified protection class as per relevant Indian Standard for all Indian manufactured equipments or for equipments requiring DGMS approval.

ii) Certificate of conformity from agencies like LCIE, Baseefa, PTB, CSA, UL etc., for compliance to ATEX or other recognised standards for all equipments manufactured outside India.

iii) For field mounted PLC Cabinets, purge enclosure with Type X/Type Z NFPA 496 certification is also acceptable meeting the hazardous area certification. Field mounted PLC Cabinets shall also be weather proof to IP 54 as a minimum.

f) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate from the specified requirement, they must include a list of deviations item wise, summing up all the deviations from the purchaser's data sheets and other technical specification along with the technical reasons for each of these deviations.

g) Certificate for specified SIL requirement (e.g. SIL-3) from Independent Testing Agency (e.g. TUV/EXIDA).

h) Catalogues giving detailed technical specifications, model decoding details and other related information for each item / sub-system covered in the bid.

1.2.3 The equipment being offered / supplied shall be of latest proven version available in the current manufacturing range.

1.2.4 The system hardware, software and firmware and any bought-out components, as offered, shall be latest field proven and should have been operating satisfactorily for a period of minimum 6 months continuously on the bid due date in the validly similar size and application specified in the purchaser's data sheet. Items with prototype design shall not be offered or supplied. Whenever any bought out item is offered to meet the configurational

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requirements specified in the Requisition, it shall also be proven in use to meet the functional requirements.

1.2.5 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. shall be indicated in the job specifications which shall be part of Requisition

1.2.6 Whenever specified, vendor shall furnish tested values of failure rates, probability of failure on demand and test intervals for safety integrity level analysis.

1.2.7 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals shall be in English language only.

1.2.8 Vendor shall also quote for the following:

a) Two year's operational spares for each sub-system and their accessories which shall include the following as a minimum:

i) All type of electronic modules e.g. I/O modules, processor modules, communication modules, power supply modules etc.

ii) All type of auxiliary items e.g. Isolators, Relays hardwired instruments, annunciator modules, receiver switches, trip amplifiers, temperature element converters etc.

iii) Switches, lamps, fuses, connectors, terminals, pre-fabricated cables, circuit breakers, relays etc.

iv) Video display units, keyboards, disc drives, PC's, network items (e.g. switches, hubs etc.) etc.

v) Network items (e.g. switches, Firewall Router cards etc.). CAT 6 cables, RJ45 jacks.

b) Any special tools and test equipments needed for the maintenance of PLCs and other items being offered by vendor. Vendor must confirm in their offer if no special tools or test equipments are needed for maintenance other than those specifically indicated in purchaser's data sheet.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets. The required number of prints and soft copies shall be dispatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design manuals, installation manual, operation and maintenance manual etc., submitted by the vendor after placement of purchase order shall include the following, as a minimum:

a) Specification sheet for each sub-system, auxiliary instrument and bought out item.

b) Certified drawings for complete system including the following:

i) System Configuration Diagram.

ii) General Arrangement drawings for panels, cabinets, marshalling racks, hardwired consoles, operator console, programming terminal etc with complete dimensional details, internal construction and weight in kilograms.

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iii) Control room layouts e.g. console room, rack room and engineering room layout with all dimensions in millimeters.

iv) Channel base frame drawings for console room, rack room and engineering room.

v) Input/ output assignment.

vi) Logic diagrams.

vii) Loop wiring diagram for all tags.

viii) Power supply distribution diagram.

ix) Memory loading calculations/ Scan time calculations.

x) Modbus address mapping/ Protocol/ Pin Detail wherever required as per requisition.

xi) Dynamic graphic diagrams.

xii) System grounding drawing.

xiii) SIL certificate (wherever applicable) for the PLC along with detailed SIL report of the PLC firmware models / versions/ revisions utilized

xiv) Safety manual for PLC

xv) Hazardous area certificates for the item like Intrinsic Safe Isolators.

c) Design manuals and functional design specifications which shall include hardware design manual, software design manual and special software specifications.

d) Copy of Type test certificates of all components including test certificates / report for suitability against required Environmental condition, EMI / RFI protection, shock and vibration.

e) Copy of Test certificates for all tests indicated in this specification.

f) Installation manual containing installation procedure for programmable logic controllers and other items covered in the Requisition.

g) Power-on, start-up and internal testing procedures.

h) Software debugging and system configuration procedures.

i) Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.

j) Any other drawings and documents specifically indicated in vendor data requirement enclosed with the Requisition.

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2.0 DEFINITIONS

The various terms used in this specification are defined as follows:

2.1 Programmable Logic Controller

The class of control systems which can be programmed to execute plant shutdown and / or interlock / sequence logics to the specified safety integrity levels and also regulatory control functions in specific applications.

2.2 Accessible

A system feature that is viewable by and interactive with the operator and allows the operator to perform user permissible control action e.g. set point change, auto-manual transfers or on-off actions.

2.3 Assignable

A system feature that permits an operator to direct a signal from one device to another without the need for change in wiring, either by means of switches or via other data entry devices like keyboard commands to the system.

2.4 Configurable

The capability to select and connect standard hardware modules to create a system or the capability to change functionality or sizing of software functions by changing parameters without having to modify or regenerate software.

2.5 I/O

Input / Output with respect to process / operator.

2.6 PLC Console (Operator)

PLC console (Operator) is the operator's main plant interface device through which operator can view, monitor and control the plant and can give instructions to peripherals to execute commands, and shall have protective access to configure and maintain the system.

2.7 PLC Engineering Console (Programming)

PLC Engineering console (Programming) shall be the engineer's main interface device through which engineer can configure / program and maintain the system, and shall have protective access to monitor and control the plant, give instructions to peripherals to execute commands.

2.8 Local Level

All those sub-systems, which directly interface with field devices shall be referred to as local level.

2.9 Central Level

Operator Console and Programming Terminal, which present data acquired from local level devices, shall be referred as Central Level.

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2.10 Database

Database shall be defined as the information stored temporarily or permanently in the system which can be accessed by various programs to meet all its functional requirements.

2.11 Loop Integrity

A system shall be said to have loop integrity if the failure of one component in the system/ sub-system does not affect more than one loop.

2.12 System Loading

System loading for a sub-system is defined as the percentage of time a sub-system spends in carrying out various activities referred to the use of memory, CPU time and communication capacity in the worst case of high sub-system operation out of the designed / designated cycle time of the sub-system.

2.13 Redundancy

A system component shall be termed as redundant if it takes over automatically online the operation in the event of the failure of the main component without causing any interruption in the system and upsetting the process. The repaired or replaced device shall be brought in-line only through operator action without upsetting system operation.

2.14 Switchover Time

Time required for a back up instrument / system to come on-line automatically in case of the failure of the main instrument / system.

2.15 Scan Time (t_s)

Scan time of a logic loop is the end-to-end response time of a sub-system and shall be defined as follows:

The scan time for a logic loop shall be defined as the total time taken by a sub-system e.g. programmable logic controller to read input from the input terminal, process input, execute logic, updating logic output and write output at the output terminal for all the logics configured within the subsystem.

2.16 User's Memory

Free memory space available after utilisation of memory required for system operation, configuration and implementation of application and other system related functions for implementation of user defined specific programs such as plant calculations, process optimization or MIS (like free formatting of certain logs). The programs shall either be written in high level language or system specific language.

2.17 Event

An event shall be defined as any action taken by the operator via operator keyboard or switches on hardwired console like change of set point, change of control mode, start/stop of motor, open/close of shut down valves, alarm acknowledge, etc.

2.18 Sequence of Event (SOE)

Arranging events in the sequence of their occurrence in time with a specified time resolution by a program is defined as sequence of event.

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2.19 Sequence of Event Recorder (SER)

Sequence of event recorder, when specified, shall identify, store and print alarms with the specified time resolution between two events. SER shall also transfer data to operator sub system over communication sub system.

2.20 Real Time Trend

Real time trend shall be defined as a continuously progressing graphical record showing updated parameter with most recent value and a past record of minimum of 10 minutes without pressing any additional key for moving backward in time.

2.21 Plant Information Network

High-level communication network which serves various users within a plant and transfer information for the purpose of unit / plant monitoring. This network is different than control network and is generally realised using open communication protocol network e.g. OPC etc.

2.22 Tag

A Tag is a collection of attributes that specify either a control loop or a process variable, or a measured input, or a calculated value, or some combination of these, and all associated control and output algorithms. Each tag is unique.

3.0 SPARES PHILOSOPHY

3.1 The system including sequence of event recorder, hardwired instruments etc. shall meet the following spare philosophy. This philosophy shall also be applicable for items like isolators, relays, terminals, lamps, push buttons etc.

3.1.1 Mandatory Spares

Vendor shall include following mandatory spares in their scope of supply:

3.1.1.1 Installed Engineering Spares

Installed engineering spares shall be provided in each sub-system for each type of module to enhance the specified system functional requirements by 20% as a minimum. The basis of offering installed engineering spares shall include:

a) For a system with conventional and / or smart analog input / output, discrete (contact) input / output, 20% spare input / output of each type shall be considered for calculating I/O modules and all other related accessories.

b) For all serial input / outputs to the system including network switches/firewall, 20% spare ports of each type shall be provided.

c) 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, isolators, terminals etc.

d) The engineering spares shall be wired up to the field cable interface and shall be in ready-to-operate condition when field cable is connected to spare assigned terminals.

e) Spare pairs of the incoming cables shall be terminated on spare terminals in the marshalling / isolator cabinets as applicable.

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f) The system shall be fully engineered considering 20% installed engineering spares including processor loading.

3.1.1.2 Spare Space Requirement

In addition to installed engineering spares specified in Clause 3.1.1.1 of this specification, the system shall be provided with following spare space:

a) The cabinets of the programmable logic controller system shall have 10% usable spare space, as a minimum, for installing additional I/O cards of each type in future and the PLC processor shall have additional 10% capacity to handle these I/O's. In addition, provision shall be kept for internal wiring of the same up to the I/O terminals.

b) Processor system of programmable logic controller shall have capability to execute additional 20% logics.

c) Each operator console shall contain 20% usable spare group and related display capability in addition to as specified in para 3.1.1.1 of this specification.

d) The system shall have capability to extend its historical trending, logging and user's memory by 20% to meet future expansion with/without adding additional memory modules.

e) The communication sub-system shall have sufficient capacity to handle additional data contributed by addition of 20% I/O over and above installed engineering spares.

f) Usable spare space in cabinets to install 10% spare hardwired items like relays, switches, lamps, fuses, circuit breakers, isolators, terminals etc. in future.

3.1.1.3 Spare Memory Requirement

a) The system shall be provided with a minimum of 40% spare memory capacity, as required for application program and data base to meet specified functional requirements.

b) It shall be possible to extend the memory by at least 20% over and above the actual requirement at a later date.

3.1.1.4 Spare Software Capability

a) Sufficient additional software capacity shall be available in the system to take care of spares requirement as specified in para 3.1.1.1 and 3.1.1.2 of this specification to meet all functional requirements as per para 4.0 of this specification.

b) Unless specifically indicated otherwise, the offered system shall have software licenses to cover all the tag numbers indicated in the Requisition, including installed engineering spares and spare space indicated in clause 3.1.1.1 and 3.1.1.2 of this specification.

3.1.1.5 Predefined Mandatory Spares

a) Mandatory spares shall be ware-house spares and shall be supplied as loose items.

b) Mandatory spare module of 5% or minimum one module of each type, whichever is higher, must be supplied for each type of modules being used excluding modules used in consoles, servers, Personal Computers.

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c) For items like network components including ethernet switches, hardwired instruments like isolators, relays, lamps, fuses and circuit breakers, power supply units complete item limited to 5% or minimum one no., whichever is higher, of each type shall be supplied as predefined mandatory spare.

3.1.1.6 Consumable Spares

Any paper, ribbon, printer heads, toner and ink required for printers, video copier or any other consumable item shall be supplied along with system required for minimum of six months duration after system acceptance.

3.1.1.7 Commissioning Spares

Unless otherwise specified, vendor shall be responsible to supply all spares which are found necessary to replace failed modules, failed sub-systems, or corrupted / faulty software while performing pre-commissioning and commissioning activities.

3.1.2 Two Years Operational Spares

Two years operational spares shall be as per Clause 1.2.8(a) of this specification and shall be quoted separately.

4.0 DESIGN AND CONSTRUCTION

4.1 Design Requirements

4.1.1 Programmable logic controller shall be microprocessor based system which shall be used to execute all the process and safety shut-down logic of the plant. When specified, it shall also execute plant interlock logics and sequence operation and analog control. Programmable logic controller shall be an independent unit and shall not depend on any of its functionality on any other system including Distributed Control System.

Moreover, wherever exchange of safety parameters between the different PLC sub-systems is required for interlock execution, separate secured communication network shall be provided between these PLC sub-systems with each card having adequate secure parameters for executing all logics. Installed spare hardwired IOs shall not be used for this purpose. For SIL certified PLCs, this communication network between PLC nodes shall also be SIL certified.

4.1.2 The system shall be of modular construction and expandable in future by adding additional modules which shall be easily accessible for maintenance and repair. The type of modules shall be kept to the minimum possible in order to have interchangeability and low inventory.

4.1.3 **System Availability**

a) The system shall be designed ‘fault tolerant’ as a minimum by selecting high grade components of proven quality and proper design of system electronics.

Redundancy shall be provided, as a minimum, as per this specification to improve system availability and reliability. Due considerations shall be given to the environmental conditions particularly for field mounted sub-system, if specified in job specifications, during system design.

b) The system shall have a high MTBF value and shall have well proven record of operating in hydrocarbon plants.

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c) The system shall be designed with 99.995% or greater availability. The availability shall be defined as follows:

$$\text{Availability} = \frac{\text{Mean time Between Failure (MTBF)}}{\text{MTBF + Mean time to repair (MTTR)}}$$

For the purpose of calculations, consider mean time to repairs as Eight (8) hours unless the manufacturer recommends higher value for MTTR. It is therefore necessary that:

i) Vendor covers all necessary spare parts in 2 years recommended operational spares which shall be necessary to meet specified MTTR time.

4.1.4 Operating Environmental Conditions

4.1.4.1 Environmentally Controlled Location Installation

a) All subsystem of Programmable Logic Controllers located in Control Room, Local Control Room or in Satellite Rack Room shall be able to operate satisfactorily as per below conditions.

FOR	TEMPERATURE	NON CONDENSING HUMIDITY
Operation	10-35°C	20-80% RH
Storage & Transportation	(-)30 to 60°C	5-95% RH

b) In addition to above, all such sub-systems shall also be able to operate satisfactorily in case of air conditioning failure with ambient temperature of 50°C and 90% non-condensing humidity until the system safe operating limits are exceeded. The minimum period of continuous operation in such condition shall be 48 hours at least once in a month without any damage or degradation of system performance. Vendor, therefore, shall provide continuous temperature monitoring for each cabinet housing items / equipments generating heat, such as system cabinets, isolator cabinets, relay cabinets, consoles etc and also provide alarm for operator alert in case the safe operating temperature limits are exceeded. For marshalling cabinets and Power distribution cabinets, temperature monitoring through temperature switches is acceptable.

c) Chemical filters have been provided in the incoming air conditioning air to limit the concentration of contaminants below following limits:

Contaminants (Corrosive Gases)	Concentration
SOx	< 0.01 ppm by volume
NOx	< 0.05 ppm by volume
H_2S	< 0.003 ppm by volume
Cl_2	< 0.001ppm by volume

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All sub-systems and system components shall be suitable for operating continuously in the above mentioned corrosive environments.

d) Shock & vibration: The equipment shall withstand transportation and handling by air, sea and road under packed conditions, conforming to MIL-STD-810F (Military Standard: Environmental Test Methods) specifications for shock (Method 514.3) and vibration (Method 514.5) or their commercial equivalent.

4.1.4.2 Outdoor Installations

a) Sub-systems or system components which are installed outdoor shall be suitable to continuously operate at ambient temperature and humidity specified under ambient conditions. The heat generation effect of current carrying for the electronic modules shall also be considered. For this purpose, the system shall be rated for minimum 5 deg C more than the maximum ambient temperature specified. In case the system is not suitable for the above conditions, necessary cooling arrangement shall be provided.

b) Unless otherwise specified, all PLC sub-systems or system components installed outdoor shall have corrosive environmental protection coating meeting the environmental classification class G3 as per ISA-S71.04.

4.1.5 **Transient, Static and EMI / RFI Protection**

4.1.5.1 The system shall be internally protected against system errors and hardware damage resulting from:

a) Electrical transients on power wiring.

b) Electrical transients on signal wiring.

c) Connecting and disconnecting devices or removing or inserting printed circuit boards in the Programmable Logic Controller (PLC).

4.1.5.2 All sub-systems and system components shall be capable of accepting various signal inputs for its direct use while preventing noise errors due to electromagnetic interference (EMI) or radio frequency interference (RFI) including nearby radio stations, hand held two way radios, solenoids, relays or contactors carrying heavy currents as per levels of Environmental electromagnetic phenomenon defined in IEC-61000-6-2/ EN-50082-2. The system shall have total noise immunity from UHF / VHF radio communication equipments, (RFI) and (EMI) noise generating equipments as per IEC-61000-4/ EN-50082-2.

4.1.5.3 For interplant, inter unit and other system cables routed in the field, the level of surge immunity required for equipment signal ports shall be increased to level 2 as defined in IEC-61000-4-5 and the system shall operate according to performance criterion B as defined in IEC-61000-6-2.

4.1.6 **On-line Replacement**

4.1.6.1 On-line replacement of any module of programmable logic controller shall be possible in such a way that removal and addition of the module shall be possible and safe without de-energising the system. Furthermore, there shall not be any interruption of the system and process upset while replacing a faulty module in case of TMR, QUAD and dual redundant PLCs.

4.1.6.2 Apart from system modules, power supply units shall be replaceable on-line without disrupting the process and without affecting the system redundancies. It shall be possible to hot swap any faulty system module without degrading the system safety or operation or

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freezing the output status. The switchover to the healthy module shall be bumpless. The swapped module shall take over the function of the failed module without any manual programming.

4.1.7 **Electrical Isolation**

Galvanic or optical isolation shall be provided for all field signals. The isolation levels shall be as follows:

Analog I/O channel to system ground : 1500V AC

Discrete I/O channel to system ground : 500V AC

External isolation (Isolators for analog I/O channels and interposing relays/ isolators for discrete I/O channels) shall be provided to meet the above.

Isolation shall also be provided between Engineering / operator console/PLC programming terminal and related sub-systems connected to it if there is any possibility of high voltage being transmitted to the sub-systems.

4.1.8 **Design Requirements of Equipments in Hazardous Area**

4.1.8.1 Unless specifically indicated, the field devices are beyond the scope of this specification. However vendor shall be fully responsible for integrating these devices with their system including compiling and maintaining the engineering data base of these devices and incorporating the data base into the Integrated Asset Management System (whenever specified in the requisition).

4.1.8.2 General requirements

a) Unless otherwise specified, all instruments in hazardous area shall be intrinsically safe type.

b) For conventional instrumentation, entity concept shall be used for selecting proper intrinsic safe isolators.

c) Interfacing of non-hazardous area analog Instruments and non-intrinsic safe analog instruments shall also be through intrinsic safe isolators only to ensure same PFD of interfacing devices in analog circuits.

4.1.9 **Repeat Signals**

4.1.9.1 Unless otherwise specified in the job specifications, following philosophy shall be followed for repeat signals:

a) Whenever repeat signal/ contact outputs are required as per job specifications following philosophy shall be followed:

i) For intrinsically safe analog input and non-intrinsically safe anlog input, IS isolator with dual output shall be utilized.

ii) For other contact inputs, repeat contact shall be provided using electro-magnetic relays.

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4.1.10 **Surge Protection**

4.1.10.1 Surge protection devices (SPD's) shall be provided on the system to limit the surge voltages reaching beyond the safe limits, under normal, abnormal or lightning strike condition. Unless otherwise specified, SPD's shall be provided at least at the following locations:

a) All serial signal and communication cable except FO going from or to control system and from one location to another outside the control building at both control system end. All serial signal cables (UTP / STP / coaxial and not fiber optical)

b) All power incoming cable (110V AC, 110V DC, 240V AC, etc), UPS or non UPS, at the power supply distribution cabinet.

4.1.10.2 The selection of type and rating of SPD shall be selected such that the introduction of this device shall not change the characteristics or reliability of an application, whether it is for the protection of power system, signal such as analog or communication signal, as applicable. The SPDs shall comply with the requirements of IEC-61643-21.

4.1.11 The system shall be designed fault tolerant and shall utilize high quality components of proven quality. Any single system fault shall not degrade the system safety or functionality or affect operation. The system shall have certified Safety Integrity Level as per IEC-61508 / 61511 as applicable and as per Safety Integrity Level specified in job specification. Unless otherwise specified, it shall meet the availability requirement specified in Clause 4.1.3 of this specification.

4.1.12 Unless otherwise specified in the requisition, the scan time of programmable controller shall be less than 250 milliseconds for SIL certified PLCs. The scan time for standard Non-SIL PLCs shall be less than 100 milliseconds. Scan time for a PLC shall be as defined under para 2.15 of this specification. The PLC processor sizing shall be done considering the PLC scan time taking into consideration all the I/Os specified in the requisition including installed spare IOs and IOs for future spare space.

The PLC sizing shall meet the specified scan time taking into consideration all the I/Os specified in the requisition including installed spare IOs and IOs for future spare space. Other activities like diagnostics routines, output / dump of data to peripherals, development of sequence blocks or any other activity which consume processor time shall also be accounted while computing scan time. For SIL certified PLCs, this shall also be in line with SIL certification.

4.1.13 Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds. This shall be demonstrated during FAT.

4.1.14 The system shall be programmed in principle as per the logic diagrams. Owner / Consultant reserve the right to revise or review the logic diagrams even after acceptance of any offer. The programming language of offered PLC shall be as per IEC 61131.

4.1.15 Whenever the requirement of SIL is specified for the PLC, it shall meet the requirements of SIL level specified and shall be certified by an independent body (e.g. TUV/EXIDA) for complying requirements of IEC-61508 / 61511 as specified. For shutdown application requiring SIL certification, PLC shall always meet SIL 3 requirements. For SIL Certified PLC assembling and engineering shall be done from an FSM certified factory.

4.1.16 The system shall have extensive set of self diagnostics hardware and software for easy and fast maintenance of PLC. Routine checks should run automatically at frequent intervals for identifying any fault in software or hardware. Diagnostics shall be required at local as well as console level.

4.1.17 Safety isolators shall be provided by the vendor for all intrinsically safe input/output analog circuits wherever field signals are from electrically hazardous area. In such cases, the system

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shall be designed intrinsically safe based on entity concept. For electrically hazardous area, 50% rule as per IEC-60079 shall be applied for selecting suitable IS isolators for the field cable distances given in the requisition for the specified Gas Group of each unit. Entity parameter checking and validation of the Intrinsic Safe circuit for use in the specified hazardous area shall be carried out by vendor as part of PLC engineering.

4.1.18 Unless otherwise specified all intrinsically safe isolators shall be 3 port isolating type only providing isolation between;

i) Input and output (non-hazardous to hazardous side of isolators)

ii) Power supply and input

iii) Power supply and output

The minimum isolation level shall be 250 VDC.

4.1.19 **Alarm Start-up By-pass Switches and Emergency Shutdown Switches**

4.1.19.1 Startup by-pass (SBS) switches for alarms

All SBS's shall be configured in the ESD system (i.e. PLC) and shall be operable from operator console or hardwired console as per requisition. All such by-pass switches shall be alarmed and shall have audit trail.

4.1.19.2 All Emergency (ESD) switches shall he hardwired and shall be pull type with red coloured knob or push type with protective cover as specified in the requisition. Control room mounted ESD switches shall be installed on hardwired console.

4.1.19.3 The ESD switch contact shall be used in ESD system (PLC etc) for logic implementation and event history.

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4.1.19.4 All ESD Switches shall be provided with at least 2 independent NO contacts and 2 independent NC contacts.

4.2 System Configuration

4.2.1 General

a) PLC system configuration shall be as specified in the job specification. For emergency shutdown system application specified with SIL classification, the system configuration shall be TMR or QUAD or DMR as per the job specification and shall be certified by independent agency e.g. TUV/ EXIDA.

b) Regardless of the action feature selected (except for single architecture), the failure of single component shall not result in a failure of correctly executed safety function. The degradation mode for the selected configuration e.g. 4-2-0, 3-2-1-0 or 3-2-0, etc. shall be documented in SIL certification report.

c) In general, the PLC system shall comprise of various sub-systems as described in the subsequent clauses of 4.2.

4.2.2 Input/Output subsystem

4.2.2.1 Each I/O module shall have its own processor. I/O modules configured in redundant configuration, shall have their processors properly synchronized.

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4.2.2.2 Unless otherwise specified, system shall accept analog 4 – 20mA inputs and contact inputs. The maximum number of Input/Output per I/O module shall be limited as per the following table.

Sl. No.	Type of Configuration	Maximum No. of I/Os
1	Single I/O system	8
2	Dual I/O system	16
3	Triple Modular Redundant system (TMR)	32
4	Quadruple Modular redundant System (QUAD)	16

In case of PLC certified for SIL requirements, the maximum number of I/O's shall be governed by the SIL certification applicable for specified SIL level.

4.2.2.3 Each I/O channel shall be galvanically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1500 volts AC. External isolators/relays shall be provided for all inputs and outputs of the PLC.

4.2.2.4 Each I/O shall be protected against the reversal of polarity of the power voltage to I/O.

4.2.2.5 Each input shall be provided with filters to filter out any noise in the input line and contact bouncing noise, as applicable.

4.2.2.6 All the inputs / outputs shall be double ended upto the I/O card i.e. two wires per input / output and not with common return for all inputs/ outputs. However, for non SIL certified PLCs, common return terminal for upto 8 channel at digital IO card level from the respective relays is acceptable.

4.2.2.7 The interrogation voltage to the inputs and power supply for 2-wire instruments shall be powered from separate redundant power supply / supplies and shall not be a part of PLC, unless otherwise specified. This power supply shall be supplied at one point and shall be distributed by the vendor.

4.2.2.8 a) Each I/O module channel status shall be represented on the operator console.

b) When specified, input module shall be capable of monitoring the input contacts for any wire open fault and short circuit.

4.2.2.9 Analog Input Module

a) Input module shall be able to accept 4~20 mA DC input from smart transmitters (e.g. 4 – 20mA HART).

b) The module shall have 14 bit A/D resolution accuracy of ±0.25% of full scale over the entire range, unless otherwise specified.

4.2.2.10 Output Contact

a) Output contacts from the PLC shall be potential free dry contacts with contact rating as per para 4.2.2.10 b) of this specification.

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b) The output contact rating shall be as follows:

Sl. No.	APPLICABLE FOR	VOLTAGE RATING	CURRENT RATING
1.	All output cards driving solenoid valve and alarm annunciator system unless otherwise specified		
	Category – I	110 V AC/ DC	0.5 A
	Category - II	24 V DC	2 A
2	All motors/pumps/compressor output cards unless otherwise specified.		
	Category – I	240 V AC	5.0 A
	Category - II	110 V DC / 220 V DC	0.2 A

c) The category of contacts shall be specified in the Requisition. Each output shall be short circuit proof and protected by fuse. Visual indication of fuse blown must be provided for each module.

d) When specified contact output module shall have monitored output features like wire open and short circuit.

4.2.2.11 Where inputs or outputs have multiple field devices for the same measurement or device, the corresponding inputs / outputs shall be configured in separate I/O modules located in different racks.

4.2.2.12 Where single input signal is available for QUAD or TMR configuration, inputs shall be multiplied to feed inputs to each input modules / channels.

4.2.3 **Processor System**

4.2.3.1 The processor shall have capability to implement all the control functions required to implement the logic scheme as logic/ladder diagram.

4.2.3.2 The size of the memory shall be sufficient for storage of the program instructions required by the logic schemes and other functional requirements. Offer shall indicate the amount of memory capacity occupied by the actual program and spare capacity available for future program modifications or additions.

4.2.3.3 Memory shall be non-volatile. However in case volatile memory is provided, battery backup shall be provided with a minimum of 3 months lifetime to keep the program storage intact. A battery drain indication shall be provided at least one week before the battery gets drained.

4.2.3.4 Watchdog timer shall be a software device. The healthiness of processors shall be continuously monitored by watchdog timer. Any hardware or software problem in the processor system, which shall include, CPU, memory, power supply, communication interface etc. shall cause the watch dog timer to report processor failure.

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4.2.3.5 Wherever dual redundant processor is specified, redundancy shall be provided in such a way that in case of failure of the main processor, the standby shall take over automatically online. The changeover shall be bumpless. Redundancy shall be provided for complete processor system including processor, power supply and communication sub system.

4.2.3.6 In case of triple modular redundant system all the three processors shall execute the same instructions/program and check their results and vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.7 In case of Quad system, individual processor shall execute the same instructions/ programs and check their results within same CPU module and majority vote to correct any faulty result. The faulty processor diagnostic shall be made available.

4.2.3.8 Failure of a single processor in dual redundant, triple redundant system and two processors in QUAD system shall not affect the system. In case of failure of complete processor system i.e. both processors in case of dual configuration, two or more in case of triple redundant system and more than two in case of QUAD system, outputs shall take failsafe state automatically unless otherwise specified in the data sheets.

4.2.3.9 In case multiprocessor configuration is offered, the processors must be able to communicate with each other over the interconnecting data link. Vendor must ensure that system performance shall not be degraded by any means when such a system is offered.

4.2.3.10 It shall be possible to generate the first out alarm by the PLC in case where a group of parameters are likely to trip a system.

4.2.4 **PLC Console (Engineering / Programming)**

4.2.4.1 The PLC console shall be used for programming, program storing, fault diagnostics and alarm monitoring. Whenever specified, it shall also be possible to use this console for plant operation. The functionality to operate as engineering / programming terminal or operator terminal or both shall be as specified in the job specification.

4.2.4.2 It shall consist of at least one colored 21” active matrix TFT type LCD display unit with backlit LED and one programming / operating keyboard, mouse and printer. If laptop is specified in the job specifications, the same shall be of 15” TFT type LCD display.

4.2.4.3 PLC console when used for plant operation shall also meet the functional requirements as per clause 4.2.5 of this specification. The operator station shall comply with ISO 9241-5, 9241-302 and 9241-303.

4.2.4.4 The keyboard shall be easy to operate with each key clearly identified.

4.2.4.5 All illegal entries shall be rejected by the terminal and shall be identified by warning signal on VDU.

4.2.4.6 Manual forcing of any input or output contact connected to PLC shall be possible from keyboard. Forced functions shall have an associated audit trail.

4.2.4.7 It shall be possible to modify, add or delete the application program on line without affecting the outputs.

4.2.4.8 PLC Console shall display logic and/or ladder diagram indicating power flow and shall show description and status of each contact. It shall also be possible to display process alarms and diagnostic messages as and when they appear. Further it shall also be able to display I/O map in a user defined format.

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4.2.4.9 It shall be possible to print out the ladder/logic diagram on the dedicated PLC printer. The printer in addition shall also print out:

a) The diagnostic messages as and when generated and diagnostic reports, when called for.

b) Process alarms connected to the programmable logic controller as and when they appear and alarm report whenever initiated. The choice of printing alarms on this printer shall be operator selectable from a key lock / password protected switch on PLC console.

c) The I/O maps showing status of all inputs and corresponding outputs in a user defined format.

4.2.4.10 The PLC console shall be provided with self diagnostics feature which shall display error messages and initiate an audible alarm if the fault is detected. Wherever specified, a potential free contact for diagnostic group alarm shall be provided which shall be connected to the hardwired alarm annunciator system.

4.2.4.11 The system shall be able to identify the failure at least up to the module level including I/O system and redundant processor and report print out.

4.2.5 **PLC Console (Operator)**

4.2.5.1 Where dedicated PLC operator console is specified, it shall be used for operation of plant, fault diagnostics, alarm monitoring and report generation. The operator interface subsystem shall have single tier/duel tier construction as per the job requirement. The operator station shall comply with ISO 9241-5, 9241-302 and 9241-303.

4.2.5.2 It shall consist of coloured 21" active matrix TFT type LCD display unit with backlit LED, operator keyboard and printer unless specified otherwise. Unless otherwise specified, each monitor shall be colour LED display unit, with a 160° wide viewing angle.

4.2.5.3 At least two number cursor control devices shall be provided in addition to keyboard which may include touch screen, mouse, track ball etc.

4.2.5.4 PLC operator console shall have complete graphic capability and shall be able to display process dynamic graphics, overview and group view displays. It shall be possible to operate the plant i.e. start and stop of rotating machinery, opening and closing of valves, PID function etc. from dynamic graphics and group displays available on PLC operator console.

4.2.5.5 It shall be possible to monitor, historise and print out all process alarms, diagnostic alarms and alarm reports.

4.2.5.6 The time stamping of all alarms shall be as per PLC processor time stamping or I/O module stamping.

4.2.5.7 The system shall be able to store and display stored data wherever required. The minimum storage capacity shall be for 30 days at 1 minute sample rate for all the inputs specified, diagnostic alarms, process and first out alarms, manipulation data etc.

4.2.5.8 The system shall be able to generate shiftly, hourly, daily, weekly and monthly reports. The log format shall be furnished during detailed engineering.

4.2.5.9 The system shall be supplied with first out alarm generation capability. The resolution of alarm shall be as per processor cycle time, as a minimum.

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4.2.6 **Communication Subsystem**

4.2.6.1 The PLC communication subsystem shall be a digital communication bus that provides a high speed data transfer rapidly and reliably between the processor, I/O sub-system, PLC console and other devices connected in the PLC system.

4.2.6.2 Redundancy in PLC communication subsystem shall be provided as follows unless otherwise specified:

a) For single architecture, the communication subsystem between PLC processor and I/O subsystem shall be single unless otherwise specified. This shall include single communication bus and single interfaces/buffers.

b) For dual I/O configuration, each I/O sub set shall have separate communication interface and bus for connecting to PLC processors. However, for non SIL PLCs, Ring network with bidirectional communication is also acceptable so that if communication in clockwise direction fails at any I/O node, communication is automatically reversed to anti-clockwise mode for uninterrupted communication of the processors with each I/O Rack. It shall be ensured that the primary and secondary IO cards are in separate racks with dedicated link to the communication network.

c) For the triple redundant system, each processor shall have a separate set of PLC communication subsystem.

d) For the Quad systems each I/O subset shall have redundant communication interface and bus for connecting to the redundant CPU modules.

e) The communication subsystem between processor subsystem and PLC console shall be dual redundant, consisting of two separate communication interfaces and two buses, each one configured in redundant mode, unless this is only used as programming aid.

4.2.6.3 In case of redundant PLC communication sub system, on the failure of the active device, the redundant device shall take over automatically without interrupting the system operation. Information about the failed device shall be displayed at local as well as on PLC console. It shall be possible to manually switch over the communication from main bus / device to redundant bus / device without interrupting any system function.

4.2.6.4 The mechanism used by the system for error checks and control shall be transparent to the application information / program. Error checking shall be done on all data transfers by suitable codes.

4.2.6.5 In general, PLC shall provide data in a well established protocol format preferably MODBUS protocol.

Wherever remote I/O is specified in the requisition, it shall be redundant and SIL3 certified (for SIL3 PLCs).Segregation for the remote I/O shall follow the same philosophy of group wise PLC segregation specified in the requisition. Moreover, separate PLC in remote I/O location with peer to peer communication with Host PLC through third party (TUV/ EXIDA etc.) certified SIL3 redundant network is also acceptable for remote I/O requirement. However, separate PLC shall be considered for each of the Remote I/O subsystem within each location.

4.2.7 **System Power Supplies**

4.2.7.1 Unless specified otherwise, the programmable logic controller shall operate on uninterrupted power supply (UPS). The PLC incoming power supply feeders shall be earthed and isolated

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from Non-PLC loads. The system shall be capable of operating satisfactorily at the following power supply specifications:

Voltage	110/ 240 V ±10% (as specified in requisition)
Frequency	50 Hz ±3 Hz
Harmonic contents	Less than 5%
Power interruption	20 millisecond

4.2.7.2 The power supply system shall be supplied with dual PLC feeders each capable of handling 100% of the total power supply load requirements. In case of failure of one feeder, redundant feeder shall supply the total load.

4.2.7.3 Each I/O rack shall be provided with redundant power supply connectivity so that failure of primary rack power supply does not result in consequent switchover of the I/Os also from primary to secondary. The power supply for the I/O racks shall be sized to take full load of the I/O racks.

4.2.7.4 The processor rack shall be provided with separate power supply for each processor or redundant power supply module for the processor rack such that failure of one power supply does not affect the system operation.

4.2.7.5 **Bulk Power Supply**

4.2.7.5.1 Power supply distribution other than 110V AC UPS and 240V AC non UPS shall be provided using dual redundant Bulk Power Supply (BPS).

Each Bulk power supply shall be fed from UPS and the primary and secondary UPS feeders shall independently source the primary and secondary BPS of each redundant BPS set respectively.

Separate sets of BPS shall be used for each application i.e. PLC subsystem and conventional instrumentation / input interrogation.

4.2.7.5.2 Each Bulk Power Supply (BPS) shall be provided in redundant configuration and with surge protection capability. Each BPS in a redundant set shall be sized considering 70% of its maximum loading capacity.

4.2.7.5.3 Redundant MOSFET based OR-ing modules shall be provided at the BPS output for balanced load sharing between two BPS in redundant configuration.

For each redundant set of BPS and their MOSFET OR-ing modules, any one BPS / MOSFET OR-ing module failure shall generate an alarm to the operator. Digital I/Os required for this error contact of each set shall be considered as part of system diagnostics.

4.2.7.5.4 Isolators/ relays shall be fed individually from the BPS supply without any looping between adjacent isolators/ relays. Power feed module shall not be used.

4.2.8 **Self Diagnostics**

4.2.8.1 The system shall have an extensive set of self diagnostic routines which shall be able to identify all permanent and transient system faults / failures at least up to module level including redundant components and power supplies through detailed VDU displays and report print out.

4.2.8.2 At the local level, failure of a module in any subsystem shall be identified by an individual LED.

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4.2.8.3 Diagnostic software shall have the capability to provide information about the failed module/system either in the form of a system configuration display or provide information in the form of a "statement".

4.2.8.4 PLC shall be provided with Auto I/O testing facility as a standard diagnostics features. Self diagnostic software shall have capability to detect channel faults which make the system permanently close/open in the I/O modules or I/O signal conditioning modules (in case of triple redundant system). This shall be achieved by automatically running the self diagnostic software at cyclic intervals. However, system performance shall not be degraded during the running of this diagnostic software.

4.2.8.5 System for the following functionalities shall be supplied when specified:

a) Long storage historisation

b) Log report generation

c) First out alarm generation

4.2.8.6 System diagnostics shall be capable of identifying, locating and reporting the following faults, as a minimum:

a) Processor fault

b) Communication fault

c) I/O module fault

d) Power supply fault

e) Over temperature monitoring

f) Permanently close / open (stuck on or off) fault

g) Memory fault

h) Signal redundancy fault

Any other additional diagnostic alarm if available as a standard shall also be provided by vendor.

4.2.8.7 Testing software shall be capable of detecting faults in case of normally closed system as well as in normally open system.

4.2.8.8 Feedback must be provided in case of triple redundant system and QUAD system from the output voter system to detect any latest faults of the system in addition to other diagnostic software.

4.2.9 **System Software**

4.2.9.1 The system software shall include all programs for the PLC and PLC console which are required to perform all the PLC functions including communication and self-diagnostics. Whenever PLC is specified for shutdown application with SIL classification, the system shall be designed and engineered in full compliance with the requirement of IEC-61511. Whenever different functional logics are combined within a common PLC, the safety related I/O's of each functionality shall be kept segregated within the system.

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4.2.9.2 Logic program shall also be recorded on the suitable media and which shall be delivered together with the system.

4.2.9.3 The PLC programming language for implementation of logic operations shall be based on the following representations:

a) Logic diagrams - Binary logic symbols such as AND, OR, NOT Gates, Timers and Flip-Flops.

b) Ladder diagram - Series / parallel connection of relay contacts.

c) Combination of (a) & (b) above.

4.2.9.4 Diagnostic package and its related equipment and software shall be supplied. A list of additional diagnostic packages available and the packages provided, including the description and capabilities, shall be provided with separate quote, wherever asked.

4.2.9.5 It shall be possible to print out the ladder/logic diagram on a dedicated printer. The printer shall also print out all diagnostic reports. The software package shall enable the owner to modify/add/delete any part of program both on-line as well off-line and for documentation.

4.2.9.6 Software for the generation of various displays including dynamic graphics wherever specified to be provided as per given below:

4.2.9.6.1 It shall be possible to display dynamic graphic of plant on the operator console VDU screens. Graphic displays shall be field configurable only through PLC Console (Programming terminal) with standard / user defined graphic symbols. Dynamic graphic displays of different sections of the plant shall be displayed on different pages.

4.2.9.6.2 The system shall have graphic symbol library as per ISA-5.1 and 5.3. In addition standard industrial symbols like distillation columns, heat exchangers, pumps, compressors, tanks etc. shall also be provided as a standard.

4.2.9.6.3 Graphic displays shall be interactive type through which it shall be possible to control the process. It shall also be possible to send motor start/stop and shutdown valve open/close commands, as specified in job specifications, from this display.

4.2.9.6.4 It shall be possible to view the process variable and alarm points and view and change set point value, manipulated variable, controller mode etc. from the graphic display. Also rotating machinery (i.e. compressor / pump) status and valve status shall be displayed on the graphic display with different colours.

4.2.9.6.5 Various colours used in the generation of graphics like colour of the process lines, utility lines, Instrument signal lines and event modifier conditions shall be finalised during detailed engineering. The colours used to identify event modified conditions shall generally be as follows unless otherwise indicated during detailed engineering:-

Green	:	Valve open, pump running.
Red	:	Valve closed, pump stopped.
Flashing Red	:	All points alarm / Shut down valve transition state.

4.2.9.6.6 It shall be possible to go from any graphic page to related graphic pages or any group view or alarm summary in single key stroke using soft key function.

4.2.9.7 The software for printing alarms, system as well as process, and events on the PLC printer must be provided. All alarms must be printed as and when they appear.

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4.2.9.8 Software package for displaying I/O map showing status of inputs and corresponding output providing tag numbers as per logic diagram shall be offered. The I/O map format shall be user definable. Operating System shall be provided with office documentation software package (Word, Spreadsheet etc.).

4.2.9.9 The PLC Operating system shall be provided with the manufacturer's recommended antivirus software for the warranty period. Also, all required software patches to fix bugs for PLC and any other system / application software shall be provided by vendor for the entire logistic support period as part of his firm scope.

4.2.10 **Power Supply Distribution**

4.2.10.1 All type of power supplies shall be made available at one point. Further distribution of power supply shall be in vendor's scope.

4.2.10.2 In general, all output contacts and solenoids shall be powered with 110V±10% AC/DC/ 24V±10% DC power supply. However, the actual interrogation voltages shall be as per job specifications and logic diagrams.

4.2.10.3 The distribution network for interrogation voltage shall be designed such that a single fault in any branch shall not cause trip of the logic other than where the fault has occurred.

4.2.10.4 Sequential starting of various load centres shall be provided whenever specified.

4.2.10.5 Power supply shall be made available at one place in the Power Distribution Cabinet. Further Power distribution network shall be designed such that a single power fault in any instrument branch system shall not cause a trip of the entire system. Power distribution network shall use bus bars of adequate capacity with MCB in each branch network. Vendor may alternately select DPDT switches with HRC fuses of required short circuit characteristics. Each consumer shall be provided with a separate switch and fuse unit or MCB for isolation and protection of the system. For current rating 100 amperes and above, MCCB shall be used in place of MCB.

4.2.10.6 All cubicles lighting shall be on 240 V, 50 Hz AC normal power supply.

4.2.10.7 Each power feeder shall be monitored for its voltage and current in PLC, the transducers required for the measurement shall be located in power supply distribution boards/ cabinets (PDB).
In addition to above, following indication / alarms shall also be provided for each feeder:

a) Voltmeter, ammeter and power-on-lamp on the cabinet front of respective power supply distribution cabinet.

b) Power failure Alarm contacts for such feeder for PLC monitoring.

c) One common power failure alarm contact for alarm shall be made available.

4.2.11 **PLC Cabinets**

4.2.11.1 All PLC cabinets shall be completely wired with all modules / components in place. Inside cabinet wiring shall preferably be done using ribbon type pre-fabricated cables. All components shall be mounted inside the cabinets with proper accessibility. No components shall be mounted on the sides within the cabinets except for the utility sockets.

4.2.11.2 All the cabinets shall be free standing, enclosed type and shall be designed for bottom entry of cables. Cabinet structure shall be sound and rigid. Cabinet shall be provided with

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removable lifting lugs to permit lifting of the cabinets. Removal of lifting lugs at site, after installation, shall not leave any opening in the cabinets.

4.2.11.3 Cabinets shall be fabricated from cold rolled cold annealed (CRCA) steel sheet of minimum 1.5 mm thickness for sides and TOP and 2 mm thickness for doors and suitably reinforced to prevent warping and buckling. The rack/ rail mounting plates inside the cabinets shall be of 3 mm thickness. Cabinets shall be thoroughly deburred and all sharp edges shall be grounded smooth after fabrication. Cabinet frame shall be of 9 fold profiled CRCA steel sheet or of Angle iron frame using minimum section of 50 x 50 x 4 mm angle.

4.2.11.4 Cabinet painting procedure shall include blast cleaning, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet blasting wherever required. Two coats of paint in the panel colour shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at site. Colour of the panels shall be as per Requisition.

4.2.11.5 Each cabinet shall be maximum 2100 mm high (excluding 100 mm channel base), 800 mm wide and 800 mm deep, in general. Construction shall be modular preferably to accommodate 19" standard racks. All cabinets shall be of same height.

4.2.11.6 Cabinets shall be equipped with front and rear access doors. Doors shall be equipped with lockable handles and concealed hinges with pull pins for easy door removal.

For a group of cabinets in each row having inter-panel wiring, Walk through cabinets can be provided with side cover for the end cabinets on each side.

4.2.11.7 In order to effectively remove dissipated heat from the cabinets, ventilation fans along with vent louvers backed by wire fly screen shall be provided in all cabinets and consoles having PC hardwire drives. Ventilation fans shall be provided in dual configuration. A temperature element (resistance temperature detector or semiconductor type sensor) shall be provided in each System cabinets and temperature switch as a minimum in each marshalling/ PDB cabinet for temperature measurement.

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment/ cabinet/ console in part or in complete.

Ventilation fan assembly shall operate on UPS power supply for system cabinets and on Non-UPS 240V AC power supply for other cabinets and consoles, unless otherwise specified. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the numbers of cabinets are compacted (supplied in mechanical joined conditions), each cabinet shall be provided with separate ventilation fan assembly. Ventilation fans shall be side mounted.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA.

Following signals and alarms shall be provided separately as follows:

i) Fan failure alarm for each system cabinet in PLC

ii) Temperature indication of each system cabinet in PLC.

iii) A common high temperature and fan failure alarm in the PLC for each marshalling / PDB cabinets / consoles for a group of maximum 10 adjacent cabinets / consoles as per the requisition.

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4.2.11.8 Internal illumination shall be provided for cabinets to ensure proper illumination level of 250 lux for performing maintenance activities.

LED Lamps shall be provided in each cabinet which shall be activated individually by door operated switches. The lamps shall activate when door is opened and deactivate when the door is closed. The door lock switches selected shall have undergone life cycle cyclic test of at least 1000000 operations and test certificate for the same shall be provided from the manufacturer. A manual over-ride switch shall be provided inside the cabinet which shall keep the lamp deactivated even when the door is open.

The cabinet lighting shall operate on 240V AC Non-UPS power supply.

4.2.11.9 Equipment within the cabinet shall be laid out in an accessible and logically segregated manner. Cable glands shall be provided and supplied by vendor for incoming and outgoing cables to prevent excessive stress on the individual terminals. All metal parts of the cabinet shall be electrically continuous and shall be provided with a common grounding lug.

4.2.11.10 Name Plates:

All panels / consoles / cabinets shall have name plates fixed on the front, back and inside with following details:

Front and Back	: Tag number and description
Inside	: Manufacturer's name, purchase order number and year of manufacture, part number of manufacture.

4.2.12 **Control Panel /Hardwired Console**

4.2.12.1 Control panels, if required, shall be non-graphic self supporting, free standing cubicle with back doors made up of sectional steel panels. Each section shall be maximum 2100 mm high, 1200 mm wide and 1000 mm deep and shall be mounted on 100 mm high channel base. Care shall be taken to ensure that the face of the panel is truly flat and smooth.

4.2.12.2 Panels / hardwired console shall be fabricated from 3.0 mm thick cold rolled steel sheet. Angle iron frame shall use a minimum section of 50x50x4mm angle.

4.2.12.3 Front of panel/console instrument nameplates shall be black laminated plastic with white core. Nameplate shall be provided on the rear of the panel also for each instrument.

4.2.12.4 Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each panel. Similar arrangement shall also be made on the inner side of doors of console.

4.2.13 **Wiring Requirements**

4.2.13.1 All wiring shall conform to API RP 552- Transmission Systems. Different signal level cables shall be routed with separation distances as recommended by this code.

4.2.13.2 All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

4.2.13.3 All wiring in the raceways shall be properly clamped. All incoming cable and outgoing cables shall be terminated by vendor at marshalling rack. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

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4.2.13.4 Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

4.2.13.5 Vendor can alternately offer prefabricated cables for interconnection between different cabinets and panels.

4.2.13.6 Wire termination shall be done using self insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall be avoided.

4.2.13.7 Terminal housing shall be strictly sized with considerations for accessibility and maintenance. Minimum distance required between various components is listed below. These distances are clear distances and are excluding the width of the raceways or any other component / item mentioned herein. Following clearances should be considered:

a) Distance between terminal strip and side of the cabinet parallel to the strip, up to 50 terminals, shall be minimum 50 mm.

b) Distance between terminal strip and, top and bottom of the cabinet shall be minimum 75 mm.

c) Distance between two adjacent terminal strips shall be minimum 100 mm.

d) Additional distance for each additional 25 terminals shall be minimum 25 mm.

e) Distance between cable gland plate and the bottom of the strip shall be minimum 300 mm.

4.2.13.8 All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical. All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off.

4.2.13.9 No splicing is allowed in between wire/ cable straight run.

4.2.13.10 Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip. Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

4.2.13.11 Cabinet and rack layout shall be made considering proper accessibility and maintenance.

4.2.13.12 For external wiring from interposing relays to powered field output devices like solenoid valves, it shall be ensured that the negative terminal of the power supply is connected to the field side and the positive to the relay side so that positive shutdown / de-energisation of solenoid valve is ensured on relay contact open.

4.2.13.13 For field signals getting interfaced with PLC through isolators (IS / non-IS), cable termination can be done in the isolators directly without the use of separate Terminal blocks. However, in such cases, terminal blocks shall be provided only for terminating the spare pairs of the field cables.

4.2.13.14 Terminals for all digital outputs with powered contact from PLC end shall be provided with fuses on the positive terminal. Fuse blown indication LED shall be provided for all such

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fused terminals. Terminals for digital outputs to MCC shall be potential free and without any fuses.

4.3 Earthing

4.3.1 All system equipment such as marshalling cabinets, system cabinets and other powered equipment shall be provided with following type of grounding system:

a) Protective Earth / Electrical Earth

b) System earth / signal earth

System /Signal earth shall be totally separate from protective/electrical earth.

4.3.2 Protective Earth / Electrical Earth

a) Earth metallic enclosure / cabinet / console etc. shall be provided with electrical earth lug, as a minimum.

b) All earthing lugs of metallic equipment indicated in Clause 6.4.2(a) above shall be connected redundantly to electrical protective earthing system bus-bar / earthing station using a minimum of 6 sq mm solid copper conductor PVC insulated wires. For this purpose, earth looping with permanent shorting link cables shall be acceptable for a maximum of 10 nos. adjacent cabinets in the same row for connecting to protective earth station / bus-bar.

4.3.3 System Earth

a) System earth shall be totally noise free dedicated earthing system and shall be fully isolated from electrical protective earth. This earth must be very high integrity system and shall be used to ground zero volt references and signal cable grounds.

b) System earth shall be less than one (1) ohm grounding system or as per vendor's recommendation with its own dedicated earth pits. The earth pits shall be suitably located outside the control room and away from any heavy noise plant equipment. Earth pit shall not be in the scope of PLC vendor unless otherwise specified.

The earth pit design shall be as per IS-3043 code of practice for earthing. A minimum of two (2) number of earth pits, in redundant configuration, shall be provided in each Control room / SRR / Remote IO cabinet location for System earth. In case number of pits required to meet system earth resistance are more than one (1) number, the number of system earth pits shall be two times the actual number of pits required to meet the redundancy requirement specified above. All these system earth pits shall be securely connected with each other to form a one homogeneous system earth grid.

c) Each marshalling / system cabinet etc. shall be provided with system earth bus-bar which shall be insulated from the metallic body frame. This bus-bar shall be used to earth also signal zero volt references and signal cable screens. Terminals used for termination of spare conductor pairs / cores of multi-pair signal / control cables shall be connected to system earth bus-bar. Shorting links shall be used for spare terminal looping.

d) System bus-bars in the multiplexed cabinets can be joined together by permanent shorting links. System bus-bars of other cabinets can also be connected together provided they are permanently joined using 35 sq. mm stranded copper conductor cable.

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e) The redundant System earth pits at each location shall be connected to the Electrical protective earthing system through suitable surge isolation and protection device for lightning equipotential bonding. These lightning surge isolation and protection devices shall comply to the requirements of IEC 62561-3.

4.4 Interface with DCS

The PLC shall be required to be interfaced to the Distributed Control System bus whenever specified. A suitable interface shall be offered in order to achieve the following functions:

a) Display of all input points under alarm/first out alarm connected to PLC or generated by PLC, continuous indication for analog signal on the main DCS operator console.

b) Generate shutdown reports on the logging printer of Distributed Control system.

c) To receive certain operational commands from the operator console for the operation of certain output devices connected to PLC.

d) To display diagnostic message of PLC.

In general, PLC shall provide data in a well established MODBUS protocol format based on TCP/IP (preferably) or RS 485 serial communication.

The interface shall be dual redundant unless otherwise specified.

The speed of data transfer shall be such that any change in I/O which is to be updated on the operator console shall not exceed 3 second from the time event to update on the operator console screen considering one second standard update rate in DCS operator console.

The system shall have capability to synchronize the time of all the sub-systems/ nodes within the system using the Purchaser's GPS time reference provided either directly through NTP/ IRIG ports or through one time daily external pulse connectivity from Purchaser's DCS. This shall ensure that data acquired by all sub-systems will have the same and common global time reference.

4.5 Sequence of Event (SOE) Function Requirement

Sequence of Event, whenever specified, for analog and digital inputs shall be generated and time stamped in PLC. The maximum resolution between two events shall not exceed specified PLC scan time unless specified otherwise. A separate SOE PC with colour 21" active matrix TFT type LCD display unit with backlit LED and printer shall be provided for PLC sub-system unless specified otherwise.

The following signals or changes of state shall also be logged as part of the Sequence of Event functionality:

For each hard wired analog input:

- Shutdown / trip alarm
- Input Measurement diagnostic status (e.g. input out of range)
- Maintenance override status (wherever provided)
- Input force status.

For each hard wired digital input:

- Shutdown / trip alarm
- Input status (e.g., line breakage)

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- Maintenance override status (wherever provided)
- Input force status.

4.6 Miscellaneous Requirements

4.6.1 Line monitoring

Line monitoring of digital field signals shall be provided in the system through the interface devices as per the following considerations:-

a) For non-Intrinsic Safe digital outputs used in non-fail safe logics like energized to trip/ actuate, Line monitoring relays shall be provided.
b) For digital outputs utilizing digital output Intrinsic Safe Isolators, Line monitoring facility shall be activated for all non-fail safe logics and also where dual Solenoid valves or TMR Solenoid Valves are utilized for On-Off valve trip action.
c) Line monitoring status of all above cases shall be alarmed in Operator Console.

4.6.2 All the interposing relays shall be low power continuously rated type and shall have integral LED for status.

4.6.3 The PLC system shall be compliant to security Level -1 of IEC-62443 / ANSI/ISA TR99.00.01 as a minimum.

5.0 TESTING, INSTALLATION, COMMISSIONING AND ACCEPTANCE

5.1 General

5.1.1 This specification defines the basic guidelines to vendor for factory testing and acceptance, installation, commissioning and field acceptance of the complete PLC system. On the basis of this specification, vendor shall submit their own detailed testing, installation, commissioning and acceptance procedure. For hardware, the procedure shall include test name, purpose of test, test equipment / set up, definition of input, test procedure, results expected and acceptance criteria. Similarly for software, it shall include test name, details of the method, list of tests, sequence of execution, results expected and acceptance criteria. For PLC system with SIL 3 requirement, certificate for hardware & software (Like TUV/ EXIDA) shall be verified.

5.1.2 The testing and acceptance of the system shall be carried out on the approved testing procedures and criteria based on this specification and vendor's standard testing requirements and procedures.

5.2 Factory Acceptance Tests (FAT)

5.2.1 Vendor shall test and demonstrate the functional integrity of the system hardware and software. No material or equipment shall be transported until all required tests are successfully completed and certified "Ready for Shipment" by the owner/consultant.

5.2.2 The purchaser reserves the right to be involved and satisfy himself at each and every stage of inspection. The purchaser shall be free to request any specific test on any equipment considered necessary by him although not listed in this specification, as a part of approval of factory testing procedure. The cost of performing all tests shall be borne by the vendor.

5.2.3 Vendor to note that acceptance of any equipment or the exemption of inspection or testing shall in no way absolve the vendor of the responsibility for delivering the equipment meeting all the requirements specified in Requisition.

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5.2.4 It shall be vendor's responsibility to modify and/or replace any hardware and modify the software if the specified functions are not completely achieved satisfactorily during testing and factory acceptance.

5.2.5 Schedule of FAT shall be included in the Vendor's proposal.

5.2.6 Vendor shall not replace any system component/module/sub-system unless it is failed. A log of all failed components/modules in a sub- system shall be maintained which shall give description of the failed component/module, effect of failure on the sub-system, cause of failure and number of hours of operation before it failed. If malfunction of a component/module in a sub-system repeats, the test shall terminate and vendor shall replace the faulty component/module. Thereafter the test shall commence all over again. If even after this replacement, the sub-system fails to meet the requirements, vendor shall replace the full sub-system by the one meeting the requirements and the system shall be tested all over again. If a sub-system fails during the test, which is not repaired and made operational within four hours of active repair time after the failure, the test shall be suspended and restarted all over again only after the vendor has replaced the device in the acceptable operation.

5.2.7 Testing and FAT shall be carried out in two phases. The minimum requirements for testing during these two phases shall be as follows:

5.2.7.1 Under the first phase, vendor shall perform tests at his works to ensure that all components function in accordance with the specification for each type of test. A test report shall be submitted for purchaser review within one week of completion of this test. Phase II testing (witness inspection) shall start only after this.

All sub-systems shall undergo a minimum of 15 days (360 hours) burn in period (un-interrupted power on) and this can include FAT duration. Should there be a failure noted during FAT, this duration shall be extended. It may include any such time for which the system has been kept powered on even for system generation and Phase-I testing.

Following tests shall be performed by the vendor and reports shall be forwarded to purchaser:

a) Quality control test which shall be carried out to assure quality of all components and modules in accordance with vendor's quality control and assurance procedures.

b) System pre-test which shall be physical check of all modules, racks, cabinets etc.

c) System power-up test which shall test functionally all hardware and software. This shall include testing of redundancy, System performance on power supply variations, application software testing and system diagnostic verification.

d) Internal Test report or Type Test reports for the system components suitable for function in temperature of 50°C and 90% non-condensing humidity for 48 hours.

e) All functional tests as per clause 5.2.7.2 c) shall also be conducted by vendor as part of their Pre-FAT tests and test reports for same to be submitted to Purchaser for review before commencement of FAT.

5.2.7.2 The second phase of testing shall systematically, fully and functionally test all hardware and software in the presence of purchaser representatives. All subsystems shall be interconnected to simulate, as close as possible, the total integrated system. Following minimum tests shall be carried out:-

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a) Visual and mechanical testing, which shall be carried out in principle to assure correct, proper, good and neat workmanship by the vendor This testing shall include dimensional verification, Layout verification as per approved GA drawings, Verification of Sheet thickness / Quality of painting (outer and inner) / Nameplates, identifiers and tag plates / Adherence to ferruling philosophy / Dressing of wires / prefabricated cables and clearances / Locks and handles as a minimum.

b) Verification of Bill of Material. The Bill of material verification shall include both hardware and software.

c) Functional testing:

This shall include the simulation of each input and output to verify proper system response. The testing as a minimum shall include:

i) Complete system configuration loading.

ii) Demonstration of all PLC system builder functions including addition/deletion of an input/output, addition/ deletion of a rung or an element in a rung, generation of dynamic graphics and other views, report generation etc.

iii) 100% checking of logics configured in the PLC by connecting switch/lamp at input/output, by simulating inputs and verifying outputs preferably using simulator, other related functions like forcing, first out shall also be verified.

iv) Checking of scan time. Scan time verification shall be carried out during Factory Acceptance Test based on the specified requirements considering discrete input by given step change and Step input or slow ramp input (typical frequency of 4 cycles / second) with amplitude corresponding to 16mA (4mA to 20mA or vice versa) for all conventional analog and smart (HART) inputs from a signal generator. The scan time values so observed shall be within 90% confidence level.
The inputs to the system shall be:

- Step input i.e. 0 or 1 for all contact inputs. Step input can be generated by wiring back a digital output configured for the purpose.
- Step input or ramp input for all analog inputs. However, for PLC, the scan time check with analog inputs shall only be for record purposes.

v) Checking of all PLC console displays, keyboard and touch-screen operation (wherever specified), printer/hard copier functions etc.

vi) System redundancy checks including correct changeover of the back-up unit in case of failure of main unit.

vii) System diagnostic checking for all subsystems on local level as well as on console, including checking of the testing software for I/O modules/signal conditioning modules, when specified.

viii) Checking of output status on processor failure.

ix) Checking of first-out alarm generation.

x) Simulation of power failure and system restart auto boot-up of system configuration and program after power restoration.

xi) Checking of System diagnostics including Auto I/O testing feature, as applicable.

d) Test certificates of all components, Manufacturer's Test Certificates (TCs) of all bought - out items and Statutory Certificates shall be submitted for purchaser' review.

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5.2.8 Vendor shall notify the purchaser at least three (3) weeks prior to factory acceptance test. In the event that representative arrives and the system is not ready for testing, vendor shall be liable for back charges for any extra time and expenses incurred.

5.3 Installation, Testing and Commissioning

5.3.1 Vendor shall offer the services of an installation team which would install the equipment in the control room, lay the interconnecting cables inside control room, check-out, test and commission the system.

All technical personnel assigned to the site by the vendor shall be fully conversant with the supplied system and software package, and shall have both hardware and software capability to bring the system on line quickly and efficiently with a minimum of interference with other concurrent construction and commissioning activities.

5.3.2 Vendor's responsibility at site shall include all activities necessary to be performed to complete the job as per Requisition including:

a) Receipt of hardware/software and checking for completeness of supplies.
b) Installation of the system including for free supply equipment, if any.
c) Field cable termination and inter-cabinet cabling and termination.
d) Check out equipment installation.
e) Checking of interconnections, hardware and software configuration, overall system functioning etc.
f) Loop checking.
g) Field tests.
h) Commissioning and on-line debugging of the system.
i) Involvement during plant commissioning and performance of final acceptance test.
j) Co ordination for integration with DCS / other third party system.

5.3.3 **Field Inspection**

5.3.3.1 All equipments shall be inspected thoroughly by vendor after its receipt at site for completeness and proper functioning. Vendor must initiate the remedial action, in case unsatisfactory operation of any item is observed, with intimation to Engineer-in-charge.

5.3.3.2 Vendor must document all observations including details of any malfunction observed. Items/ equipments requiring total replacement must document the reasons for the same.

5.3.4 **Loop Checking**

5.3.4.1 Loop checking shall be carried out by vendor including checking the interconnections, configuration and overall system functioning.

5.3.4.2 Vendor's scope of work as a part of system installation and loop checking shall include termination of field cables in the control room, checking of interconnection between instrument/equipment, glanding, ferruling/tagging of interconnecting cables in control room, ferruling of field cables in control room and performing overall loop performance check.

5.3.4.3 Vendor shall coordinate with the field contractor for smooth and proper loop checking. Any discrepancy found during checking shall be brought to the notice of the Engineer-in-Charge. Complete loop checking shall be performed in his/her or his/her authorised representative's presence.

5.3.4.4 The input signals shall be simulated by disconnecting/connecting the field wires for all field switches connected to PLC. All field transmitters connected to control room shall be loop checked at 0%, 50% & 100% of full scale (for both increasing and decreasing signals). Wherever receiver cards are used, the set point shall be generated by giving the input signal

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to receiver card. All outputs shall be checked in field, either for actual operation of solenoid valve or actual pick-up of electrical contactor for rotary equipments. Shutdown schemes shall be checked for proper functioning, configuration and actuation.

5.3.4.5 After loop checking is completed, vendor shall connect back any terminals and connections removed for loop checking.

5.4 System Acceptance

5.4.1 The owner shall provisionally takeover the system from vendor after System acceptance test. System acceptance test shall be started only after the satisfactory performance of loop checking and verification of all loop checking records by Engineer-in-charge.

5.4.2 The system acceptance test shall be carried out in the presence of owner's representative and Engineer-in-charge or his authorised representative. The tests carried out in System acceptance test shall be fully recorded and duly signed by all representatives participating in the System Acceptance Testing.

5.4.3 Vendor shall carry out the following functional tests, as a part of system acceptance test, as a minimum:-

a) Hardware verification as per final Bill of Material.
b) Visual and mechanical check-up for proper workmanship, identification, ferruling, nameplates etc.
c) System configuration as per approved configuration diagram.
d) Demonstration of all system function, display and diagnostics.
e) Checking of correct change-over of redundant devices.
f) Checking of various peripheral devices like printers and printing of all reports.
g) Complete checking of logic system, loading of user's program and checkout of results.
h) Checking of proper functioning of all disc drives, alarm summary, alarm history etc.
i) Proper information transfer on the information network by verifying system displays and printout.

5.5 Final Acceptance Test

The owner will take over the system from the vendor after the final acceptance test, which is defined as successful uninterrupted operation of the integrated system for three weeks. Vendor's personnel shall be present during the test. Any malfunctioning of the system components shall be replaced / repaired as required. Once the system failure is detected, the acceptance test shall start all over again from the beginning. The warranty period commences from the day owner takes over the system.

6.0 GENERAL REQUIREMENTS

6.1 Vendor shall comply fully with the general requirements of PLC system including logistic support services, documentation, warranty, maintenance contract and shipping instructions.

Post Warranty Maintenance Contract

Vendor shall quote separately for post warranty maintenance contract after warranty period for five years for the complete system as per commercial terms and condition of the requisition and the type (i.e. comprehensive or non-comprehensive) of post warranty maintenance shall be as specified in job specification. The personnel deployed during post-warranty maintenance shall have thorough knowledge of the system and at least two years

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of experience on the maintenance of similar system. Any other conditions of contract required by vendor shall be explained in the offer.

7.0 SHIPPING

7.1 All the materials used for packing, wrapping, sealers, moisture resistant barriers and corrosion preventers shall be of recognised brands and shall conform to the best standards in the areas for the articles which are packed.

7.2 Workmanship shall be in accordance with best commercial practices and requirements of applicable specification. There shall be no defects, imperfections or omissions which would tend to impair the protection offered by the package as a whole.

7.3 The packing shall be suitable for storing in tropicalised climate, the ambient conditions, being specified in job specifications.

7.4 Shipment shall be thoroughly checked for completeness before final packing and shipment. Vendor shall be responsible for any delay in installation or commissioning schedule because of incomplete supply of equipments.

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थरमोकपल्स, आरटीडी एवंथरमोवैल्स केलिए मानकविनिर्देश

STANDARD SPECIFICATION FOR THERMOCOUPLES, RTDs AND THERMOWELLS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	03.11.2021	Revised and reissued as standard specification	MG/SM	DVP	MN	SM
4	02.08.16	Revised and reissued as standard specification	SM	SA/ASD	RG	RN
3	15.12.10	Revised and reissued as standard specification	SB	RP	TGM/JMS	ND
2	03.05.05	Revised and reissued as standard specification	KI	HCJ	PM	VJN
1	01.10.96	Revised and reissued as standard specification	RK	BRS	RB	AS
0	10.05.88	Issued as standard specification	PVS	TSN	AKV	AK

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
NPT	:	National Pipe Thread
PTC	:	Performance Test Code
RTD	:	Resistance Temperature Detector
SS	:	Stainless Steel

Instrumentation Standards Committee

Convenor: Mr. Mainak Nandi

Members: Mr. ArupjyotiSaikia
Mr. Sachin Garg
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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets describes the requirements for the design, materials, nameplate marking, inspection, testing and shipping of thermo-couples, RTDs and thermowells.

1.1.2 The related standards referred herein and mentioned below shall be of the latest edition of the following codes, standard practices and publications, unless otherwise specified:

ASME	American Society of Mechanical Engineers.	
	B1.20.1	Pipe Threads General Purpose (Inch)
	B16.5	Pipe Flanges and Flanged Fittings
	B16.20	Metallic Gaskets for Pipe Flanges
API	American Petroleum Institute	
	RP 551	Process Measurement Instrumentation.
ASME PTC 19.3 TW	Performance Test Code-Temperature measurement	
EN	European Standards	
	10204	Inspection Documents For Metallic Products
IS/IEC	Indian Standards/ International Electro technical Commission	
	IS/IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere
	IS/IEC 60529	Degree of Protection provided by Enclosures (IP Code)
	IEC-60751	Industrial Platinum Resistance Thermometers and Platinum temperature sensors
	IEC-60584-1:	Thermocouples–Part 1: EMF specifications & Tolerances
IS	Indian Standards	
	7358	Specifications for Thermocouples.

1.1.3 In the event of any conflict between this standard specification, job specification, data sheets, statutory regulations, related standards, codes etc. the following order of priority shall govern:

a) Statutory Regulations

b) Job Specification/ Data Sheets

c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets indicate the material of construction for sensing element, thermowell etc. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the specified fluid and its operating conditions.

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b) Vendor shall supply the Thermowell meeting vibration analysis as per ASME PTC 19.3TW latest edition.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Material Requisition.

1.2.2 All items as offered shall be field proven and should have completed trouble free satisfactory operation for a period of minimum 6 months on the bid due date in the similar application with process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.3 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals etc., shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required shall be submitted by the vendor as per Vendor data requirement attached with the requisition.

1.3.2 Final documentation consisting of design data, installation &maintenance manuals, test certificates & reports etc. shall be submitted by vendor after placement of Purchase order, as per vendor data requirement.

2.0 DESIGN AND CONSTRUCTION

2.1 Thermocouples

2.1.1 The type of thermocouple shall be as specified in purchasers data sheets. However when the type of thermocouple is not specified in purchaser's data sheet, following shall apply:

Copper-Constantan (ISA-Type-T)	:	(-) 200 to 200°C
Chromel-Constantan (ISA-Type-E)	:	200 to 600°C
Chromel-Alumel (ISA-Type-K)	:	600 to 1200°C
Platinum Rhodium-Platinum (ISA Type-S)	:	600 to 1600°C
Platinum Rhodium-Platinum Rhodium (ISA Type-B)	:	600 to 1700°C

2.1.2 The thermocouple element shall be 18 AWG for Single type thermocouples and 20 AWG for Duplex type thermocouples, unless otherwise specified in purchaser's data sheet. Single or Duplex type thermocouples shall be specified in Purchaser's data sheet.

2.1.3 The thermocouple properties and limits of error shall be as per IEC-60584-1.

2.1.4 Thermocouple shall be minimum 316 Stainless Steel sheathed magnesium oxide insulated, ungrounded type, for all tags with operating temperature less than 350 deg C, unless otherwise specified. For tags where operating temperature is greater than or equal to 350 degC, sheath material shall be Inconel as a minimum. Sheath OD shall be selected to suit the thermowell ID, subject to minimum sheath OD as 1 mm less than the thermowell ID.

2.2 Resistance Temperature Detectors

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2.2.1 The type of RTD shall be as specified in purchaser's data sheet. In general RTD shall be 3 wire type with platinum element having 100 ohms resistance at 0°C, selected for temperature range of (-) 200 to 650°C.

2.2.2 The element shall be of highly refined material of reference grade and shall have been stress relieved. RTD including its calibration shall be as per IEC-60751 to have standard electrical resistance & temperature coefficient of resistance.

2.2.3 The wire shall be wound on a ceramic core and immobilised against strain or damage. The winding shall be of bifilar type. The leads shall be copper up to terminal block.

2.2.4 The element shall be within a metal sheath, in a manner which provides good thermal transfer and protection against moisture. The sheath material shall be 316 Stainless Steel, unless otherwise specified. Sheath OD shall be selected to suit the thermowell ID, subject to minimum sheath OD as 1 mm less than the thermowell ID.

2.3 Common Head assembly specifications for Thermocouples & RTDs

2.3.1 Temperature element assemblies shall be with threaded heads and shall be spring loaded. The heads shall consist of a case, screwed on cover and terminal block. The Temperature element shall be screwed to the terminal block. Separate screw shall be provided on the terminal block for terminating the incoming cables. There shall be an extra terminal in the terminal block connected to the head for grounding the shield.

2.3.2 Unless otherwise specified, the assembly shall confirm to the following standards;

a) The heads shall be weatherproof to IP 65 as per IS/IEC-60529

b) In case of flameproof construction, heads shall be flame proof as per IS/IEC-60079 and weather proof to IP 65 as per IS/IEC-60529

2.3.3 The case shall be suitable for mounting terminal blocks for single or duplex type Temperature element assemblies.

2.3.4 A heat resistant and moisture proof asbestos free gasket shall be fitted between the case and cover. Head support chain (between case and cover) material shall be of stainless steel.

2.3.5 The terminals shall be permanently and legibly identified for their polarity. The terminal block shall be permanently and legibly marked with the IEC letter code to designate the type of Temperature element.

2.3.6 For Duplex type Temperature element, one entry of the element head shall be provided with SS316 plug, unless otherwise stated in the Purchaser's datasheet.

2.4 Thermowells

2.4.1 Unless otherwise specified, the thermowell material shall be minimum 316 Stainless Steel. Alternate material as SS 316L / SS 316 Ti shall also be acceptable instead of SS 316 subject to meeting process conditions specified in the data sheet.

2.4.2 Thermowells with immersion length up to 500 mm shall be machined out of forged bar-stock. Built-up thermowell with welded wall construction shall be acceptable for immersion length of greater than 500 mm,unless specified otherwise in purchaser's datasheet.

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2.4.3 The base of the thermowells shall be chosen to fit the instrument without air gap for minimizing measurement lag.

2.4.4 Thermowell flange material, rating and facing shall be as specified in the data sheet. Suitability of thermowell rating shall be verified as per the operating and design pressure/temperature conditions for individual tags as per ASME 16.5.

2.4.5 All thermowell weld joints shall be full penetration weld type.

2.4.6 Thermowell immersion length shall be as specified in purchasers data sheet. Where immersion length is not specified in purchaser's data sheet, following shall govern:

Line Size	**Immersion Length**
From 4"to 6"	280mm
From 8" to 20"	320mm
From 20" to 24"	400 mm
Vessels/Columns (side mounted)	400 mm
Above 24"& upto 42"	500 mm

Built-up thermowell shall be considered for line size above 42" and immersion length shall be as specified in the purchaser's data sheets. Immersion length is based on 200 mm length between flange face and outer wall of pipe and 200 mm length between flange face and inner wall of the vessel. Unsupported length shall be considered accordingly in the vibration analysis.

2.4.7 Vendor shall carry out the vibration analysis of thermowell as per ASME PTC 19.3TW latest edition and shall provide suitable design for the thermowells wherever necessary. Thermowells shall be suitable for stresses due to stream velocity condition. Any design change necessary as a consequence to this vibration analysis shall be included and provided by vendor.

Modifications to meet wake frequency shall be in the following order of precedence:
a) Maximum possible increase of thermowell OD for fitting into nozzle ID.
b) Decrease of thermowell length by not more than 50 mm from that specified in purchaser's data sheet.
c) Step design or any other proven design by vendor

For all such changes, vendor must obtain prior approval from purchaser before proceeding with the fabrication of thermowells.

2.4.8 All the thermowells in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or carbon tetrachloride.

3.0 NAMEPLATE

3.1 Thermocouple/RTD's

3.1.1 Each thermocouple / RTD assembly shall be provided with a stainless steel nameplate attached firmly to it, furnishing the following information:

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a) Tag number as per purchaser's data sheets.

b) Thermocouple type/RTD element type (along with sensor part number).

c) Type of protection whether sheathed or beaded.

d) Grounded or Ungrounded.

3.2 Thermowell

3.2.1 The following information shall be punched on the extension of the thermowell:

a) Tag number as per purchaser's data sheets.

b) Thermowell material as per purchaser's data sheets.

c) Thermowell immersion length 'U'.

3.2.2 The following information shall be punched on the thermowell flange at a visible place:

a) Nominal flange size in inches and rating in pounds.
b) Flange material as per purchaser's data sheets.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 Proper care shall be taken in shipping. All items shall be adequately packed to withstand shipping conditions, without damage.

5.2 All thermowells in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN/CHLORINE SERVICE', as applicable.

5.3 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

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STANDARD SPECIFICATION FOR THERMOCOUPLE EXTENSION CABLES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	09.08.21	Revised and Reissued as Standard Specification	SM/SJ	RK	MN	SM
6	01.04.16	Revised and Reissued as Standard Specification	SMK	RK	RG	RN
5	29.11.10	Revised and Reissued as Standard Specification	RK	RG	TGM/JMS	ND
4	03.05.05	Revised and Reissued as Standard Specification	NPG	AKG	PM	VJN
3	27.01.98	Revised and Reissued as Standard Specification	PM	RK	BRS	AS

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Abbreviations:

PVC	:	Polyvinyl Chloride
FRLS	:	Flame Retardant Low Smoke
XLPE	:	Cross linked Poly ethylene

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
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Mr. Sachin Garg
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Mr. Mayank Kaushik
Mr. Sourav Mukherjee
Ms. K Pratheepa
Mr. R K Gupta (Projects)

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheet forms the requirements for design, materials, manufacturing, inspection, testing and shipping of thermocouple extension cables.

1.1.2 Cables shall comply with latest edition of the following standards prior to the date of the purchaser's enquiry.

ASTM	American Society for Testing and Materials	
	D 2863	Test method for measuring the minimum oxygen Concentration to support candle like combustion of Plastics (oxygen index).
BS	British Standards	
	BS EN 50288-7:	Multi-element metallic cables used in and digital communication and control. Sectional specification for instrumentation and control cables.
IEC	International Electro technical Commission	
	60584-3	Extension and compensating cables - Tolerances and identification system.
	60332	Tests on electric and optical fibre cables under fire Conditions.
IS	Indian Standards	
	1554	Part 1 PVC insulated (heavy duty) electric cables-working voltage up to and including 1100V.
	3975	Mild steel wires, formed wires and tapes for armouring of cables.
	5831	PVC insulation and sheath of electric cables.
	8784	Thermocouple compensating cables.
	10810	Method of test for cables.
	-Part 40	Method for testing uniformity of coating on zinc coated articles.
	-Part 41	Mass of zinc coating on steel armour
	-Part 58	Oxygen Index test
	-Part 61	Flame Retardant test
	-Part 62	Flame Retardance test for bunched cables

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Material requisition.

1.2.2 All documentation submitted by vendor including their quotation, catalogues, drawings and documents etc. shall be in English language only.

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1.2.3 Vendor's quotation shall include the following:

a) Unit rate per metre for each type of cable, which shall be used for any addition or deletion of the quantity.

b) Minimum number of eight PVC / rubber end caps shall be supplied with each drum.

1.3 Drawings and Data

1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in the vendor data requirement sheets attached with the requisition.

1.3.2 Final documentation consisting of design and constructional data submitted by the vendor after placement of order shall include the following, as a minimum.

a) Specification sheet for each type of cable along with test certificates and test reports.

b) Cable details giving electrical characteristics, overall diameter, diameter under armour and diameter over armour.

2.0 DESIGN AND CONSTRUCTION

2.1 Constructional Requirements

2.1.1 Type and material of extension/compensating cable core shall be as per IS 8784 and IEC 60584-3 as applicable. Thermocouple extension or compensating shall be suitably decided based on the type of thermocouple.

2.1.2 Primary insulation shall be 85°C polyvinyl chloride (PVC) type C as per IS 5831. Thickness of primary insulation shall be 0.5 mm as a minimum.

2.1.3 Unless specified otherwise, insulation, inner sheath and outer sheath colour shall be as per IEC 60584. However it is vendor's responsibility to re-confirm insulation and sheath colour with purchaser prior to manufacturing. The thickness of the sheath shall be as per IS 1554 part 1.

2.1.4 Inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST2 (90°C) as per IS 5831 and shall meet the following requirements:

a) Oxygen index of PVC shall be over 30 at 27° C ±2°C.

b) Temperature index shall be over 250°C.

c) Inner and outer sheath shall posses flame retardant properties meeting requirements for bunched cables as per IS 10810 part 62 category AF or IEC 60332 Part 3 category–A.

d) A rip cord shall be provided for inner sheath.

e) Outer sheath shall be suitable for protecting the cable against rodent and termite attack.

2.1.5 Armour over inner sheath shall be of galvanised steel wire/ flat. The dimensions of Armour shall be as per IS 1554 part 1. Requirement and methods of tests for armour material and uniformity of galvanization shall be as per IS 3975 and IS 10810 part 40 respectively.

2.1.6 Each pair shall be shielded. Shield shall be aluminum backed by Mylar/ polyester tape bonded together helically applied with the metallic side down 25% overlap on either side and 100%coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm^2 multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminum side of the shield.

2.1.7 The cores of the pair shall be twisted and minimum 10 twists shall be provided per meter of cable.

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2.1.8 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving shall be legible and indelible.

2.1.9 Tolerance in overall diameter of cable shall be within ± 2 mm over offered value.

2.1.10 The cables used in installations under the jurisdiction of Director General of Mines and Safety (DGMS) shall meet all requirements of DGMS. The word "Mining Cable" shall be embossed / engraved on the cable outer sheath as per IS 1554 part 1.

2.1.11 Drum length and length tolerance.

2.1.11.1 The length of the cables in each drum (drum length) shall be as specified in the purchaser data sheets .Where no drum length is indicated in the data sheet /material requisition, following shall be apply:

Drum length for single pair cable : 500 metre
Drum length for multi-pair cable : 1000 metre

2.1.11.2 Actual produced drum length shall not vary by more than ± 3% from the length indicated in purchaser's datasheet or clause 2.1.11.1 of this specification, as applicable.

2.1.11.3 Tolerance over total ordered length shall not vary by more than +0% and -2% for total length for a type of cable.

2.1.12 For ISA type S (Platinum Rhodium / Platinum) thermocouple and for ISA type R (Platinum Rhodium / Platinum) thermocouple, compensating cables are also acceptable. For type R thermocouple, compensating cable shall be type RCA and for type S thermocouple, the compensating cable shall be type SCA as per IEC 60584-3. Material of compensating cable for both type R and type S thermocouple shall be copper for positive lead and copper Nickel alloy for the negative lead as per IS 8784.

2.2 Electrical Characteristics

2.2.1 Thermoelectric specifications and limits of error shall be as per IEC 60584-3. All thermocouple extension cable shall be matched and calibrated in accordance with IEC-60584-3 to be included.

2.2.1 Mutual capacitance of the pairs or adjacent cores shall not exceed 250 pF / m at a frequency of 1 KHz.

2.2.2 Capacitance shall not exceed 400 pF / m between any core and screen at a frequency of 1 KHz.

2.2.3 Core inductance shall not exceed 4 mH / km.

2.2.4 The drain wire resistance including shield shall not exceed 30 ohm / km.

2.2.5 Electrostatic noise rejection ratio shall be over 76 dB.

2.3 Type-I (Single pair shielded cable)

2.3.1 Each core shall be made of 16 AWG solid conductor.

2.3.2 All other specifications shall be as per clause 2.1 and 2.2 of this specification.

2.4 Type-II (Multi-pair cable with individual pair shield and overall shield)

2.4.1 Each core shall be 20 AWG solid conductor.

2.4.2 In addition to individual pair shield overall shield shall be provided. Overall shield shall be of aluminum backed up by mylar/polyester tape helically applied with metallic side down either side 25% overlap or 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be similar to individual pair drain wire and shall be in continuous contact with the

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aluminum side of the overall shield.

2.4.3 Overall twist of all pair shall be as per vendor's standard.

2.4.4 A pair of communication wire shall be provided for multi-pair cables. Each wire shall be 0.5 mm^2 of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

2.4.5 Pair identification shall be with numbers at interval of not more than 250 mm.

2.4.6 All other specifications shall be as per clause 2.1 and 2.2 of this specification.

2.5 Type-III: (Multi-pair cable with individual pair shield and overall shield)

2.5.1 The cable shall be same as type II except conductor size shall be 16 AWG.

2.5.2 All other specifications shall be as per clause 2.1 and 2.2 of this specification.

3.0 NAMEPLATE

Each cable drum shall be marked with the following information at a visible place;

a) Manufacturer's name

b) Type and size of the cable

c) Length of the cable in meters contained in the drum

d) Gross weight

e) Drum number

f) Direction of rotation of drum for unwinding by means of an arrow.

g) Purchase order number.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

Cables shall be dispatched in wooden drums securely battened, with take off end fully protected against damage.

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STANDARD SPECIFICATION FOR SIGNAL CABLES

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					Approved by	
8	10.12.21	Revised and Reissued as Standard Specification	RK	ASDB	MN	SM
7	28.03.17	Revised and Reissued as Standard Specification	SMK	RK	RG	RN
6	15.12.10	Revised and Reissued as Standard Specification	RSD	RP	TGM/JMS	ND
5	03.05.05	Revised and Reissued as Standard Specification	NPG	AKG	PM	VJN
4	27.01.98	Revised and Reissued as Standard Specification	PM	RK	BRS	AS

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Abbreviations:

DC	:	Direct Current
EPR	:	Ethylene-Propylene Rubber
FR	:	Flame Retardant
FRLS	:	Flame Retardant Low Smoke
PE	:	Polyethylene
PETP	:	Polyethylene Terepthalate
PVC	:	Polyvinyl Chloride
XLPE	:	Cross Linked Poly Ethylene

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets, covers the requirements for design, materials, manufacturing, inspection, testing and shipping of signal cables.

1.1.2 Cables shall comply with latest edition of the following standards prior to the date of the purchaser's enquiry.

ASTM	American Society for Testing and Materials	
	D 2843	Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.
	D 2863	Test method for measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index).
BS	British Standards	
	EN50288-7	Multi-element metallic cables used in and digital communication and control. Sectional specification for instrumentation and control cables.
	EN 60228	Conductor of Insulated Cables
IEC	International Electro technical Commission	
	60811-201	Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness.
	60331	Testing of Fire Resistant cables.
	60332	Tests on bunched wires and cables.
	60092	Electrical Installations of Cables
	60754	Test on Gases Evolved during Combustion of materials from Cables – Part 1, 2.
IS	Indian Standards	
	1554 Part 1	PVC insulated (heavy duty) electric cables-working Voltage up to and including 1100V.
	3975	Mild steel wires, formed wires and tapes for armouring of Cables.
	5831	PVC insulation and sheath of electric cables.
	6380	Elastomeric insulation and sheath of electric cables
	7098	Cross-Linked Polyethylene Insulated PVC sheathed Cables
	10810	Method of test for cables.
	Part 40	Method for testing uniformity of Zinc coating on Steel armour
	Part 41	Mass of zinc coating on steel armour
	Part 58	Oxygen Index test
	Part 59	Determination of the amount of halogen acid gas evolved during combustion of polymeric material taken from cables
	Part 61	Flame Retardant test
	Part 62	Flame Retardance test for bunched cables
	Part 63	Smoke densities of electric cables under fire conditions
	Part 64	Measurement of Temperature Index

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

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b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 All documentation submitted by vendor including their quotation, catalogues, drawings and documents etc. shall be in English language only.

1.2.3 Vendor shall furnish unit price per metre for each type of cable, which shall be used for any addition or deletion of the quantity.

1.3 Drawings and Data

1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in the vendor data requirement sheets attached with the requisition.

1.3.2 Final documentation consisting of design and constructional data submitted by the vendor after placement of order shall include the following, as a minimum.

a) Specification sheet for each type of cable along with test certificates and test reports.

b) Cable details giving electrical characteristics, overall diameter, weight, diameter under armour and diameter over armour.

2.0 DESIGN AND CONSTRUCTION

2.1 Constructional Requirements

2.1.1 Cables shall be heavy-duty type, 500V grade.

For polyvinyl chloride (PVC) Type C cables, primary insulation shall withstand maximum conductor temperature of 85°C and shall meet the requirement specified in IS 5831. Thickness of primary insulation shall be 0.5 mm as a minimum. For PE insulated cables, primary insulation shall withstand maximum conductor temperature of 70°C Polyethylene. For XLPE insulated cables, primary insulation shall withstand maximum conductor temperature of 90° C and shall meet the requirement specified in IS-7098 (Part-1).

The type of primary insulation shall be as specified in purchasers data sheets.

2.1.2 Inner sheath colour of signal cables shall be black. Outer sheath colour shall also be black except for cables used in intrinsically safe systems. The outer sheath colour for all such cables used in intrinsically safe application shall be light blue. The thickness of the sheath shall be as per IS 1554 part 1.

2.1.3 Inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST2 (90°C) as per IS 5831 and shall meet the following requirements:

a) Minimum Oxygen index of PVC shall be 30 at 27 °C ±2°C.

b) Temperature index shall be over 250 °C.

c) Inner and Outer sheath shall posses flame retardant properties meeting requirements for bunched cables as per IS 10810 (Part 62) category AF or IEC 60332 category A.

d) A rip cord shall be provided for inner sheath.

e) Outer sheath shall be suitable for protecting the cable against rodent and termite attack.

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f) Inner and Outer sheath of all cables shall be water resistivity type.

2.1.4 All types of cables shall be armoured type unless otherwise specified. Armour over inner sheath shall be of galvanised steel wire (flat or round wire type). The dimensions of armour shall be as per IS 1554 (Part 1). Requirement and methods of tests for armour material and uniformity of galvanisation shall be as per IS 3975 and IS 10810 (Part 40) respectively.

2.1.5 Each pair/triad shall be shielded. Shield shall be of aluminium backed by mylar / polyester tape bonded together helically applied with metallic side down having 25% overlap on either side and 100% coverage. Minimum shield thickness shall be 0.05 mm. Drain wire shall be 0.5 mm^2 multi-strand bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.

2.1.6 Overall shield shall be of aluminium backed up by mylar/polyester tape helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.075 mm. Drain wire shall be similar to individual pair/triad drain wire and shall be over the overall shield.

2.1.7 The cores of a pair triad shall be twisted with a minimum of 10 twists per metre of cable.

2.1.8 Sequential marking of the length of the cable in meters shall be provided on the outer sheath at every one meter. The embossing /engraving/printing shall be legible and indelible.

2.1.9 Tolerance in overall diameter of cable shall be within ± 2 mm over offered value. The actual overall diameter (O.D) of the manufactured cable shall meet the O.D specified by the vendor in the offer and purchase requisition within the specified tolerance limits.

2.1.10 The cables used in installations under the jurisdiction of Director General of Mines and Safety (DGMS) shall meet all requirements of DGMS. The word "Mining Cable" shall be embossed on the cable outer sheath as per IS 1554 (Part 1).

2.1.11 Drum length and length tolerance

The length of the cables in each drum (drum length) shall be as specified in the purchaser data sheets. Where no drum length is indicated in the data sheet /material requisition, the following shall apply:

Drum length for single pair/ single triad cable : 500 metres
Drum length for multi-pair/ multi- triad cable : 1200 metres

Actual produced drum length shall not vary by more than ± 3% from the length indicated in purchaser's datasheet.

2.1.12 Tolerance over the total ordered length shall not vary by more than +0% and (-) 2% for total length for a type of cable.

2.1.13 Specific Requirements for fire resistant or fire survival cable.

2.1.13.1 The cables shall have circuit integrity as per IEC 60331 (Part-21).

2.1.13.2 Primary insulation shall be heat resisting elastomeric which can withstand temperature up to 90°C such as silicon rubber/mica glass tape/EPR (medium grade) as per IS 6380. Insulation thickness shall be 1.0mm minimum (0.44 mm for Silicon rubber) and shall confirm to IEC 60092.

2.1.13.3 Individual pair triad shall be shielded. The shield shall be aluminium backed by mylar/PETP tape with the metallic side down helically applied with 25% overlap on either side and 100% coverage. Minimum shield thickness shall be as per IEC 60092. Drain wire shall be 0.5mm^2 (7/0.3mm dia) multi-stranded bare tinned annealed copper conductor. Drain wire shall be in continuous contact with aluminium side of the shield.

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2.1.13.4 Inner and outer sheath shall be made of low smoke, heat resistant, oil resistant and flame retardant material with oxygen index over 30, temperature index shall be over 250°C. Acid generation shall be maximum 20% by weight as per IEC 60754. Smoke density rating not to exceed 60% as per ASTM D 2843.

2.1.13.5 The thickness of the sheath shall be as per IEC 60092. Inner and outer sheath colour shall be orange. A rip cord shall be provided for inner sheath.

2.2 Electrical Characteristics

2.2.1 Maximum DC resistance of the conductor of the finished cable shall not exceed 7.41 Ω / km at 20°C for cables with 2.5 mm^2 conductors, 12.3 Ω / km at 20°C for cables with 1.5 mm^2 conductors and 39.7 Ω / km at 20°C for cables with 0.5 mm^2 conductors.

2.2.2 **Capacitance**

2.2.2.1 Mutual Capacitance for PVC Insulated cables
The mutual capacitance of between pairs/triads or adjacent cores shall not exceed of 250 pF / metre at a frequency of 1 KHz.

2.2.2.2 Mutual Capacitance for PE/XLPE Insulated cables
The mutual capacitance between the pairs/triads shall not exceed of 100 pF / metre at a frequency of 1 KHz.

2.2.2.3 Capacitance between any core or screen
The capacitance between any core and screen shall not exceed a maximum of 400 pF / metre at a frequency of 1 KHz.

2.2.3 L/R ratio of adjacent core shall not exceed 60 μH / Ω for cables with 2.5 mm^2 conductors, 40 μH / Ω for cables with 1.5 mm^2 conductors and 25 μH / Ω for cables with 0.5 mm^2 conductors.

2.2.4 The drain wire resistance including shield shall not exceed 30 Ω / km.

2.2.5 Electrostatic noise rejection ratio of the finished cable shall be over 76 dB.

2.3 Type I (Single pair/Triad shielded).

2.3.1 Each core shall be 1.5/2.5 mm^2 (as per respective data sheet) made of 7 stranded annealed electrolytic copper conductor. Each strand shall be 0.53 mm dia for 1.5 mm2 conductor size and 0.67 for 2.5 mm2 conductor size.

2.3.2 Colour of core insulation shall be black and blue in pair and black, blue and brown in a triad.

2.3.3 All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

2.4 Type-II (Multi-pair/Multi-triad cable with individual pair/triad shield and overall shield)

2.4.1 Conductor sizes shall be 0.5mm^2 made up of 7 strands of annealed electrolytic copper conductor. Each strand shall be of 0.3 mm diameter.

2.4.2 Overall twist of all pair/triads shall be as per vendor's standard.

2.4.3 A pair of communication wire shall be provided for multipair / multitriad cables. Each wire shall be 0.5 mm^2 of plain annealed single or multistrand copper conductor with 0.4 mm thick 85°C PVC insulation. Insulation shall be green and red colour coded.

2.4.4 A pair identification shall be with numbers at interval of not more than 250 mm. Pair identification to be printed on the primary insulation for multi-cables.

2.4.5 All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

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2.5 Type-III (Multi-pair/ Multi-triad cable with individual pair/triad shield and overall shield)

2.5.1 The cable shall be same as type-II cable, except conductor size shall be 2.5 mm^2 made of 7 stranded annealed electrolytic copper conductor. Each strand shall be of 0.67 mm dia.

2.6 Type-IV (Multi-pair /Multi-triad cable with individual pair shield and overall shield)

2.6.1 The cable shall be same as Type II, except conductor size shall be 1.5 mm^2 made of 7 stranded annealed electrolytic copper conductor. Each strand shall be of 0.53 mm dia.

2.7 RS-485 Cable

2.7.1 The cable shall be 2Pair x 1 mm2 made of 7 stranded annealed electrolytic copper conductor. Each strand shall be of 0.43 mm dia. All other specifications shall be as per clauses 2.1. and 2.2 of this specification.

3.0 NAMEPLATE (Identification on Cable Drums)

Each cable drum shall be marked with the following information at a visible place;

a) Manufacturer's name

b) Type and size of the cable as per material requisition.

c) Length of the cable in meters contained in the drum.

d) Gross weight

e) Drum number

f) Direction of rotation of drum for unwinding by means of an arrow.

g) Purchase order number.

4.0 INSPECTION AND TESTING

4.1 Purchaser reserves the right to inspect and witness testing of all the items at vendor's works as per Inspection Test Plan and approved quality documents. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

4.2 Immediately after completion of electrical tests, the ends of the cable shall be sealed to prevent Ingress of moisture with suitable PVC / rubber caps.

5.0 SHIPPING

Cables shall be dispatched in wooden drums securely battened, with takeoff end fully protected against damage. Minimum number of eight PVC/rubber end caps shall be shipped with each drum.

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मुख्य नियंत्रण पैनल और सहायक उपकरण के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR CONTROL PANEL AND ACCESSORIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	28.03.22	Revised and Reissued as Standard Specification	AT/JJ	KKP	MN	SM
4	27.03.17	Revised and Reissued as Standard Specification	NA	RK	RG	RN
3	22.07.11	Revised and Reissued as Standard Specification	SM	RG	RP/ JMS	DM
2	07.03.06	Revised and Reissued as Standard Specification	RG	TGM	PM	VJN
1	26.03.98	Revised and Reissued as Standard Specification	RK	BRS	RB	AS

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Abbreviations:

AC	:	Alternating Current
DC	:	Direct Current
DPDT	:	Double Pole Double Throw
HRC	:	High Rupturing Capacity
LED	:	Light Emitting Diode
NPT	:	National Pipe Thread
PVC	:	Poly Vinyl Chloride

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets covers the requirements for the design, materials, fabrication, wiring, painting, nameplate marking, inspection & testing, shipment and site activities including installation of control panels and accessories.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

ASME	American Society of Mechanical Engineers	
	B 1.20.1	Pipe Threads
	B 16.5	Pipe Flanges and Flanged Fittings: NPS½ through NPS24 Metric/Inch Standard
	B 16.20	Ring joint Gaskets and Grooves for Steel Pipe Flanges..
API	American Petroleum Institute	
	MPMS	Manual of Petroleum Measurement Standards
	RP 552	Transmission Systems
EN	European Standards	
	10204	Inspection Documents for Metallic Products
	50288-7	Multi-element Metallic Cables Used in Analogue and Digital Communication and Control- Part 7: Sectional Specification for Instrumentation and Control Cables
NFPA	National Fire Protection Association	
	496	Purged and Pressurised Enclosure for Electrical Equipment.
IS/IEC	Indian Standards/ International Electro Technical Commission	
	IS/IEC-60079	Electrical Apparatus for Explosive Gas Atmosphere
	IS/IEC-60529	Classification of Degrees of Protection Provided by Enclosures
	IEC-61000-4	Electromagnetic Compatibility for Industrial : Testing and Measurement Techniques.
	IS-5	Colours for Ready Mixed Paints.
	IS-2062	Hot rolled Medium and High Tensile Structural Steel.

1.1.3 In the event of any conflict between this standard specification, data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

a) Statutory regulations

b) Job Specifications, Data Sheets

c) Standard specification

d) Codes and standards

1.1.4 In addition to compliance to purchaser's specification in totality, vendor's extent of responsibility shall include the following:

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Vendor shall be responsible for panel front arrangement including proper location and spacing of instruments and accessories like switches, push buttons, lamps, terminal blocks, supporting steel members, wiring raceways etc., from the point of view of accessibility and ease of maintenance based on the indicative drawings/schemes furnished by the purchaser.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the material requisition.

1.2.2 Vendor's quotation shall include the following:

a) Whenever specifically indicated, a detailed specification sheet for each item, which shall provide information regarding type, construction, performance specification etc. of items being supplied by vendor. The material specifications and units of measurement of various items in vendor's specification sheets shall be to the same standards as those in purchaser's data sheets.

b) Proven references for each offered type of item/model in line with clause 1.2.3 of this specification.

c) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of item covered in the bid.

i) A copy of approval for control panel and accessories. from local statutory authority, as applicable, such as Petroleum and Explosives Safety Organization (PESO) in India, along with:

i) Test certificate from recognised test house like Central Institute of Mining and Fuel Research (CIMFR) / Electronics Regional Testing Laboratory (ERTL) etc. for flameproof enclosure and/ or intrinsic safety, as specified in the data sheets as per relevant Indian Standard for all Indian manufactured equipments.

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Physikalisch-Technische Bundesanstalt (PTB), Canadian Standards Association (CSA), Underwriters Laboratories (UL) etc., for compliance to ATEX directives or equivalent recognised standards for all equipments manufactured outside India.

e) List of sub-vendors of items, which are part of this enquiry but not manufactured by panel vendor. The sub-vendor list shall be subject to approval by purchaser.

f) Approximate overall shipping dimensions and weight of each panel and associated equipment.

g) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason to deviate, they may include a list of deviations, item wise, summing up all the deviations, from the purchaser's data sheets and other technical specifications along with the technical reasons for each of these deviations.

1.2.3 All items, as offered by the vendor, shall be field proven and should have been operating individually for a period of minimum six (6) months on the bid due date in the conditions

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similar to those as specified in the purchaser's data sheets. Items with prototype design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Vendor's quotation, catalogues, drawings, installation, operation and maintenance manual etc. shall be in English language only.

1.2.5 Vendor shall also quote for the following:

a) Supply of at least one kilogram of paint for final touch up at site.

b) Two years operational spares for each panel and accessories, which shall include lamps, push buttons etc.

c) Any tools and tackles needed for maintenance work. Vendor must certify in their offer in case no special tools are necessary for the offered control panels.

d) Unit prices for the following items:

i) Each individual item/accessory like relay, timer, push button etc.

ii) Installation and wiring of each item to be supplied by purchaser/vendor.

iii) Dummy panel section-unwired.

iv) Blank semi-graphic section.

v) Unit cut out rates.

1.3 Drawing and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheetsattached with the requisition.

1.3.2 Final documentation consisting of design data, installation manual, maintenance manual etc. submitted by the vendor after placement of purchase order shall include the following, as a minimum;

a) Specification sheet for control panels, instruments and accessories.

b) Certified drawings for each control panel, which shall provide following details:

i) Control panel front arrangement drawing showing all dimensions including bezel/cut out dimensions.

ii) Loop wiring drawings showing the terminal numbers of each instrument/ accessory used in the wiring.

iii) Ladder drawings and relay wiring drawings showing terminal numbers for interlock/shutdown.

iv) Power supply distribution drawings with terminal numbers, incoming/ outgoing feeder size, fuse and isolator rating etc.

c) Vendor shall provide test certificates for all the tests indicated in Clause 4.0 of this specification.

d) Maintenance procedure including replacement of instruments and accessories in vendor scope.

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2.0 DESIGN AND CONSTRUCTION

2.1 Control panel and accessories shall be designed and fabricated in accordance with the drawings/data sheets enclosed with the Enquiry. Applicable standards and codes shall include relevant sections of API-MPMS, API RP 552.

2.2 The design of the electronic instruments, relays etc. shall be in compliance with electromagnetic compatibility requirements as per IEC 61000-4.

2.3 Construction

2.3.1 Control Panel sizing shall be carried out based on equipment being installed keeping in view the maintenance clearances and easiness of operation. Although the panel dimensions shall be guided by the actual requirements, in general panel shall have the following dimensional details:

Height : 2000mm

Width : 800mm / 1200mm (maximum)

Depth : 800mm/1000mm(maximum)

Cabinets shall be rigidly mounted on 100mm high channel base. Construction shall be modular preferably. In any case, vendor shall not proceed with panel manufacturing before getting prior approval from the purchaser.

2.3.2 Panels shall be free standing type. Panels with instruments mounted on the front shall be fabricated from 3 mm thick cold rolled steel sheet. If the same is not available, 4 mm thick Hot rolled steel sheet shall be used. All other panels shall be fabricated from 2mm thick cold Rolled steel sheet. Angle iron framework shall use a minimum section of 50 x 50 x 4 mm Angle. Cabinet frame shall be of 9 fold profiled CRCA steel sheet or of Angle iron frame using minimum section of 50 x 50 x 4 mm angle. Panel painting procedure shall include blast cleaning, grinding, chemical cleaning, Surface finishing by suitable filler and two coats of high grade lacquer with wet blasting Wherever required. Two coats of paint in the panel colour shall be provided for non-glossy High satin finish. Final coat shall be given after assembly at site.
For local control panel, Steel sheets for panels shall be cut on a squaring shears to ensure tight flush joint when butted together. Adjacent panels are bolted together with cadmium-plated bolts and nuts. Bolts or screw shall not be exposed on the face of the panel. Welded coupling of panel section is not allowed. Adjacent panels shall be assembled with face flush. Gaps or cracks shall not be visible from the front of assembled panels.The Cut outs between Inter-panel shall be fitted with Rubber Grommets.

2.3.3 Where specified vendor to provide one digital clock on the panel front. Clock display shall be seven segments LED with AM/PM or 24-hour mode, which shall be field selectable. Display shall be visible from a distance of 7 metres arc covering an angle of minimum 120°.

2.3.4 All exposed surfaces in plain view shall be perfectly level, smooth and free from any protrusions and tool or clamp marks. All edges including cut outs shall be ground smooth.

2.3.5 Rear of each panel section shall have a steel framework assembled to it for supporting instruments, raceways and other accessories like power distribution boxes etc. Panel stiffeners shall be welded to the rear of the panel and shall not interfere with instrument installation. All structural shapes of steel members shall be as per IS-2062.

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2.3.6 Enclosed cubicle panels shall have removable hinged doors (rear) for easy maintenance and Accessibility of the instruments. Doors shall be double leaved type with handle and shall be Provided with lock and key. Adequate illumination shall be provided inside the panel. All Light fittings shall be suitable for 240 V, 50 Hz AC. Power supply greater than 240 V shall not enter the control panel.

2.3.7 All cable entries to the panel shall be from panel bottom only using cable glands/ MCT of adequate size including supply of cable glands. Cable gland plate thickness shall be a minimum of 3 mm cold rolled cold annealed(CRCA) as a minimum. All unused cable entries must be plugged. Wherever requirement of MCT (Multi Cable Transit) is only specified, all cables entering the panel shall be through MCT blocks including supply & installation of MCT block by supplier.

2.3.8 One telephone socket, and 110V 50 Hz/ 240V 50 Hz plug in outlets shall be provided for every three panel sections.

2.3.9 Lifting Hooks (4 Nos.) shall be provided for each panel. Removal of Lifting Hooks shall not leave any opening into the Panel.

2.3.10 Normal mounting heights on panel of instruments (centre lines of instruments to floor) shall conform to the following, with minor adjustments depending upon instruments selected:

1	Instruments	Bottom Row Middle Row Top Row	1100mm 1350mm 1600mm
2	Annunciators	-	1950mm
3	Electrical push buttons, Selector switches, lamps, etc.	-	700mm

The Acknowledge, Reset and Test Push Buttons shall not be located more than 1500 mm Height. No Instrument/Controls/Push Buttons/Terminal Blocks/Test Plugs shall be mounted upto 300 mm height from bottom.

2.3.11 The design of panel shall incorporate provision for expansion by installing adequate spare capacity. Each panel shall be designed to accommodate the following additional equipment, as a minimum:

a) 20% of panel front/inside mounted instruments including lamps, push buttons, switches, relays etc.
b) 20% additional power feeders each provided with switch fuse assembly.
c) 20% additional spare windows in alarm annunciators.
d) 20% spare cable entry points.

2.3.12 All nuts, bolts, screws, washers (lock or flat) and hinges shall be of stainless steel. All fastening links shall also be of stainless steel.

2.3.13 Document pocket / wallet shall be provided on the inner side of front and rear doors of each cabinet and on the inner side of the door of each cabinet.

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2.4 Local Control panel

Local Control panel and accessories shall be suitable for location in non air-conditioned building. Panel and associated accessories shall be designed to withstand environmental conditions at site. Panel in open areas shall be weatherproof to IP-55 as per IS/ IEC-60529. Gasketed, Toughened Glass Doors, shall be used for normal visibility wherever required.

2.4.1 Panels Located in Hazardous Area

2.4.1.1 Pressurised Panel

Pressurisation shall be as per NFPA-496 type X (for panels located in Zone-1 or Zone-2) in general. However, actual requirements shall be as specified in job specification. Vendor shall provide all the instrumentation and accessories being mounted on/inside the panel, including the pressurisation kit. Make/model of all instrumentation shall be subject to approval by owner. The pressurisation kit shall be complete with filter regulator, differential pressure purge rotameter and differential pressure indicator on front panel, differential pressure switch for alarm or power cut off as per area classification and for remote alarm in case of pressurisation failure. The control unit and other electrical components like pressurisation status, purge medium control solenoids, Junction Box, Power distribution board etc. required for purging/ pressurisation of panel shall be flame proof. All incoming/outgoing contacts from panel shall be routed through the flameproof control unit, which will provide isolation of the contacts automatically during pressurisation failure in case of IEC-Zone-1 area, or manually through a switch for maintenance purpose. Pressurisation level adjustment should be possible externally without depressurising the panel. The atmospheric open end of differential pressure gauge/switch shall be provided with bug screen. No hazardous gas shall be piped inside the panel. All cut-outs shall be properly gasketed for good pressurisation. An additional glass door opening at the front shall be provided for weather protection of instruments mounted on the front of the panel. All instruments shall be calibrated at shop before despatching the panel. Glass door, if any, shall be of shatterproof glass. Cable glands shall be double compression types. Instruments that are liable to get damaged during shipment shall be removed and despatched loose along with the panel.

2.4.1.2 Flame-proof Panel

These panels shall be duly certified by statutory authority, as mentioned in clause 1.2.2 of this specification, for safe use in specified hazardous area. Glass door if any shall be of shatterproof glass. All special tools shall be supplied for maintaining these panels. Cable glands shall be double compression types.

Weatherproof panel but with all electrical components and accessories flameproof. All electrical components and accessories shall be flame proof and duly certified by statutory authority as mentioned in clause 1.2.2 of this specification. Cable glands shall be double compression type

2.4.1.3 Pneumatic Panel

2.4.1.3.1 Air Supply

i) Each pneumatic instrument shall be fed through 1/4" isolation valve and air filter regulator. Air reducing station shall be provided for panels housing more than ten instruments

ii) Air pressure reducing station shall have two parallel branches each consisting of block valves, filter and regulator. Pressure relief valve and a pressure indicator shall be installed at the common outlet. Each branch of air reducing station shall be designed for full capacity.

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iii) Vendor shall furnish air supply piping from a point on the panel framework to the inlet side of the pressure reducing station or alternatively to the inlet side of individual pressure regulators. A flanged connection shall be provided on the framework to connect the inlet piping.

iv) Fittings and 1/4" valves downstream of the filters at the air reducing station shall be of brass material. All headers shall be minimum 2" and shall be nickel-plated brass material.

v) Air supply header shall be extended from downstream side of the main pressure reducing valves across the length of the panel.

vi) The air header shall be installed with proper slope towards the dead end. A brass gate valve shall be provided at the dead end of the air header for cleaning or draining the header. Air reducing station shall not hinder access to bulk head fittings.

vii) Where miniature type instruments are used, vertical sub-air headers for each panel shall be provided with 1/4" NPT (F) brass needle valves. In all cases 10% spare take-off points with needle valves shall be provided for future use.

2.4.1.3.2 Tubing

i) Vendor shall supply and install all tubing between instruments to bulkhead fittings and from auxiliary items such as pressure switch rack mounted within panel.

ii) All bulkhead union shall be suitable for SS tube on either side. 10% spare bulkhead fittings shall also be supplied.

iii) Tube fittings shall be compression, double ring ferrule type.

iv) 6 mm OD x 1 mm thick SS tube shall be used for tubing inside the panel and accessories. It shall be 316L Stainless Steel fully annealed, seamless and cold drawn as per ASTM A269/A269M.

v) PVC ducts shall be used for laying of tubing behind the panel, racks etc. Rubber grommets shall be provided wherever tubings are taken in and out of instruments, racks etc.

2.4.2 Local control panel shall be supplied along with sun shade unless its requirement is specifically indicated as "not required" in the job specifications.

2.4.3 Unless otherwise specified, the material of construction of junction boxes shall be followed as below:

i) Enclosures: Cast light metal alloy

ii) Internal plate: Nickel plated steel / Aluminium rails.

2.5 Painting

2.5.1 The entire surface of panels and accessories, comprising front, rear and sides shall be treated and painted as follows:

a) All surfaces including structures shall be sand blasted and grinded until they are smooth and free of scale, rust etc.

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b) Chemical treatment shall be done to remove rust, oil, entrapped impurities and other foreign materials.

c) If necessary, suitable filler shall be applied to all pits and blemishes on the surfaces.

d) The front surface of the panels shall be painted with three coats of sealing primer and surfacer. The entire surface shall be wet sanded between coats. Two coats of finish paint of high-grade lacquer enamel shall be given at shop.

e) All other surfaces including those of accessories shall be painted with two coats of sealing primer and surfacer and two coats of lacquer enamel finish paint.

f) A final coat of finish paint of high grade lacquer enamel shall be given at site after assembly and filling of front panel butt joints with suitable filler, to present a continuous panel surface.

g) The finish of the final coat shall be of semi-gloss texture to minimise light reflection.

2.5.2 Unless otherwise specified, exterior portion of all panels and closed cabinets shall have a colour of light admiralty grey shade ISC No.697 as per IS-5 (RAL-7035). Panel rear surface, frame works and bulkhead plates/gland plates shall have a finish colour of light admiralty grey shade ISC No.697 as per IS-5 (RAL-7035). Channel base shall be of black colour (RAL-9005).

2.6 Electrical System

2. 6.1 General Requirements

2.6.1.1 All equipment and wiring in control room shall be of general-purpose type unless otherwise specified.

2.6.1.2 All wiring shall confirm to API-MPMS, RP 552 and shall be as per approved drawings.

2.6.1.3 All wiring shall be housed in covered non-flammable plastic raceways which shall be arranged for easy maintenance. Raceways shall have 50% spare capacity. Rubber/plastic grommets shall be used for wire entry into individual instrument cases and for entry/exit of cables through raceways.

2.6.1.4 Wires carrying measurement signals associated with thermocouple, resistance temperature detectors (RTD), pH Instruments and other low-level signals shall be routed in separate wire ways and not along with power cables.

2.6.1.5 All intrinsically safe and non-intrinsically safe (24 Volt powered) wiring shall be routed in separate wire ways, separate from non-intrinsically safe (other than24 Volt powered) and power wiring. The minimum separation shall be 150mm. If they have to cross, the crossing should be as close to right angle as possible. Parallel runs of AC and DC wiring closer than 300mm shall be avoided. Intrinsic safe raceways shall be light blue in colour.

2.6.1.6 Intrinsically safe terminals shall be adequately separated from non-intrinsically safe terminals. The minimum separation shall be 50 mm. Intrinsic safe terminals shall be light blue in colour.

2.6.1.7 Panel wiring for signal and controls shall be carried out using 500 V grade, 1.0 mm^2 stranded copper conductors with flame retardant PVC insulation. Power supply wiring between distribution box and individual instruments shall be done using 500 V grade, 1.5 mm2 stranded copper conductors with XLPE/PVC insulated, FRLS type . All internal wiring will be supplied by the panel vendor.

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2.6.1.8 Alarm wiring shall be through multicore cables between alarm terminal box and annunciator directly without any intermediate terminals. Raceways on panel to have sufficient space to accommodate such wiring. Vendor to install and wire all annunciators including signal lights, bull's eye lamp, push buttons, audible devices etc.

2.6.1.9 All wiring, external to main panel/racks (except for alarm annunciators), shall terminate in terminal boxes/terminal strips and their quantity and size shall be determined by vendor. Panel shall be supplied completely wired requiring only field connection at site.

2.6.1.10 All terminals shall be of mechanical screw clamp/screw less type with pressure plates as per job specification. Self-insulating crimping wire lugs shall be used for all terminations on terminal blocks, whereas forked tongue type or lug with eyehole type shall be used for termination on screwed terminals such as on relays, push buttons, lamp etc. Terminals shall be suitable to accept 2.5mm^2 size conductor, as a minimum. Terminal blocks shall be rated for 500V. Separate set of terminals for terminating incoming power cables shall be provided, suitable for cable 4 mm2 (min.) or one size higher than incoming power cable conductor size. At least 20% spare terminals evenly distributed throughout the panels shall be provided.

2.6.1.11 Generally, no more than two wires shall be terminated on a single terminal. Additional terminals shall be used for looping if necessary. Use of shorting links for looping shall be avoided.

2.6.1.12 Where panel is located in hazardous area, all electrical components including junction boxes shall be flame proof Ex'd' suitable for hazardous area specified in material requisition and weatherproof to IP55. However, electrical components provided inside enclosure with Type X purge as per NFPA496 need not be flameproof as there will be power cut-off on purge failure.

2.6.1.13 Terminals housings shall be sized with due consideration to accessibility and maintenance. Following guidelines shall be observed:

a) 100 mm minimum space shall be provided between terminal strips and sides of the box parallel to the strip for up to 50 terminals and an additional 25 mm for each additional 25 terminals.

b) 100 mm minimum space to be provided between adjacent terminal strips for up to 50 terminals and an additional 25 mm for each additional 25 terminals.

c) 100 mm minimum space shall be provided between terminal strip and top or bottom of the box for upto 50 terminals and an additional 25 mm for each additional 50 terminals.

d) The bottom of any terminal strip shall not be lower than 300 mm from the gland plate unit in any cabinet.

2.6.1.14 All terminal strips shall be mounted on suitable anodised metallic or plastic stand off. Terminal strips shall be arranged group wise for incoming and outgoing cables separately.

2.6.1.15 Color Scheme

a)	Status Lamps		
	On/Open/Permissive	:	Green
	Off/Close/Emergency	:	Red
b)	Alarms		
	Normal/Pre-trip alarms	:	Amber

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Shutdown alarms	:	Red

c) Push/Pull buttons

On/Open	:	Green
Off/Close	:	Red
Acknowledge	:	Green
Reset	:	Red
Test	:	Blue
Emergency shut-down (ESD) (Push-button with cover/ Mushroom push button)	:	Red

ESD push button shall be provided with acrylic protective cover.

e) Wire colour code for panel and accessory shall be as follows:

Power supply hot	:	Red
Power supply neutral	:	Black
Ground	:	Green
Alarm System	:	Yellow
Signal: IS	:	Blue
Signal: Non:IS	:	Grey

2.6.2 Power Supplies

2.6.2.1 Main power distribution box shall have copper bus bars suitable for required current rating. Bus bars shall be suitably insulated. Provision of reducing type of lugs is not acceptable. Main power supply box shall be provided with two pole circuit breakers of thermo magnetic type.

2.6.2.2 Each section of main panel shall have a separate power supply distribution box with two pole toggle switches and glass cartridge fuses. Power supply to individual instruments shall be through DPDT isolation switch and HRC fuse. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protectionVendor shall provide two pole circuit breakers of suitable rating for power distribution.

2.6.2.3 It shall be possible to switch off incoming power to panel from panel front. All such power on/off switches shall be flameproof type, for panel/ cabinets located in hazardous area.

2.6.3 Grounding

2.6.3.1 Each panel section and accessory equipment in control room shall be provided with an earthing lug and shall be grounded to an earth bus bar to be provided by purchaser. All panel structure, racks, cabinets etc shall be connected to this power ground bus.

2.6.3.2 In addition to above, vendor shall also provide a separate instrument system ground bus along the panel length. This shall be electrically isolated from panel structure, equipment, incoming cable armour etc. All circuit grounds, shields , drain wires and intrinsic safety

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barrier shall be connected to the 'system ground' bus which is isolated from 'AC mains earth'. This bus shall typically be 25 mm wide and 6 mm thick of copper. The total resistance of system ground shall be less than one (1) ohms unless otherwise recommended by system manufacturer. Both ends of this bus bar shall have suitable terminals for further connection to ground electrode by purchaser. Creation of multiple grounds in a loop should be avoided.

2.6.4 Identification and Marking

2.6.4.1 All electrical terminals and equipment on the panel and other accessories shall be identified with appropriate tag, cable marker etc.

2.6.4.2 All terminals in a terminal strip shall be identified by their individual numbers located integral with the terminal itself.

2.6.4.3 Interconnecting multicables shall be identified by metal tags as indicated in cable schedules.

2.6.4.4 Wiring at terminals shall be identified by the terminal number and termination services at the other end of the wire. Wiring at instruments and accessories like alarm relays, push buttons etc shall be identified by the item tag number and terminals number and the termination service at the other end of the wire. Ferrule shall be used for this purpose.

2.6.4.5 Identification markers as mentioned above shall be indicated in vendor drawings.

2.6.4.6 For pneumatic panel, Air supply tubes and signal tubes etc shall be provided with PVC sleeves with inscription strips fitted on it at either end. Sleeves for air supply shall be in red while other sleeves shall be yellow in colour

2.6.5 Internal illumination shall be provided for all cabinets to ensure proper illumination level of 250 lux for performing maintenance activities.

LED Lamps shall be provided in each cabinet which shall be activated individually by door operated switches. The lamps shall activate when door is opened and deactivate when the door is closed. The door lock switches selected shall have undergone life cycle cyclic test of at least 1000000 operations and test certificate for the same shall be provided from the manufacturer. A manual override switch shall be provided inside the cabinet which shall keep the lamp deactivated even when the door is open. The location of lighting fixtures must not interfere with doors and other equipment and shall be accessible for maintenance.

2.7 Whenever weatherproof local panel is provided by vendor for classified area, the Alarm Annunciator shall be either intrinsically safe or Flameproof and push button, lamps; selector switches shall be flame-proof "Exd" type mounted on LCP. IS Barriers/ relays for IS alarm annunciator shall be supplied by vendor along with IS annunciator and potential free non-flameproof contact for the same shall be considered from the PLC / DCS/ control systems. In such case of panel with flameproof components, the barriers for IS Annunciators or any other field IS devices need to be inside certified flameproof "Exd""enclosure or X-purge enclosure.

The IS power supply module for alarm annunciator shall be installed in a flameproof box in local panel by vendor. For Lamps, wet contact shall be considered from the PLC/ control system and the lamp test logic shall be realized in PLC/ control system. The Power supply distribution box inside the Local Panel shall also be flame-proof "Exd'. IS PCs for display of loop powered indicators, wherever specified, shall be used in weather-proof local panels.

Intrinsically Safe (IS) type with minimum 15" Display (Remote interactive PC terminal) unit certified suitable for the hazardous area shall be mounted on the panel front of local control panel of the package, wherever IS PC is considered. Single serial interface (RS 485 with

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Modbus RTU protocol or Modbus TCP/IP Protocol, as available) corresponding to these signals from control system shall be considered and vendor's scope shall include all necessary converters, power supply module, connectors at both ends along with serial communication cables for connecting to serial interface cards. For serial interface with Plant DCS, the IS PC shall be designed to be slave device with the plant DCS as master. IS PC shall be equipped with required driver software for displaying graphics.

The PC terminal shall be equipped with necessary keyboard suitable for specified hazardous area.

3.0 NAMEPLATE

3.1 Front panel nameplates shall be fixed by means of chrome or nickel plated counter sunk screws. These nameplates shall provide information like tag number, service, multiplication factor etc. Unless otherwise specified in the project documents, the front panel nameplate shall be as per the following dimensions and details:

Width	: 250 mm
Height	: 75 mm
Thickness	: 5mm
Text colour	: Black
Background colour	: White
Text size	: 18 mm
Letter type	: Arial

3.2 Nameplates shall be provided for all front panel instruments and accessories. For sub miniature instruments, nameplate shall be written on the nameplate slip supplied along with the instrument. For other instruments and accessories (push buttons, lamps etc) nameplates with 1.5 mm thick black laminated plastic with white engraved letters shall be provided. Front panel instruments shall also be identified by their tag numbers on nameplates fixed by adhesives on panel back surface.

3.3 All equipment and component inside the cabinet shall be clearly tagged using a suitable laminated plastic engraved with black lettering on a white background, affixed on the mounting plate within the cabinet and not on the equipment / component.

3.4 Rack nameplates inside cabinet to be fixed by suitable adhesives and shall generally be 15 mm high with 5mm letter height to indicate item tag number.

3.5 The following mandatory details shall be placed inside the cabinet in a visible location:

Customer name, order number, type, serial number, power supply, power consumption, approved certificates for IP enclosure and hazardous location, weight and year of manufacture.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per inspection test plan. All these tests shall be completed by the vendor and test report shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 Each panel and accessory shall be suitably packed and protected from damage due to transportation, loading and unloading.

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5.2 Each component part requiring identification for proper assembly at site shall be place wise marked.

5.3 Shipping breaks shall be provided as applicable to avoid panel damage during transportation.

6.0 SITE ACTIVITIES

6.1 Vendor shall furnish a detailed activity schedule covering various activities like installation of panel and accessories, laying of cables, wiring, interconnection, testing etc in consultation with engineer-in-charge.

6.2 Vendor shall install all panel and accessories in the control room as per final approved layout drawings.

6.3 Control panel and semi graphic shall be checked for proper alignment and defect, if any, shall be rectified.

6.4 Vendor shall install all panel mounted instruments, alarm annunciators and other free issue items as per approved drawings.

6.5 Painting, wiring, cabling etc shall be done as per the respective clauses of this specification.

6.6 Functional tests for panel and accessories shall be carried out after actual installation, wiring, interconnection to the satisfaction of the engineer-in-charge.

6.7 Vendor shall assist field contractor for loop checking.

6.8 Vendor shall maintain the control room and workplace neat and clean. Minor civil work, if necessary, shall be carried out by vendor arising due to damage to flooring during panel installation.

6.9 Vendor shall arrange to draw and transport free issue material and is responsible for safe custody of the same.

6.10 Vendor shall prepare and furnish as built drawing for final record.

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पैकेज युनिटों के लिए इंस्ट्रुमेंटेशन मानक विनिर्देश

STANDARD SPECIFICATION FOR INSTRUMENTATION OF PACKAGE UNITS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	08.12.20	REVISED AND REISSUED	SM	KS	MN	SM
3	16.03.15	REVISED AND REISSUED	RK	RKG	RG	SC
2	29.06.09	REVISED AND REISSUED	RG	RP	TGM	ND
1	25.06.97	REVISED AND REISSUED.	RK	BRS	RB	AS
0	30.06.86	ISSUED AS STANDARD SPECIFICATION.	RK	RB	AKV	AK

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
AC	:	Alternating Current
AWG	:	American Wire Gauge
CPU	:	Central Processing Unit
CRCA	:	Cold Rolled Cold Annealed
DCS	:	Distributed Control System
DPST	:	Double Pole Single Throw
DTM	:	Device Tool Manager
EDDL	:	Electronic Device Description Language
FDT	:	Field Device Tool
FF	:	Foundation Fieldbus
FISCO	:	Fieldbus Intrinsically Safety Concept
FNICO	:	Fieldbus Non-Incendive Concept
HART	:	Highway Addressable Remote Transducer
HIC	:	Hand Indicating controller
I/O	:	Input /Output
IP	:	Ingress Protection
LAS	:	Link Activity Scheduler
LED	:	Light Emitting Diode
MCB	:	Miniature Circuit Breaker
MR	:	Material Requisition
NB	:	Nominal Bore
NC	:	Normally Close
NO	:	Normally Open
NPT	:	National Pipe Threads
NPTF	:	National Pipe Threads Female
NPTM	:	National Pipe Threads Male
P&ID	:	Piping and Instrumentation Diagram
PID	:	Proportional, Integral and Derivative
PLC	:	Programmable Logic Controller
PTC	:	Performance Test Code
PTFE	:	Poly Tetra Fluoro Ethylene
PVC	:	Poly Vinyl Chloride
RAM	:	Random Access Memory
RB	:	Rockwell Hardness in B Scale
RTD	:	Resistance Temperature Detector
RTU	:	Remote Terminal Unit
SPDT	:	Single Pole Double Throw
TMR	:	Triple Modular Redundant
UPS	:	Uninterrupted Power Supply
URV	:	Upper Range Value
WC	:	Water Column

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Instrumentation Standards Committee

Convener : Mr. Mainak Nandi

Members : Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
Mr. Mayank Kaushik
Mr. Sourav Mukherjee
Ms. K.Pratheepa
Ms. R K Gupta (Proj.)

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PART I

GENERAL SPECIFICATION OF

INSTRUMENTATION

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1.0 GENERAL

1.1 Scope

1.1.1 This specification together with the attachments covers the design and engineering of instruments, control systems, accessories and materials, along with special test equipments, where the supply is part of a package being supplied by vendor. This specification is general and all instruments/systems included may not be required for the proposed package. The scope shall be as defined in the scope of supply of Instrumentation.

1.1.2 The detailed scope of work, specific job requirements, exclusions, deviations, additions etc. if any, will be indicated in Scope of Supply of Instrumentation and Job Specification of Instrumentation included in the Requisition / Tender.

1.1.3 This specification provides only the qualitative specifications of commonly used instruments. Specifications of Instruments not covered in this specification shall be submitted by vendor for Purchaser review.

1.1.4 Vendor shall be fully responsible for design, material selection, sizing and selection of the proper instruments for their system. The compliance to this specification does not absolve the vendor of the responsibility towards contractual obligations with regards to completeness, proper selection, satisfactory operation and easy maintenance of the unit/ package.

1.1.5 All items, as offered, shall be field proven and should have been operating satisfactorily for a period of minimum 6 months on the bid due date in the similar application with the process conditions similar to those as specified in the purchaser's data sheets. Items with proto-type design or items not meeting provenness criteria specified above shall not beoffered

1.1.6 In the event of any conflict between this specification, data sheets, related standards, codes etc., the vendor shall refer the matter to the purchaser for clarification and only after obtaining the same should proceed with the engineering & manufacturing of the item in question. DCS/ PLC is not included in this specification. Vendor shall refer specifications attached separately in case DCS/ PLC is included in scope of supply.

1.2 Bids

1.2.1 Vendor shall provide the following information along with their offer:

a) Compliance to Complete Requisition/Tender.

b) Utility requirements including Power consumption and Instrument air supply, Nitrogen, Cooling Water, Steam consumption. The offer shall indicate the power requirement for Uninterrupted Power Supply (UPS), Non-UPS power clearly indicating the locations for each.

c) Estimated heat load for the equipment located in satellite rack room / control room.

d) Control room size and layout (Tentative)

1.2.2 Vendor shall clearly define the operational philosophy proposed, which shall be in line with requirements specified in the job specification. Vendor shall also clearly indicate the provision of control panels and control systems required for the package along with offer.

1.2.3 Documents like Instrument list and typical specifications and any other details if submitted by vendor in their bid, shall not be reviewed and shall be retained for records only. All such details shall be submitted by vendor only after the finalization of P&ID (Piping and Instrument Diagram) during detail engineering. No implication shall be admissible on the basis of these documents and vendor shall be responsible for completeness and correctness of the same with respect to Purchase Requisition/Tender.

1.2.4 Vendor's offer, catalogues, drawings, instrument manuals etc. shall be in English.

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1.2.5 In addition to mandatory spares, commissioning and consumables indicated elsewhere in this specification, Vendor shall also quote recommended spares for 2 years normal operation and maintenance for the complete instrument and control system for the offered package.

1.3 Applicable National/International Standards:

1.3.1 Design and terminology shall comply, as a minimum, with the latest edition of following codes, standard practices and publications, unless otherwise specified:

AGA American Gas Association, Gas Measurement Committee
- Report No.3 Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids – Concentric, Square-Edged Orifice Meters
- Report No.7 Measurement of Natural Gas by Turbine Meter

AG181 Foundation Fieldbus System Engineering Guidelines

ASME American Society of Mechanical Engineers
- B 1.20.1 Pipe Threads.
- B 16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
- B 16.47-B Large diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard
- B 16.20 Ring Joint Gaskets and Grooves for Steel Pipe Flanges.

ANSI/FCI American National Standards Institute/Fluid Controls Institute
- 70.2 Control valve seat leakage classification.

ANSI/ISA American National Standards Institute/Fluid Controls Institute/International Society of Automation
- 100.11a Wireless systems for industrial automation: Process control and related applications

API American Petroleum Institute
- RP 520 Sizing, Selection and Installation of Pressure Relieving System in Refineries.
  Part-I - Sizing and Selection
  Part-II - Installation
- RP 521 Guide for Pressure Relieving and Depressurizing Systems.
- RP 526 Flanged Steel Safety Relief Valves.
- RP 527 Seat Tightness of Pressure Relief Valves.
- MPMS Manual of Petroleum Measurement Standards.
- RP 551 Process Measurement Instrumentation.
  Part 1 - Process Control and Instrumentation.
- RP 552 Transmission Systems
- RP 554 Process Instrumentation and Control
- RP 555 Process Analyzers
- STD 2000 Venting Atmospheric and low pressure storage tank.
- STD 670 Machinery Protection Systems
- STD 598 Valve inspection & testing

ASME American Society of Mechanical Engineers.
- ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1: Rules for Construction of Pressure Vessels.
- PTC 19.3 TW : 2016 Thermowell Performance Test
- MFC-3M Measurement of Fluid Flow in Pipes using Orifice, Nozzle and Venturi
- MFC-14M Measurement of Fluid Flow in Pipes using Small Bore Precision Orifice Meters

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ASTM	American Society for Tests and Materials	
AERB	Atomic Energy Regulatory Board	
BS / EN	British Standard / European Standard	
	50288-7	Multi Element Metallic Cables used in Analogue and Digital Communication and Control – Part-7 : Sectional specification for Instrumentation and Control cables
	10204	Inspection Document for Metallic Products
	12266	Industrial Valves – Testing of Metallic Valves : Pressure Tests, test procedures and acceptance criteria
IBR	Indian Boiler Regulations.	
IS/IEC	Indian Standard /International Electrotechnical Commission.	
	60079	Electrical Apparatus for Explosive Gas atmosphere.
	60085	Electrical Insulation – Thermal Evaluation and Designation
	60332	Tests on electric and optical fibre cables under fire conditions - Part 1-1: Test for vertical flame propagation for a single insulated wire or cable - Apparatus Parts and Sections
	60529	Classification of degree of protection provided by enclosures.
	60534-2	Industrial Process Control Valves-Flow capacity.
	60584-2	Thermocouples – Tolerances
	60587	Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion
	60751	Industrial Platinum Resistance Thermometer and Platinum Resistance Sensors
	61285	Industrial Process Control Safety of Analyser Houses
	61000-4	Electromagnetic compatibility for Industrial Process measurement and Control equipment
	61158	Foundation Fieldbus Specifications
	61804-3	Functional blocks for process control – part 3 Electronic Device Description Language (EDDL)
	62591	Industrial networks-Wireless communication network and communication profiles-Wireless HART
IS	Indian Standard	
	5	Colors for ready mixed paints.
	319	Specification for free cutting Brass bars, rods and sections
	1239	Mild steel tubes, tubular and other wrought steel fittings
	1271	Specification of Thermal Evaluation and Classification of Electrical Insulation
	1554	PVC insulated (heavy duty) electric cables-working Part I voltage up to and including 1100V
	2074	Ready mixed paints, air drying, red oxide- zinc chrome.
	3624	Specification for pressure and vacuum gauges
	5831	PVC insulation and sheath of electric cables
	7358	Specifications for Thermocouples
	8784	Thermocouple compensating cables
	16485	Flame Arresters - Performance Requirements, Test Methods and Limits for Use

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ISA	International Society of Automation
	S-5.1 Instrument Symbols and identification
	S-5.2 Binary logic diagrams for process operations.
	S 7.0.01 Quality standard for Instrument Air
	S-75.xx Standards related to Control Valves
ISO 5167	Measurement of fluid flow by means of orifice plates, nozzles and venturi tubes inserted in circular cross-section conduits
ISO 16852	Flame arresters - Performance requirements, test methods and limits for use
ISO 15848-1	Industrial valves - Measurement, test and qualification procedures for fugitive emissions - Part 1: Classification system and qualification procedures for type testing of valves
ITK	Interoperability Test Kit (latest version)
NACE	National Association of Corrosion Engineers
NEC	National Electric Code
NEMA	National Electrical Manufacturer's Association
NFPA-496	National Fire Protection Association - Purged and pressurized enclosures for electrical equipment
OSHA	Occupational Safety and Health Authority.
SAMA	Scientific Apparatus Maker's Association

1.4 Drawing and Data

1.4.1 Detailed drawings, data and catalogues required from the vendor shall be as per Vendor Data Requirement attached elsewhere in the Requisition / Tender. In case the tender / requisition specifies requirement of submission of drawings / documents in specific software & versions (for example, Smart-plant Instrumentation (SPI) Latest version), all applicable documents as per vendor data requirement shall be prepared by vendor using the same software and version as specified in the tender / requisition. Vendor shall handover the final SPI database file (i.e. ".db") for complete package for loading into Purchaser's database.

1.4.2 The minimum requirements expected from the various documents listed in Vendor Data Requirement shall be as follows:

1.4.2.1 **Document Control Index (DCI)**

This document lists out all drawings and documents prepared and/or submitted by vendor to purchaser after placement of order through vendor portal. Following information shall be available in this document:

a) Name and number of each drawing and document listed.

b) Expected and Actual date of submission to purchaser.

c) Review category of the documents

All of the above information shall be in accordance with the Vendor Data Requirements (VDR).

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1.4.2.2 **Instrument Index**

Instrument Index lists out all instruments appearing on the P&ID without any exception. It is a basic instrument document which is necessary for the smooth execution of a job and is also a reference document after the completion of job. Instrument Index shall be prepared in EIL Format in the specified software.. In case, any other format is used, it must contain all information as listed in this format as a minimum & the format shall be subject to owner's approval.

1.4.2.3 **Sub Vendor List (for Instruments and Accessories)**

The list of sub-vendor is specified elsewhere in the requisition / tender. Vendor shall propose sub-vendors as per the list from whom vendor is likely to procure these items. Instrument Sub-vendor shall meet the enlistment conditions of EIL approval at the time of placing the order on sub-vendor for the Project Approved Vendor List. The EIL approval conditions are available with the Sub-Vendors. Vendor shall follow the approval requirement.

For Instruments / items not covered in the vendor list, Vendor shall get approval from purchaser/ owner for the vendors proposed, prior to the placement of order. In such cases the sub-vendors suggested shall be manufacturer of repute and it shall meet the provenness criteria specified in this document.

1.4.2.4 **Instrument Sizing Calculations**

Following sizing calculations shall be applicable, in general, duly approved by the authority indicated in Vendor's Standard Quality Plan;

a) Control valve including noise and velocity,

b) Pressure relief valves/pilot operated pressure relief valves/rupture disc/breather valve/flame arrester.

c) Flow element including orifice plates, averaging pitot tubes, venturi, flow nozzle, Coriolis Mass Flowmeter, Restriction Orifice Sizing to check occurrence of Multiple restriction orifice based on pressure drop indicated in the process data datasheet.

d) Utility consumption calculation including power supply (UPS/Non UPS), Instrument air, steam for tracing, cooling water, nitrogen etc.

e) Cable sizing calculations for power cables.

f) Intrinsically safe loop calculation for proper selection of cables considering various entity parameters.

g) Fieldbus Segment loading calculations.

h) Thermowell wake frequency calculations as per ASME PTC 19.3.

1.4.2.5 **Utility & Power Requirements**

a) Utilities (Cooling water, Nitrogen, instrument Air, steam for tracing)

i. The utilities available along with their respective operating and design conditions (temperature & pressure) for cooling water, instrument air , nitrogen & steam (for tracing) is indicated elsewhere in the tender.

ii. Vendor shall indicate the maximum / Normal / Minimum requirement for each utility at each location.

b) Power (UPS / Non-UPS)

i. The available UPS & Non-UPS power along with its voltage & type (AC / DC) is indicated elsewhere in the tender.

ii. Vendor shall indicate the power consumption requirement, in-rush current with duration and power factor and incomer size requirement at each location.

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1.4.2.6 **Nozzle Elevation for Level Instruments**

Nozzle elevation for level Instruments represent the nozzle elevation, nozzle sizes and rating, requirement of stand-pipes, type of level instrument etc. for all the vessels, columns, exchangers and tanks shall be in the format provided.

1.4.2.7 **Purchase Requisition (PR)**

Purchase Requisition shall contain following information as a minimum but updated in line with the finally accepted offer of the successful vendor including:-

a) Instrument specifications including detailed instrument data sheet and special requirements, if any

b) Testing and Inspection requirements

c) Vendor's Technical catalogue with model decoding and Vendor's Sizing calculation for applicable items like control Valves, Safety Valves, Flow elements etc.

d) Vendor data requirements

e) Tag wise applicable Statutory Certificates

f) Approval from PESO Approval for Projects being executed in India in addition to statutory certificates.

g) For international projects, statutory approval certificates from ATEX/PTB/TUV etc. shall be provided even for items manufactured in India.

h) Other related documents like Standard Specifications, Quality Assurance requirements etc.

1.4.2.8 **Functional Schematics**

Functional Schematics details out the functionality of all the loops shown on the P&ID including their correlation. The schematic shows all the hardware necessary to configure a loop including their physical location, their interconnection and important software blocks as applicable to make a loop complete. Similar loops may be combined under the same functional schematic.

1.4.2.9 **Logic Diagrams**

Vendor / contractor shall prepare logic diagram which shall include owner, vendor and sub-vendor's specified requirements. The schematic shall be prepared based on ISA S5.2 – A Binary Logic Diagrams for Process Operations and shall show the physical location of Input/output devices, their interconnection with functional blocks, bench status of all electrical devices etc. The schematic shall also be supplemented with operational requirements like startup and process bypasses, reset and shut down push buttons, selector switches, status lamp etc.Any soft tags as information to DCS shall be shown in the logic diagram.

1.4.2.10 **Instrument Loop drawings**

Each loop (FF & Non-FF) shall have a separate Instrument Loop drawing which shall show each component from field device to final receiver including physical location; initiating device, its terminal number; junction box with its terminal number; cable number with pair number/polarity; receiver instrument terminals/cabinet terminals; system functional blocks of loop in simplified manner (without configuration details). Fuse rating shall be shown wherever fuses are applicable in the loop drawing.

1.4.2.11 **Control Room Layout**

Indicative control room layout shall be provided in the tender. Vendor shall prepare detailed control room layout on control room architectural drawing and shall also show layout of equipment in engineering room/computer room etc. Control room layout drawing shall indicate the location of control panels, system cabinets, marshalling racks and other

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auxiliary cabinets, consoles with monitors, hard wired consoles, printers, non-system panels/cabinets including panels/cabinets for packages, LEL panel, fire alarms panels or any other equipment required to be installed in control room.

1.4.2.12 **Panel Front Arrangement**

This drawing shall show the arrangement of panel mounted instruments like indicating instruments, alarm annunicator, indicating lamps, push buttons/switches etc. including their approximate sizes and their mounting locations.

1.4.2.13 **Configuration Diagram**

The basic configuration diagram shall be provided in the tender. Vendor shall prepare detailed configuration diagram with graphical representation of all major hardware required for the control system control system which are necessary to meet all the expected functional requirements.

1.4.2.14 **Dynamic Graphic Display Drawings**

These drawings provide a graphic representation of P&ID's arranged in a sequence which when displayed on the HMI, shall provide easy and logical operational views.

1.4.2.15 **Input/ Output Assignment**

This document indicates the physical assignment of various I/O modules and their respective channels to various physical inputs and outputs.

1.4.2.16 **Instrument Duct/Tray/Trench Layout**

Instrument duct/tray /trench drawing indicating routing of main instrument duct/tray trench in the unit/plant shall be prepared on plot-plan/Equipment layout and shall show the size, cross-section at various locations, general notes, symbols, reference drawings and the control room entry.The scope shall be as per the tender and it shall match the drawing provided in the tender.

1.4.2.17 **Instrument Location Plans**

Instrument Location Plans shall show the location of instruments, location of tapping points, location of local panels, junction boxes, main cable trenches, instrument air distribution scheme etc. These drawings are prepared on equipment layout drawings in 1:50 or 1:100 scale depending on density of instruments.

1.4.2.18 **Instrument Cable Schedule**

The instrument cable schedule shall show all instrument and power cables required for complete instrumentation. The document shall show tag number, cable number, type, length and size of cables, type of junction box, identity of local panel, control room panel/cabinet location etc. The document shall also show the size of terminals considered for power junction boxes and the dimensions of cable considered by the vendor. The cable type and size shall be as per the details provided elsewhere in the tender.

The cable schedule document shall include all single & multi pair cables indicating terminations of instruments, field junction boxes and respective termination in satellite rack room / Control room cabinets. The instrument cable schedule shall be prepared on EIL format.

1.4.2.19 **3D Modelling:**

Whenever 3D modeling is included in package vendor's scope, it shall include the following instrumentation items as a minimum:

a. Instrument Cable Duct/ Cable trench

b. Analyzer shelter/ cabinet

c. Local Control Panels

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d. Prefabricated Hook-ups (as applicable for the project)

e. Gas Detectors, Hooters / beacons

f. CCTV Camera along with water tank (wherever supplied)

g. Instrument Junction Boxes

h. Instrument Stanchions and Canopy

i. For DP type level Instruments with Drain / Vent connected to CBD/ ABD / Flare

j. Volume bottles for Control valves & on-off valves.

k. Fire/Flame detectors.

l. ESD Push buttons/ Field push buttons/ lamps

1.4.2.20 MCT Block Assignment

MCT Block assignment drawing shall be prepared by the vendor if supply of MCT frame and blocks is in vendor's scope of supply.

1.4.2.21 Instrument installation Standards and Hook-up drawings

Instrument Installation standards and Hook-up drawings shall be generated by package vendors for applicable instruments in package vendor scope of supply.

2.0 DESIGN PHILOSOPHY

2.1 Instrumentation shall be complete in every respect in accordance with latest approved P&IDs for the safe, efficient and easy operation, start up and shut down of the plant.

2.2 All instruments and equipment shall be suitable for use in a hot, humid and tropical industrial climate in which corrosive gases and/or chemicals may be present. As a minimum, all instruments and enclosures in field shall be metallic construction, dust proof and weatherproof to IP-65 as per IS/IEC-60529 and secure against the ingress of fumes, dampness, insects and vermin. Instruments like flowmeters located below grade (in sumps, pits etc.) shall have ingress protection of IP-67.All external surfaces shall be suitably treated to provide protection against corrosive plant atmosphere.

2.3 The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 61000-4 'Electromagnetic compatibility for Industrial Process measurement and Control equipment.

2.4 Instrument Requirements for Classified Area:

a) Certified Intrinsically Safe (IS) equipment as per IS/IEC-60079-11 shall be used, in general, in hazardous area, for conventional loops.

b) Field instruments in fieldbus loops shall be designed and certified as per the hazardous area protection specified in Job Specification.

c) In case intrinsically safe equipment is not available, flameproof enclosures as per IS/IEC-60079-01 may be considered.

d) Junction boxes, cable glands and accessories required for flameproof instruments shall also be certified flameproof.

e) All non-flameproof panels and cabinets installed in classified area shall be purged as per requirements specified in NFPA-496, as a minimum with Type X or Z as applicable.

f) For FF junction box (High Power trunk),Exe type of protection is acceptable. However, the cable glands shall be "Ex-d" certified, ET type with check-nut.

g) Other type of protection specified in IS/IEC-60079 shall not be used.

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2.5 Statutory Approvals

a) Contractor shall be responsible for obtaining all statutory approvals, as applicable, for all instruments and control systems.

b) In addition, equipments/instruments/systems located in the hazardous area shall be certified by the local statutory authorities for their use in the area of their installation. In general following certification shall be given:

i) For all intrinsically safe/ FISCO/FINICO/ explosion proof/flameproof equipment/ instruments/systems or equipments with any other type of protection allowable as per this package which are manufactured abroad and certified by any statutory authority like Laboratorie Central Des Industries Electriques(LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres(Baseefa), Factory Mutual(FM), Underwriters laboratories(UL) etc. for compliance to ATEX directives or other equivalent standards. All these equipment/ instruments/systems shall additionally have the approval of Petroleum and Explosives Safety Organisation (PESO), Nagpur, if installed in INDIA and the same is mandatory**.**

ii) For all flame proof equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like Central Institute of Mining & Fuel research(CIMFR)/Electronics Regional Testing Laboratory(ERTL)etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO), Nagpur and a valid BIS license.

iii) For all intrinsically safe equipment manufactured locally (indigenously), the testing shall be carried out by any of the approved test house like Central Institute of Mining & Fuel research(CIMFR)/Electronics Regional Testing Laboratory(ERTL)etc. The equipment shall in addition bear the valid approval from Petroleum and Explosives Safety Organisation (PESO), Nagpur.

c) Approvals other than above shall neither be offered nor will these be acceptable.

d) Atomic energy regulation board (AERB) approval for nucleonic instruments.

2.6 Ranges for instruments shall be selected in general, such that in normal process operation the indication is between 35% to 65% of the range i.e. middle 30% of the full working range.

2.7 All instrument type shall be strictly as per the P&ID.

2.8 Field mounted process switches shall not be considered unless its use is unavoidable and the same shall be subject to purchaser's approval. Instead transmitters shall be used along with primary element. In case switch has been considered, same shall be provided with sealed micro switch contacts rated for the specified application. Also contacts shall be SPDT type unless otherwise specified. Contacts used in intrinsically safe applications shall be suitable for the application.

Tuning fork type switches can be used for tank overfill protection.

2.9 Intrinsically Safe System Requirements (for Non Fieldbus Instruments)

Following points must be considered while designing an intrinsically safe system;

a) All intrinsic safety isolators shall be active type with three port isolation.

b) IS isolators shall be provided by the vendor for all intrinsically safe input/output analog circuits wherever field signals are from electrically hazardous area. In such cases, the system shall be designed intrinsically safe based on entity concept. For hazardous area for Gas Group IIC, 50% rule as per IEC-61079 shall be applied for selecting suitable IS isolator for the filed cable distances given in the requisition. The IS isolator shall be

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certified by a statutory authority like Baseefa, LCIE, CSA, UL, PTB, CIMFR etc., for the use in the area classification as specified elsewhere in the job specifications. The proper selection of the IS isolators shall be the vendor's total responsibility.

c) Each input and output in a loop shall have separate IS isolator. No IS isolator shall be shared between two loops or input/outputs.

d) Any device required to be connected to any intrinsically safe loop in the hazardous side permanently or temporarily shall also be certified intrinsically safe.

f) Configurator and local indicator shall also be certified for the hazardous area classification.

2.10 Power Supplies and their Distribution

a) Power supply shall be made available at the following voltage levels, unless otherwise specified:

°	For Instruments, Control Systems, Analyzer	240V AC/110V AC UPS
°	Solenoid Valves, Relays, lamps	24V DC/ 110 V AC UPS
°	Input interrogation voltage	24V DC
°	Panel/cabinets lighting	240V AC Non-UPS ± 10%

In case 24 V DC is required for Input interrogation, relays and lamps, any other vendor supplied instruments/ electronics), same shall be considered by the vendor using dual redundant power packs (110 V AC to 24 V DC converter). 24 V DC feeders shall not be provided by Purchaser unless indicated specifically in the job specifications.

b) All instruments, control systems (PLC and DCS) and analyzer system shall be able to operate at the following UPS specification:

Voltage level	:	240V AC/110V AC± 10%
Frequency	:	50 Hz ±3 Hz
Power interruption	:	20 millisecond

c) Power feeders shall be supplied to the vendor at only one location. All further distribution within the package shall be taken care of by the vendor. Number and size of power feeders shall be informed during detail engineering. Vendor shall provide adequate number and size of terminals and cable glands required.

d) Instrument power circuits shall be individually protected and isolated from fault with the help of fuses and DPST switches. Power supply to the individual instrument shall be disconnected with the help of DPST switch and protected with the help of fuses. Miniature circuit breakers (MCB's) may be selected in place of switch fuse unit in case protection is provided for overload protection.

e) For the following vendor supplied systems which can accept redundant UPS power supply feeders, primary feeder shall be used to power the primary components and the secondary feeder for the secondary components inside the system cabinets:-

(i) Machine Monitoring System

(ii) Anti-Surge System

(iii) Governor System

(iv) Over-speed Protection system

(v) Any other standalone microprocessor based system

Wherever redundant UPS power supply is provided by the Purchaser to Vendor supplied systems, vendor shall ensure that common 240 or 110 V AC UPS bus-bar is

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not made inside the system cabinets. Only 24V DC bus bar where required shall be allowed inside the cabinets using redundant Bulk power supplies (BPS) and corresponding ORings.

2.11 Alarm Philosophy

a) Alarms shall be provided to give audible and visual warning of any process and machine malfunction in the package.

b) All trips shall have a pre-trip warning alarm in addition to alarm at the trip condition.

c) Package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciated on the local panel as per approved P&ID.Both Intrinsic Safe (IS) type or Flameproof (Ex'd') type Alarm Annunciators are acceptable for Local Panel.

d) 'Fail-safe' type with normally closed alarm contacts shall be used.

2.12 All line or equipment mounted instruments like control valves, pressure relief valves, thermo-wells, orifice flanges, level instruments etc., installed on pipes and vessels under IBR shall be certified by IBR or their authorized representative.

2.13 Location of process connections shall be from the side or from the top of the process equipment but not from the bottom unless bottom nozzle requirement is specifically required as per Licensor. This requirement is applicable to both pipes and vessels. The location of bottom side (wherever used as per Process Licensor requirement) connection for level measurement shall be extended minimum 50mm inside the equipment with the approval of purchaser to prevent plugging due to dirt or other suspended solids. In addition, the connections shall be short, vertical or horizontal and without any pockets.

2.14 Material of construction of instruments shall be as per the material selection chart, attached as Annexure I of this specification, as a minimum. However vendor is responsible to ensure that the selected material is consistent with temperature, pressure, corrosion conditions and other process requirements.

2.15 Field Transmitters

2.15.1 SMART (4-20 mA + HART)Field Transmitters:

2.15.1.1 The field transmitters in all conventional loops shall be smart (4-20 mA + HART) type only unless specified otherwise. Field transmitters for flow, pressure, temperature, differential pressure and level applications shall be yoke mounted type unless specified otherwise. Meter electronics used for flow measurement etc. shall include all the associated items like pre-amplifier, converter, transmitter, integrator, integral output meter etc.

2.15.1.2 Field transmitter shall be intrinsically safe and meter electronics shall be intrinsically safe, in general. In case, intrinsically safe is not available from the approved vendor list enclosed with this requisition/tender, flameproof enclosure is acceptable. In case sensor/ pick up coil is intrinsically safe, suitable barrier shall be provided and installed in flameproof enclosure.

2.15.1.3 These transmitters shall be 2 wire systems having 4 - 20 mA DC output with superimposed digital signal having simultaneous analog and digital communication with HART communication protocol, unless otherwise specified.

2.15.1.4 The transmitter shall be microprocessor based and it shall incorporate a non-volatile memory which shall store complete configuration data of transmitter and sensor characterization. All necessary signal conversions, including conversion to produce output with the required protocol shall be carried out in the transmitter electronics. The configuration data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

2.15.1.5 Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness. In the event of detection

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failure, the output shall be driven to a predefined value, which shall be field configurable.

2.15.1.6 Universal hand held configurator / terminal for the configuration and maintenance of instruments with HART output shall be provided for all HART based smart instruments.Quantity of the same shall be as per Job specification document which will be part of the package input.

2.15.2 Fieldbus Field Transmitter and devices:

2.15.2.1 Fieldbus transmitters/ devices shall be provided, if specified, in fieldbus loops.

2.15.2.2 Field bus based transmitter/ devices shall meet the following requirements;

a) All instruments must satisfy the requirements of the fieldbus registration laboratory with applicable check mark like foundation fieldbus as specified in Job Specification.

b) All instruments shall be polarity in-sensitive. Also transmitter shall be LAS capability.

c) All instruments shall have Analog Input (AI) block and Proportional, Integration and Differential (PID) control block, as a minimum.

d) All instruments must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation field bus or equivalent for profibus PA, as applicable.

e) The field bus instruments shall support peer to peer communication with two wire communication and bus powered supply.

f) All instruments shall support EDDL or FDT/DTM requirements.

g) Internal software shall be configured by the vendor including the following information such as serial number, Device Tag (Tag Number) and Process description

h) All instruments shall be capable of supporting incremental Device descriptor (DD) for extra functionality and /or software revisions in device memory.

i) Soft copy of the Device Descriptor (DD) files for configuring the FF device parameters and common file format (CFF) files for integrating the device into the system shall be provided by the vendor for offline configuration by System vendor immediately after despatch.

j) Fieldbus based field indicator shall be able to indicate all signals available in the fieldbus segment, selectively.

2.15.2.3 The fieldbus / devices provided shall be able to communicate with latest universal fieldbus communicator.

2.15.3 Accuracy of transmitters (Pressure & Differential pressure), smart as well as fieldbus based shall be as follows:

Type of Transmitter	**Range of Transmitter**	**Accuracy**
Direct	760 mm WC and above	Equal to or better than ±0.065%
Direct	Less than 760 mm WC	Equal to or better than ±0.15%
Diaphragm seal	500 mm WC and above	Equal to or better than ±0.25%
Diaphragm seal	Less than 500 mm WC	Equal to or better than ±0.5%

The accuracy is defined as the combined effect of repeatability, linearity and hysteresis.

The stability shall be as follows:

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Range Of Transmitter	Stability
760 mm WC and Above	±0.2% of URL for a period of minimum 5 year
Less Than 760 mm WC	±0.2% of URL for a period of minimum 1 year

Rangeability of transmitters shall be 1:100

2.15.4 Transmitter shall update the output at least 8 times a second unless otherwise specified.

Unless specified otherwise in purchaser's specification, transmitter response time shall be as follows:

a) For transmitter range of 760 mm WC and above, the response time shall be equal to or better than 500 milliseconds.

b) For transmitter range below 760mm WC, the response shall be equal to or better than 1 second.

The response time of the transmitter shall be considered as the sum of dead time and 63.2% step response time of the transmitter.

2.15.5 Unless specified otherwise, the over-range/static pressure protection of the transmitter shall be as follows;

Range of Transmitter	Over range/ static pressure <N1>	
	Pressure Transmitter (kg/cm²)	Differential Pressure Transmitter (kg/cm²)
0 < ® < 250 mm WC	20	20
250 < ® < 1000 mm WC	40	100
1000 mm WC < ® <10 kg/cm²	40	160
10< ® <25 kg/cm²	52	160
25< ® < 100 kg/cm²	160	160
> 100 kg/cm²	200	210

<N1> However if the Over range/ static pressure value specified above is less than the maximum/ design pressure of service conditions, offered instrument shall be suitable for the maximum/ design pressure.

2.15.6 Diaphragm seal DP transmitters in flow measurement with a DP of less than 250mmWC shall be avoided and alternate type of flow meters shall be provided for such cases suitable to the process condition.

2.15.7 All transmitters shall have vent and drain facility and the same shall be provided with metallic plugs. All the cable entries shall also be provided with metallic plugs.

2.15.8 In place of capillary diaphragm seal differential pressure / level transmitter, remote sensor type differential pressure transmitter based on digital calculation shall be used wherever total capillary length combining both the legs is greater than 10 meters.

2.15.9 Line plugging detection facility shall be provided, whenever specified in requisition.

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2.16 Instrument Connections

2.16.1 The connections of instruments installed on vessels, tanks, standpipes and piping shall be as per following EIL Standards.

a) 7-52-0001 Instrument Connections on Vessels and tanks.

b) 7-52-0002 Instrument connection on Piping.

2.16.2 Pneumatic instrument connections for signal and air supply shall be 1/4" NPT (F).

2.16.3 Electrical cable entry connection shall be 1/2" NPT (F)/3/4”NPT(F) as per the cable size.

2.16.4 End connections shall meet the following, unless, otherwise specified:

a) Threaded end connection shall be NPT as per ASME B1.20.1.

b) Flanged end connection shall be as per ASME B16.5 or ASME B16.47B or AWWAC207 Cl D as per related Piping Specification.

c) When Flanges are Raised Face (RF) type, the face finish shall be as per ASME B 16.5 and shall be as follows:

125 AARH : 125 to 250 microinch AARH

63 AARH : 32 to 63 micro inch AARH

d) Grooves of ring type joint flanges shall be octagonal as per ASME B 16.20 and groove finish shall be as follows:

63 AARH : 32 to 63 micro inch AARH

2.17 Instrument Air Supply

2.17.1 Air supply at pressure specified elsewhere shall be made available to the vendor at the battery limit for distribution to the instruments.

2.17.2 For Control & On-off valve, the actuator sizing shall be done considering a pressure value 0.5 Kg/cm2 less than the minimum air pressure supplied at instrument battery limit, unless specified otherwise in job specification.

2.17.3 Instrument air quality shall be as per ISA- S 7.0.01and free from corrosive, hazardous and toxic contaminants.

2.17.4 Vendor can utilize 6 way or 12 way Air distribution Manifold for air supply to consumers within the package battery limit.

2.18 Interface with Main Control Room

2.18.1 All signals from package battery limit to purchaser’s control room shall be terminated in junction boxes or local control panels supplied by the vendor, located within package battery limit. Marshalling details between purchaser-vendor cabling shall be shown with corresponding junction box termination number allocated against appropriate purchaser's/vendor's instrument tag number in the format provided by purchaser.

2.18.2 Signals shall be segregated by providing separate junction boxes.

- Fieldbus based Signals
- Intrinsically Safe Analog Inputs/Outputs (4-20mA)
- Non -intrinsically Safe Analog Inputs/Outputs (4-20mA)
- Intrinsically Safe Thermocouple Inputs
- Intrinsically Safe RTD Inputs
- Intrinsically Safe contact Inputs
- Non-Intrinsically Safe contact Inputs
- Intrinsically safe contact Outputs

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- Non-Intrinsically Safe contact Outputs

DCS and PLC signals shall be further segregated and shall in no case be mixed up.

Dedicated terminal strips shall be provided in the local control panel to ensure segregation philosophy.

2.19 Local control loops shall be avoided. In case these are unavoidable, these shall be electronic field mounted manual loading station with specific approval.

3.0 SPARES PHILOSOPHY

3.1 Mandatory Spares

The following mandatory spares shall be provided by vendor as a minimum.

3.1.1 Predefined Mandatory Spares

Mandatory spares shall be ware-house spares and shall be supplied as loose items.

3.1.1.1 Higher of 10% or minimum one of each type (range, type, material and rating) of complete instruments for commonly used instruments such as transmitter, gauges, temperature elements, switches, probes, special cables (like cables between ultrasonic flow meter probe to pre-amplifier or JunctionBox or vibration probe to pre-amplifier or JunctionBox as applicable), Valve positioner including PST positioner.

3.1.1.2 For Control valve and on-off valve,one set of packing and bonnet gasket with tag, one set of stem seal o-ring for each actuator and piston o-ring additionally for each piston actuated valve, line bolting (set of studs and nut) and set of gasket with each tag no.

3.1.2 Commissioning Spares

Vendor shall be responsible to supply all spares which are found necessary to replace while performing pre-commissioning and commissioning activities and this includes system oriented items (hardware / software).

3.1.3 Consumable spares

Vendor shall supply consumable spares for six months or twelve month of normal operation as per job specification.

3.1.4 Engineering Spares

3.1.4.1 For Control system, installed spare module of higher of 10% or minimum one of input/output modules (including termination panels, if applicable) to enhance the system functional requirements of control system.

3.1.4.2 For Hardwired console / Local control panel:

a) A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.

b) A minimum of 20% spare status lamps / switches / pushbuttons / terminals or one no of each type, whichever is higher, shall be provided.

c) For pneumatic panels, 10% spare instrument air header branch lines and 15% spare bulkheads and tapping points shall be provided in each panel.

d) Control panels shall have additional spare-space as per clause 4.2.8 of this specification.

3.2 Spares for 2 years normal operation

Vendor shall supply a list of recommended spare parts for each instrument and system required for two (2) years of normal operation. These spares shall be quoted separately.

4.0 GENERAL SPECIFICATION OF INSTRUMENTS

4.1 Panel Board Instruments

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4.1.1 Alarm Annunciator shall be microprocessor based programmable type with plug in modules and integral power supply. Window display shall be cluster LED type integral power supply. For window display with back lighted incandescent lamps two numbers of incandescent lamps of minimum 5 watt each shall be provided for each window. For cluster type LED display, the number of LED's in the cluster matrix windows shall be sufficient to provide illumination level of at least 150 lumens. The circuit shall be designed in such a way that removal/failure of one lamp or LED from a window/ cluster shall not hamper functioning of that particular window/display. The annunciator lamps shall be replaceable from the front of the enclosure panel. In general, dedicated alarm logic module shall be used for each alarm input.

Both Intrinsically safe or Flameproof annunciator circuit can be used. For, Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area. Annunciator alarm sequence shall be as per F3A of ISA.

Alarm annunciator shall be SIL certified. Redundant card shall be used for annunciator and failure of one card shall not cause failure of indication.

The design of the alarm annunciator system shall be such that transient alarms of less than 330 milliseconds duration shall be automatically rejected.

4.2 Panel Design

4.2.1 All panels shall be supplied in pre-wired condition and shall be completely tested at manufacturer's works prior to dispatch.

4.2.2 Panels shall be freestanding type. Panels with instruments mounted on the front shall be fabricated from 3 mm thick cold rolled steel sheet. If the same is not available, 4 mm thick hot rolled steel sheet shall be used. All other panels shall be fabricated from 2mm thick cold rolled steel sheet. Angle iron framework shall use a minimum section of 50 x 50 x 4 mm angle. Panel painting procedure shall include blast cleaning, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet blasting wherever required. Two coats of paint in the panel color shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at shop before dispatch.

Unless otherwise specified, exterior/interior portion of all panels and closed cabinets shall have a color as per RAL-7035. Channel base shall be of black color.

4.2.3 Panel shall be enclosed cubicle type with each section of typically 2100 mm high, 1200 mm wide and 800 mm deep mounted on 100 mm channel base.

4.2.4 Enclosed cubicle panels shall have removable hinged doors for easy maintenance and accessibility of the instruments. Doors shall be double leaved type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 240 V, 50 Hz AC. Power supply greater than 240 V shall also not enter the control panel.

4.2.5 All cable entries to the panel shall be from panel bottom only using cable glands of adequate size. Cable gland plate thickness shall be a minimum of 3 mm cold rolled cold annealed (CRCA) as a minimum. Adequate ET type with check-nut cable glands shall be provided by vendor for cable entry. All unused cable entries must be plugged.

4.2.6 Space heater shall be provided where condensation is expected. The space heater provided shall be with temperature cut off and manual control.Air Conditioner shall be provided to maintain inside temperature and avoid failure of components if ambient temperature is more than the operating temperature of any component / equipment inside the panel. This is applicable for local control panel only.

4.2.7 The design of panel shall incorporate provision for expansion by installing adequate spare capacity. Each panel shall be designed to accommodate the following additional equipment, as a minimum:

a) 20% of panel front/inside mounted instruments including lamps, push buttons,

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switches, relays etc.

b) 20% additional power feeders each provided with switch fuse assembly.

c) 20% additional spare windows in alarm annunciators.

d) 20% spare cable entry points.

4.2.8 Panel layout shall be designed considering ease of operation. No push button or hand switch shall be located below 600 mm. Instrument mounting heights, in general, shall be as follows:

a)	Electronic Instruments	Bottom row	1100 mm
		Middle row	1350 mm
		Top row	1600 mm
b)	Annunciators	-	1950 mm
c)	Electric push buttons/ switches, lamps etc.	-	700 mm

4.2.9 The internal panel layout shall be designed considering proper approach for instruments, terminals and other accessories for maintenance, easy removal and online calibration. No instrument, terminals, power distribution box etc shall be mounted on the panel side plates inside the panel.

4.2.10 All lamps, status as well as alarm, shall be provided with lamp test facility. One single lamp test push button shall be used for each panel. Logic for lamp test shall not be implemented through relay logic in the panel.

4.2.11 **Color Scheme**

a) Status Lamps

On/Open/Permissive	:	Green
Off/Close/Emergency	:	Red

b) Alarms

Normal/Pre-trip alarms	:	Amber
Shutdown alarms	:	Red

c) Push/Pull buttons

On/Open	:	Green
Off/Close	:	Red
Emergency shut-down (ESD) (Push-button with cover/ Mushroom push button)	:	Red

ESD push button shall be provided with acrylic protective cover.

4.2.12 **Panel Wiring**

4.2.12.1 Open terminals shall generally be avoided. Terminal strips shall preferably be mounted in an enclosure. Fused terminal may be used wherever necessary.All terminals shall be of mechanical screw clamp/screwless type with pressure plates as per the job specification. Self-insulating crimping wire lugs shall be used for all terminations on terminal blocks, whereas forked tongue type or lug with eyehole type shall be used for termination on screwed terminals such as on relays, push buttons, lamp etc. Terminal blocks shall be rated for 600 V.

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4.2.12.2 A minimum of 1 mm^2 multi stranded PVC insulated copper conductor shall be used in general. All wiring shall be laid in the PVC troughs. No trough shall be more than 70% full.

4.2.12.3 Wires carrying measurement signals associated with thermocouples, resistance thermometers and other low level signals shall be routed in separate troughs/wire ways and not along with power cables. Power wiring and control wiring shall be separated by not less than 150 mm. The crossing, if unavoidable, shall be as close to right angles as possible.

4.2.12.4 Extension cables/wires shall be used for all thermocouple inputs. These wires shall be routed in separate troughs/wire-ways.

4.2.12.5 All intrinsically safe wires shall be routed in separate wire ways from non-intrinsically safe and power wiring. Intrinsically safe wiring and terminals shall be light blue in color and shall be separated from non-intrinsically safe terminals at least by 50 mm.

4.2.12.6 All incoming power feeders shall be terminated on separate terminals suitable for the incoming feeder size. These shall be located at the bottom of the panel and shall be suitably covered for protection against accidental shorting and for human safety.

4.2.12.7 Power supply shall be made available at one point. Further power distribution network shall be designed such that a single power fault in any instrument branch system shall not cause a trip of the entire system. Each consumer shall be provided with a separate switch and fuse for isolation and protection of the system.

4.2.12.8 Panel rear and front shall only be used for installation of all applicable components. Panel sides shall not be used for mounting any components unless specifically required with the approval from EIL/ Owner and only utility power sockets can be mounted on the side of the cabinet.

4.2.13 Electrical Wiring

All the cabinets, consoles and panels shall be completely wired. Interconnections shall preferably be done with the help of pre-tracked cables. Vendor may follow their standard wiring practices, however the requirements specified herein must be complied.

a) All wiring shall conform to API RP 552- Transmission Systems. Different signal level cables shall be routed with separation distances as recommended by code.

b) All wiring inside racks, cabinets, and back of the panels shall be housed in covered, non-flammable plastic raceways arranged to permit easy assembly to various instruments for maintenance, adjustments, repair and removal.

c) All wiring in the raceways shall be properly clamped. All incoming cable shall be terminated by vendor at marshalling rack with cable glanding including supply of cable glands. Total wiring cross-sectional area shall not exceed 50% of the raceway cross sectional area.

d) Separate wiring raceways shall be used for power supply wiring, DC and low level signal wiring, and intrinsically safe wiring. Parallel runs of AC and DC wiring closer than 300mm shall be avoided.

e) Vendor can alternately offer prefabricated cables for interconnection between different cabinets and panels.

f) Wire termination shall be done using self-insulating crimping lugs. More than two wires shall not be terminated on one side of single terminal. The use of shorting links for looping shall not be done.

g) No splicing is allowed in between wire / cable straight run.

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4.2.14 Terminals and Terminal Blocks

a) Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound.

b) Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used.

c) The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron).

d) The spring material for all terminals shall be chrome nickel spring steel of high tensile strength and of excellent corrosion résistance. All terminal / terminal blocks shall be DIN Rail mounted type and shall be easily removable. The size of the terminal blocks / terminals of different types shall be consistent and identical.

e) All terminal blocks shall be mounted on suitable anodized metallic or plastic stand-off.

f) Terminal strips shall be arranged group-wise for incoming and outgoing cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip.

4.2.15 Following design philosophy shall be followed while deciding the internal layout of panels, as a minimum;

a)	Distance between terminal strip and side of the panel up to 50 terminals	:	100 mm (min.) + trough width
b)	Distance between two adjacent terminal strips	:	100mm (min.) + trough width
c)	Distance between gland plate and bottom of the strip	:	300mm (min.)
d)	Distance of terminal strip from instrument/trough/panel top	:	100mm (min.)

4.3 Local Control Panel (LCP)

4.3.1 Local control panel for the package units shall be installed within the battery limit of the package considering operational and maintenance requirements and accessibility. In case of skid mounted packages, panel shall be located away from the skid.

In case local control panel is housed outdoor i.e. not in a local control room, it shall be designed to meet IP-55 requirements. In addition, panel must be provided with a rain cum sun shade/canopy.

4.3.2 Local control panel/panels shall be totally enclosed cubicles. Panel sizing shall be carried out based on equipment being installed keeping in view the maintenance clearances and easiness of operation. Although the panel dimensions shall be guided by the actual requirements, typical dimensions shall be 2100 mm height x 1200 mm width x 1000 mm depth. In any case, vendor shall not proceed with panel manufacturing before getting prior approval from the purchaser.

4.3.3 Local control panels located in the hazardous area shall either be purged type or flame proof Ex'd' or weather proof with Ex'd' components such as lamps, push buttons, switches etc. as specified in job specification. In case pressurized panels are specified the same shall be purged and pressurized as per NFPA 496 requirements to render space within the panel non hazardous. For panels located in IEC Zone 2, hazardous area type Z purging shall be used

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with a purge fail alarm in main control room. In case, panels are located in Zone 1, the power shall be cut off on pressurization failure as per X-purge requirements of NFPA-496.

An alarm shall be provided on local panel and a contact shall be provided for remote annunciation, whenever the panel pressurization falls below 2.5 mm of H2O. A protective device to protect the panel from over pressure must be provided.

4.3.4 Panel pressurization with start-up panel purging scheme shall be fully automatic however it shall be started manually from a push button. Solenoid valves and differential pressure switch required for panel purging shall be flameproof, however other items like relays, switches/pushbuttons, timers etc. shall be located in a flameproof housing. Other items like valves, restriction orifice plates, dual filter regulators, pressure gauges, rotameters etc. required for pressurization shall also be located in the non-pressurized section of the panel.

4.3.5 It shall be possible to switch off incoming power to panel from panel front. All such power on/off switches shall be flameproof type.

In addition, all those devices and terminals, which cannot be powered off from on/off switches shall also be located inside flameproof enclosures.

4.3.6 All hinges, screws and other non-painted metallic parts shall be of stainless steel material. Door handle and its latching rod shall be stainless steel type.

4.3.7 All other requirements as specified in clause 4.2 of this specification shall also be applicable for local control panels.

4.3.8 Whenever weatherproof local panel is provided by vendor for classified area, the Alarm Annunciator shall be either intrinsically safe or Flameproof and push button, lamps; selector switches shall be flame-proof "Exd" type mounted on LCP. IS Barriers/ relays for IS alarm annunciator shall be supplied by vendor along with IS annunciator and potential free non-flameproof contact for the same shall be considered from the PLC / DCS/ control systems. The IS power supply module for alarm annunciator shall be installed in a flameproof box in local panel by vendor. For Lamps, wet contact shall be considered from the PLC/ control system and the lamp test logic shall be realized in PLC/ control system. The Power supply distribution box inside the Local Panel shall also be flame-proof "Exd'. IS PCs for display of loop powered indicators shall be used in weather-proof local panels in case no. of tag local display more than Five tags. The same IS PC can also be used for local display of vibration and temperature monitoring system parameters at field instead of separate display unit at field. For 5 or less number of tags for local indication, normal IS loop powered indicators shall be provided on weather proof local panel.

Intrinsically Safe (IS) type with minimum 15” Display (Remote interactive PC terminal) unit certified suitable for the hazardous area shall be mounted on the panel front of local control panel of the package, wherever IS PC is considered. All local control panel mounted field remote output indicators, wherever required as per approved P&IDs, shall be displayed in this remote PC. Single serial interface (RS 485 with Modbus RTU protocol or Modbus TCP/IP Protocol, as available) corresponding to these signals from control system shall be considered and vendor’s scope shall include all necessary converters, power supply module, connectors at both ends along with serial communication cables for connecting to serial interface cards. For serial interface with Plant DCS, the IS PC shall be designed to be slave device with the plant DCS as master. IS PC shall be equipped with required driver software for displaying graphics.

The PC terminal shall be equipped with necessary keyboard suitable for specified hazardous area.

4.4 Local Gauge Board

4.4.1 Local gauge board shall be used to install skid-mounted instruments like pressure gauges, temperature gauges and transmitters.

4.4.2 Location of local gauge boards, when provided, shall be decided to allow easy access at the rear and front for all instruments and accessories for maintenance and operation.

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4.4.3 Gauge board shall be constructed from 3 mm stainless steel sheet with other necessary SS supporting structure.

4.4.4 Local gauge board shall be supplied with all instruments installed and completely in tubed/wired condition before shipment.

4.4.5 All pressure transmitters and gauges shall be provided with block and bleed valves securely fastened. Identification tags shall be securely fastened for easy identification. Wherever local temperature indicator is required with temperature transmitter, Loop powered indicator shall be provided.

4.5 Temperature Instruments

4.5.1 Thermowells

a) All temperature elements shall be provided with thermowells fabricated out of bar stock of minimum SS 316 material as per EIL Standard 7-52-0035.The base of the thermowells shall be chosen to fit the instrument without air gap for minimizing measurement lag.

b) Built-up thermowells shall be used in low pressure and low velocity services like in fired heaters and also where thermowell immersion lengths greater than 500 mm are required.

c) Immersion length of thermowell shall be as follows:

Line Size	Immersion length
From 4" to 6"	280 mm
From 8" to 20"	320 mm
From 20" to 24" and Vessels / columns	400 mm
Greater than 24"	500 mm

In special applications, not covered above, vendor shall decide the immersion length based on actual requirements. Immersion length is based on 200 mm length between flange face and outer wall of pipe and 200 mm length between flange face and inner wall of the vessel.

d) Any pipe line less than 4" nominal bore shall be blown to 4" size to install thermowell.

e) Thermowell flange and well material shall be as per material selection chart.

f) The vibration analysis shall be carried out as per PTC 19.3 and corrective measures shall be taken as necessary. Proprietary designs shall be selected in case conventional design thermowells do not meet wake frequency criteria as per AME PTC.

4.5.2 **Temperature Gauges**

a) Local temperature gauges shall be in general bimetallic type. The temperature bulb shall be of stainless steel construction. The gauge connection shall be all angles adjustable. Gas filled type shall be used when measuring range is beyond the limits of Bimetallic gauge or thermowell length exceeds 550 mm or in applications involving excessive vibrations. Mercury filled type temperature gauge shall not be used.Gas Filled Temeperature Gauges shall be with Full compensation and not case compensation.

b) All local temperature gauges shall have 150 mm dial size. The bulb size shall be selected to suit the thermowell.

c) Cases shall be minimum 304 SS and weatherproof to IP-65 as per IS/IEC-60529.

d) Temperature gauges shall have accuracy of ±1% URV (upper range value).

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e) Bimetallic type dial thermometers shall be avoided where excessive vibrations are encountered, such as reciprocating compressor discharge. Only filled type with capillary extension shall be used in such cases. Capillary tubing shall be a minimum of 304SS with stainless steel flexible armouring, and PVC covering over armour. Filled type gauges shall be manufactured as per relevant SAMA class.

f) Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPTF connection.

4.5.3 **Temperature Elements**

a) For remote temperature indication/recording/control/switch etc., resistance temperature detector (RTD) shall be used up to 400 deg C (operating) and above 400 deg C (operating) thermocouples shall be used. Elements shall be spring loaded, mineral insulated and shall have stainless steel sheath as a minimum.

c) Thermocouple assemblies shall be furnished with weatherproof screw type heads as per EIL Standard 7-52-0036.

d) Thermocouples shall be as per IEC-60584-2 and shall have a wire size of 18 AWG for single and 20 AWG for duplex thermocouples. These shall be magnesium oxide (MgO) filled grounded type, unless necessary otherwise. The type of thermocouple shall be selected based on temperature. The selection of type shall be as per following guidelines:

Chromel-Constantan (ISA-Type-E)	:	(-) 200 to 600^{O}C
Chromel-Alumel (ISA-Type-K)	:	0 to 1200^{O}C
Platinum Rhodium-Platinum (ISA Type-S)	:	600 to 1600^{O}C

N-type (Nicrosil / Nisil) thermocouple for hydrogen rich service in very high temperature shall be used to avoid green rot effect as per Licensor Specification.

d) The design of thermocouple assemblies shall be such that replacement on line is possible.

e) RTD (Resistance Temperature Detector) shall be platinum element 3 wire type with 100 ohms resistance at 0^{O}C calibrated as per IEC 60751. Three-wire system shall be adopted in connecting the element.

f) RTD shall be used where accuracies of the order of 0.25% or better and smaller measuring spans are required.

g) Duplex element sensors shall be supplied. Two separate cable entries shall be provided with plugs. cable entry shall be ¾" NPTF suitable for 2 pair/ triad cables)

h) Extraction or welded type skin thermocouple assembly shall be used for heater tube application. Thermocouple element shall be duplex type and element wire diameter shall correspond to 16 AWG for duplex.

4.5.4 **Temperature Transmitter**

a) Temperature transmitters shall have a built-in linearising function to produce an output linear to temperature range.

b) The Temperature transmitters with RTD shall have an accuracy of 0.075% of URV as a minimum for range above 350^{0} C, 0.15% of URV for temperature range 350^{0} C to 150^{0} C and 0.25% for calibrated range below 150^{0} C.

The Temperature transmitters with cold junction compensation for thermocouple shall have an accuracy of 0.25% of URV as a minimum for range above 350^{0} C, 0.5% of URV for temperature range between 350^{0} C to 150^{0} C and 0.75% for calibrated range below 150^{0} C.

c) Transmitters shall be provided with dual compartment with metallic separation.

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4.5.5 Burn out protection must be provided with temperature transmitters. Upscale or downscale protection shall be decided based on its application to ensure fail-safe operation.

4.5.6 All Temperature transmitters shall also have following features:

- shall be universal type i.e. suitable for accepting both RTD and Thermocouple inputs.
- Have Dual input capability with automatic transfer to back-up sensor. Accordingly both the elements of the duplex sensor shall be wired to transmitter with 2 Pair cable.
- Remote Mounting type. Vendor shall consider approximately 10 meter cabling between temperature element and transmitter.

4.6 Pressure Instruments

4.6.1 **Pressure Gauges**

a) Pressure gauge dial shall be white with black figures. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment.

b) Pressure gauges shall be weatherproof with dial size of 150 mm and shall have features like over range protection (at least 130% of max. operating pressure) and blowout discs. Glass shall be shatter proof. Pressure gauge sensing element shall be of SS 316 and movement of SS 304, as a minimum.

c) Pressure gauges shall have an accuracy of ±1% of URV as a minimum. Differential pressures gauges, diaphragm seal pressure gauges and draft gauges may have an accuracy of ±2% of URV.

d) Over range protection shall be provided whenever gauge over-range protection is not suitable for specified process design pressure. Over range protector and pulsation dampener, whenever used, shall be of SS 304, as a minimum. Pulsation dampener shall be used for all pulsating services. It shall be floating pin type, externally mounted and externally adjustable. Syphon shall be supplied for steam services.

e) Pressure gauges with range 0-100 kg/cm^{2}g and more shall have safety type solid front case.

f) Connection shall normally be 1/2" NPTM bottom.

g) Cases shall be minimum 304 SS and weatherproof to IP-65 as per IS/IEC-60529.

h) Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible.

i) Diaphragm seals shall be furnished where plugging of the element may occur or where suitable material is not available in highly corrosive services. When chemical seals are required, they shall be of the clean out type with flushing connection.

j) Where vibrations and pressure fluctuations are expected, glycerin filled type and snubber shall be used. Pressure gauges at the discharge of reciprocating compressors / pumps shall be provided with snubbers.

k) Receiver pressure gauges for local transmitter output indication shall have 100 mm dial with stainless steel element and 1/4" NPTM connection.

l) The pressure element shall be bourdon, diaphragm or bellows depending upon process condition. Single diaphragm type Differential pressure gauges shall not be considered, Instead double diaphragm type or bellows shall be considered.

4.6.2 **Pressure/Differential Pressure Transmitters**

a) Pressure/differential pressure transmitter shall have electronic state-of-art capacitance or any other type of sensor meeting all functional specifications as per clause 2.16. Element material for transmitters shall be 316 SS, as a minimum. Element material of transmitter used in hydrogen service shall be SS316L gold plated.

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b) All transmitters shall have an integral output meter. Remote mounted meters may be provided if required in addition.

c) Diaphragm seal element with capillary shall be used for congealing, corrosive and highly viscous services.

4.6.3 **Pressure Switches**

a) Process switches shall not be considered unless its use is unavoidable and the same shall be subject to purchaser's approval

b) Pressure switches shall have either diaphragm or bellow type of process element with SS 316 material of construction as a minimum. Switch type shall be sealed micro-type with contact rating suitable for specific application. Also contacts shall be SPDT type unless otherwise specified. Contacts used in intrinsically safe applications shall be suitable as per the process condition.

c) Pressure switches shall be blind type with 1/2 NPTF process connection and shall be operative in full-specified range. The switch differential shall be selected as per operating conditions.

d) Pressure switches shall have repeatability of ±0.5% of URV, as a minimum. Pressure switch shall have over range protection of at least 130% of maximum working pressure. The set pressure shall fall in the middle third (between 35% to 65%) of the adjustable range in general. Set point shall be field adjustable.

4.7 Level Instruments

4.7.1 **Level gauges**

a) All gauge glasses shall be steel armoured reflex or transparent type with body and cover material of forged carbon steel as a minimum and shall have tempered borosilicate glass with asbestos or other suitable gasket. Transparent type of gauges shall be provided with integral illuminators operating at 240 V 50 Hz Non-UPS supply and shall be suitable for electrical area classification specified. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.

b) Reflex type will be used for clean and colourless liquids, except liquids level interface. For low temperature, low boiling point service, large chamber type will be used. Transparent type will be used on acid, caustic, dirty or viscous, coloured liquids and liquid interface. Transparent type with Mica or Kel-F shields shall be used for treated water, boiler and condensate services, and for corrosive liquids, which will attack glass. Tubular gauge glasses shall, in general, not be used in Hydrocarbon/hazardous services. They may be used for non-hazardous services at ambient temperature and low pressures (less than 10 kg/cm^2goperating).

c) Large chamber gauges with frost shields shall be provided for cold services below 0^OC. Heating jacket shall be provided for viscous liquids with 1/2" flanged connection.

d) All gauges shall have top and bottom chamber connections, unless otherwise specified. However side-side chamber connection is acceptable where nozzle installation is a constraint. In addition each gauge shall be provided with ball check valves and pipe union.

e) The visible range of level gauge shall be selected to cover the complete operating level as well as measuring range of the other level instruments provided for the same purpose. In general, the visible length and C to C distance of the top and bottom level gauges shall be selected from the following:

Visible length	Centre to Centre Length
220	470
470	720
720	970

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980	1230
1230	1480
1490	1740

For side-side level gauge C to C distance shall be 10 mm less than visible length.

f) For level gauging in very viscous, corrosive liquids, liquids with crystals and high pressure service (e.g. Rating more than 600#) or whenever specified in job specifications, float operated magnetic gauges with 2" (50 mm) flanged end connections, shall be used. C to C length of single magnetic level gauge shall not be more than 2500mm.

g) All level gauges shall be provided with vent/drain valves with plug or connected to closed drain/vent as per P&ID and job specifications. For higher rating (i.e. rating more than 600 class) and Hydrogen services, flanges shall be used instead of plugs.

4.7.2 **Level Transmitter**

a) Guided Wave Radar type level instruments with accuracy ±3mm shall normally be used for level measurement up to 2500 mm with external cage and side-side connections.

b) Guided wave radar inst shall have ±3mm accuracy. The instrument shall work on TDR principle and shall be capable of measuring level of process fluid of dielectric constant as low as 1.9. Wherever dielectric constant is not specified in the datasheets, vendor supplied instrument shall be suitable for dielectric constant of 1.9 and minimum separation of interface.

c) For interface level measurement, guided wave radar or displacer level measurement shall be used as per job specification.

d) Differential pressure transmitter shall be used for level measurement above 2500 mm, for services requiring purge or where liquid might boil in external portion.

e) Differential Pressure transmitters for use on corrosive or fouling service shall generally be diaphragm wafer with extended filled capillary type. Flush or extended diaphragm type differential pressure transmitter shall be considered for special applications only. Diaphragm material shall normally be stainless steel or any other special alloy.

f) For sump levels, Guided wave radar or non- contact type radar level instrument shall be used depending on the application within accuracy ± 3mm.

g) Generally for top mounted level transmitters, internal guided wave radar type instruments shall be used for level measurement up to 3000mm. Above that non-contact type radar shall be used.

h) Level transmitters shall meet all requirements specified in clause 2.16.

i) Non Contact Radar Level Transmitters is recommended for slurry, powder, viscous and cryogenic services in process applications

4.7.3 Other Special types of level instruments like ultrasonic, hydrostatic, nucleonic, capacitance, conductivity type shall be used as necessitated by application requirements.

4.7.4 For high pressure steam drum application at least one number conductivity type (Hydrastep or equivalent) level instrument shall be provided with the other one as DP type. Also level gauges shall be of bi-color type for such application. GWR type in steam application can also be considered.

4.7.5 For solid level measurement, type of instrument shall be ultrasonic/ electromechanical/capacitance/Tuning Fork / nucleonic/non-contact type radar as per the process condition. The actual type selection shall be carried out based on the provenness of the selected type for similar type of application.

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4.8 Non-contact Radar / Servo Level Instruments

a) Tanks shall be provided with minimum 2 types of tank level instruments operating on different principles like one servo and other one non-contact radar (Antenna) type.

b) Non-contact Radar and Servo Level instrument shall be provided with ±3 mm accuracy for storage tanks / process vessels and ±1 mm for custody transfer application.

c) Non-contact Radar instrument process connection :

Process vessels
For process vessels, non-contact radar instruments shall have process connection of minimum 4" size. In case 4" nozzle is provided, the nozzle shall be 4" LWN with ID of 101.6 mm. Still well (in case required) shall be of size 4" Sch-80 and Stainless Steel metallurgy.

Atmospheric tanks with clean service
For atmospheric tanks with clean service, process connection for non-contact radar gauge shall be 8" of SS metallurgy with schedule 40 with 8" Stainless Steel 316 Sch-40 still well. Stillwell shall be having 20mmdia hole and every hole shall be turned 180 Deg. With 500mm equal space between 2 holes for entire pipe length.

Atmospheric tanks with viscous service
For atmospheric tanks with viscous service, nozzle connection shall be 24".

Pressurized Tanks
For pressurized tanks, process nozzle connection for non-contact radar instrument shall be 8". Still well shall be 6" / 4" MOC SS316 and Sch-40. Still well shall be having 20mm or 5 mm diameter hole on one side of still well with 500 mm spacing between 2 holes for the entire length of the still well. Still well size and diameter of holes shall be as per Radar instrument vendor specific requirements.

d) Servo type instruments process connection
Servo type level instrument shall have 6" process connection with 12" diameter SCH 40 still well of SS316 metallurgy, having 20mm dia. hole and every hole turned 180 deg 500 mm equal space between 2 holes for entire pipe length.

e) Raising or lowering of displacer of servo level instrument shall be possible for on-line calibration with the design of still-well. Isolation valve shall be provided for servo level instrument in pressurized tanks / spheres / bullets.

The wetted material like float, displacer, tape, wire etc. shall generally be 316 SS.

The accessories for servo-controlled level gauge shall include isolation ball valves for pressurized tanks and calibration/maintenance chamber for all tanks. Each calibration chamber shall be provided with a viewable window of blast proof glass. The calibration chamber can be either integral to the instrument or separate. Whenever calibration chamber is separate i.e. not integral to the tank level instrument, the material of construction of calibration chamber shall be stainless steel. The calibration chamber shall also permit insertion / removal of displacer for maintenance without removing the instruments.

f) Servo and Radar type instruments shall be capable of providing serial output as per vendor standard protocol or field bus protocol as per IEC-61158 in addition to analog 4-20 mA DC current output. These instruments shall also be capable of accepting input from multi element tank temperature sensors (thermocouple/ RTD), water cut probes and transmit the same as a part of serial signal from the transmitter.

g) Multi-element tank temperature sensors when used shall be provided with 3" process connection and 3" still well of SCH-40 with SS metallurgy or SCH-80 with CS

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metallurgy. For atmospheric tanks, the still-well shall be equipped with 20 mm diameter hole and every hole turned 180 degree with 500 mm space between 2 holes for the entire pipe length. For pressurized tanks, still well closed up to bottom (like thermowell, without any hole) shall be provided.

4.9 Flow Instruments

The selection of flow measurement instruments shall be based on the requirement of accuracy, repeatability, location, physical properties of the flowing fluids handled, pressure drop and ease of maintenance.

In-line flow instruments shall have a direction of flow indication clearly marked and easily visible in the final installed position.

Flow switches shall not be used without prior approval from the purchaser.

4.9.1 Orifice Plates

a) Flow measurement shall normally be carried out by using thin square edged concentric orifice plate mounted between a pair of weld neck flanges of minimum 300 pounds ANSI rating for line size 2" and above. Flange taps shall be used for line sizes upto 14" while D-D/2 taps shall be used for line sizes more than 14" (for rating 300#). However for rating 600# and above, D-D/2 taps shall be used for sizes more than 12". The material of the orifice plates shall be normally 316 SS, as a minimum.

Quadrant edge or quarter circle orifice plates shall be used for highly viscous liquids and for pipe Reynold number below 10,000.

Conical entrance type of orifice plates shall preferably be used for very highly viscous liquids upto throat Reynolds number of 250. These plates shall be fabricated as per Flow Measurement Hand Book by RW Miller.

Vent and Drain holes shall be provided for bore dia. above 25.4 mm.

b) Sizing of orifice plate shall be carried out in accordance with ISO-5167 (Latest Edition). For orifice plates not covered in ISO 5167, sizing methods shall be ASME MFC-14M (latest Edition) or AGA Report No. 3 or 'Flow measurement-Engineering Handbook' by RW Miller. Plate thickness shall be as per RW Miller.

c) Integral orifice type meter run assembly with transmitter shall be used in line size with 1.5" (40 mm) nominal diameter or below.

d) Upstream and downstream straight length shall be provided based on maximum d/D ratio of 0.7 , in general. Where it is difficult to meet this requirement, the actual d/D ratio can be considered for reducing the straight length as permitted by the codes. Flow straighteners are to be considered, where straight runs are difficult to achieve otherwise.

e) Meter taps shall be horizontal for liquids, condensable vapours and shall be from top for steam, however the transmitters shall be mounted below for these cases. The taps shall be on top for gas, non-condensible vapour, or liquids which boil at or below the maximum design ambient temperature at operating pressure. Where piping clearances are a factor, taps may be located upto 45 degree below the horizontal center line for condensable vapour and liquid. The taps may be located upto 60 degree from vertical for gas, non-condensible vapour and steam.

For Cryogenic liquid, the meter tap shall be from below the horizontal line wherein the transmitters shall be mounted above tapping.

4.9.2 Venturi Flowmeters

a) Venturi shall be designed and constructed as per ISO 5167-4(Latest Edition) or ASME MFC-3M.

b) The Venturi Flow element shall be classical, machined, non truncated type.

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c) Impulse piping connection for venturi tubes shall be provided with 1/2" NPTF connection, unless otherwise specified in the data sheet.

d) Venturi tube shall be forged/cast construction in general. However fabricated construction shall also be acceptable, wherever allowed as per ISO-5167.

e) Venturi tube shall be provided with Annular chamber / Piezo-metric Ring. Material of construction of Annular chamber / Piezo-metric Ring shall be same as material of Venturi tube.

f) Material of construction of Venturi tube shall be SS316 as a minimum. Material of construction for Throat, Divergent section and Convergent section shall also be SS316 as a minimum. Flanges shall be provided as per the material specified in the datasheet.

g) Flow calibration for those Venturi tubes, which are necessitated due to their installations outside the limits as defined in ISO 5167 for D (Pipe Inside Diameter), beta and Reynolds numbers shall be considered in the base quote

4.9.3 Averaging Pitot Tube

Averaging pitot tube in general shall not be considered unless specifically required by the purchaser. Averaging pitot tube shall meet the following requirements:

a) The flow sensor shall be continuous averaging velocity head producing type of pitot tube with four or more equal averaging pitot tube sensing ports or continuous slots to suit line velocity profile. The sensor shall also incorporate a rear port for the measurement of line static pressure.

b) Averaging pitot tube shall be of 3” flanged connection with isolation ball valve.

c) The insert retract mechanism shall be provided to allow on line removal and insertion of the average Pitot tube under maximum pressure and flow condition.

d) Vibration analysis for each averaging pitot tube element shall be done for the indicated flow condition to ensure that the averaging pitot tube is of sufficient thickness and strength to withstand the vibration effects created due to Karman vortex shedding in the fluid stream.

e) The free end of the averaging Pitot tube shall be pressure supported at the pipe wall. However, for the large pipe sizes and where vibration analysis recommends the requirement of end support, the end support/weld cap support shall be provided.

f) The offered averaging Pitot tubes shall have ±1% accuracy of actual value and repeatability of ±0.1% of actual value.

4.9.4 Variable area Flow Meters

Variable area flow meters or rotameters shall be provided as per the P&ID or where rangeability in flow precludes the use of an orifice. Variable area flow meters shall be as per ISA-RP 16.1, 16.2, 16.3, 16.4, 16.5 and 16.6. Metal tube rotameters shall be used for all fluids. External devices for indicating or transmitting shall be magnetically coupled to the float or extension.

Glass tube rotameters shall not be used unless it is necessitated for low range or for low pressure utility services for local indication and where line size is 1-1/2” (40mm) or less with the approval of purchaser.

Purge flowmeters shall be provided with needle valves.

Reducer shall be considered, in case the size of the flowmeter is less than the line size.

Unless otherwise specified, the metal tube variable area flow meter shall meet the following performance specifications:

The accuracy of Variable area flowmeter shall be of Accuracy Class 1.6 or Better as per VDE/VDI - Directive 3513.

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Repeatability better than ± 0.5% of full scale

4.9.5 Mass Flow Meters

The mass flow meters shall meet the following requirement:

a) Flow meter shall be of in-line mounting design and shall be of flanged body construction with stainless steel as minimum material of construction.

b) The mass flow meter shall be provided with the external flow tube housing. In all such cases, the flow tube housing shall have provision to monitor housing pressure continuously.

c) The mass flow meter shall have high vibration immunity.

d) Flow meter electronics shall be microprocessor based and shall include pre-amplifier, converter, transmitter electronics and integral output meter. The indication on the output meter shall be digital with engineering units.

e) The mass flow meter shall be capable of computing field density and shall incorporate temperature sensor flow fluid temperature measurement. Whenever required, the flow meter electronics shall have capability to compute volumetric flow rates. Density output provision shall be provided.

f) The meter electronics shall be protected against transients induced by lightning and power supply surges. Transient protection electronics shall preferably be provided in the terminal block. The transient protection shall meet the requirements specified in IEC-60587.

g) Unless specified otherwise in the job specification, the performance requirements for the mass flow meter shall be as follows:

i.	Flow meter accuracy:	± 0.2% of mass flow rate for liquid service.
		± 0.5% of mass flow rate for gas / vapour service.
ii.	Flow meter repeatability:	± 0.1% of mass flow rate for liquid service.
		± 0.25% of mass flow rate for gas / vapour service.

The performance requirements specified above includes the effect of zero stability of the flow meter on these parameters.

Flow accuracy shall be maintained between the minimum and maximum flow. Where only normal flow is specified, the maximum and minimum flows considered for the purpose of sizing shall be:

Maximum flow = 1.4 times the normal flow

Minimum flow = 0.4 times the normal flow

When only maximum flow is specified minimum flow shall be considered as 0.2 times the maximum flow for sizing the meter.

The maximum pressure drop at meter maximum shall not exceed the allowable pressure drop across the meter specified in the data sheet.

The meter shall be selected such that both accuracy and allowable pressure differential across the meter are complied.

4.9.6 Ultrasonic flowmeter

Ultrasonic flow measurement with insertion / spool piece design (depending on the line sizes and application) shall be considered where non-intrusive flow measuring is required.

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The Ultrasonic flow meter shall be based on transit time technology. They shall have at-least two acoustic path for process / flare applications and four acoustic paths for custody transfer applications.

The design used shall provide maximum reliability, maximum on-line performance and minimum maintenance. It shall be immune to other impurities in the fluid stream.

Ultrasonic flow meters and the meter runs/flow conditioners shall be rated for the maximum design pressure.

Spool piece type Ultrasonic flow meters shall have flanged end connections. Weld joints, if any, shall be of radiographic quality.

Clamp-on type ultra-sonic flow-meters shall not be provided unless specifically indicated in the job-specifications.

Vendor shall indicate the range of viscosities over which the measurement accuracy remains within limits.

Ultrasonic flowmeters shall be suitable for measuring the flow with the specified accuracy with upstream and downstream straight length of 10D and 5D respectively for both process and flare application. In case required calibration analysis to establish the specified performance shall be carried out by the vendor without any implication.

Spool piece type design shall be selected for meter sizes up to 16". For higher meter sizes, Insertion type design shall be used.

Ultrasonic signal frequency shall be dependent on the application. Accordingly, vendor to select suitable piezo-crystal probes meeting the specified requirements.

Meter Sizing:

Selected meter size shall ensure that flow meter operates within 85% of their standard range considering density and viscosity of the fluid. Extended range shall not be referred for the meter selection.

Vendor to ensure the velocity in the Ultrasonic flowmeter and meter run shall not exceed maximum permissible velocity.

Performance Requirements
Vendor shall meet the accuracy requirements mentioned herein, and indicate the same in the offer with sizing calculations and back-up documentation. The minimum no. of paths, as defined for each application, shall be ensured.

For Process Applications:

a) Liquids
Accuracy: ±0.5% of reading
Repeatability: ±0.3% of reading

b) Gases
Accuracy: ±0.5% of reading
Repeatability: ±0.3% of reading

c) Flare
Accuracy: ±2-5% of reading
Repeatability: ±1% of reading

For flare application, UFM model shall be suitable for measuring flow velocities from 0.3 m/s to 120 m/s with specified accuracy.

4.9.7 Vortex meter shall be considered where high rangeability is the prime requirement.

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4.9.8 Differential Pressure type flow transmitter shall meet all the requirements specified in clause 2.16.

4.9.9 Wedge flow meter shall be considered in slurry services or where powder deposits may form.

4.9.10 Thermal mass flowmeters shall be used for stack flue gas measurement.

4.10 Control Valves

4.10.1 Control valves shall normally be globe type. Other valve types like butterfly, ball, rotary plug, angle or 3way etc., shall be selected as per service and process requirements.

4.10.2 Control valve sizing shall be carried out as per ISA S75-01. The valve shall permit upto 150% of normal flow or 110% of maximum flow, whichever is higher. In general, control valves shall be sized so that the valve opening is as noted below:

At max. flow : about 90% open

At normal flow : about 75% open

At minimum flow : about 10% open.

4.10.3 Flanged control valves shall be used. Body material, body rating and flange rating shall be as per piping specifications. However body and flange rating shall be minimum 300#.

4.10.4 Valve shall be suitable for installation in both vertical and horizontal lines.Minimum control valve body size shall be 1" in general unless lower size is specifically required as per Licensor's documentations. Reduced trims can also be considered.

4.10.5 For globe valves trim characteristics shall be equal percentage type unless required otherwise. Control valve plugs shall be heavy top guided for single seated valves. Cage guiding may be used in clean applications and sizes above 2". Top guided shall be provided upto 2" valve sizes except for anti-cavitation and low noise trims.

4.10.6 Anti-cavitation trim shall be selected wherever cavitation is expected in the valve. For flashing services hardened trim shall be used and anti-cavitation trim shall not be provided.

4.10.7 Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 85dBA SPL (Sound Pressure Level). Source treatment for noise may be performed by using special trims like low noise trims, in case noise exceeds the specified level. Other methods based on merit are also permissible.

4.10.8 Valve seat leakage shall be minimum class IV as per ANSI/FCI 70.2 unless tight shutoff requirement is required as per the P&ID and valves in flare application.

4.10.9 Flanged bolted type gland packing boxes shall be used. Packing shall normally be PTFE on liquid and gas service upto 200^{O}C (design). Graphite/grafoil shall be used above 200°C(design) temperature. Asbestos based packing material shall not be used. Valves shall meet fugitive emission requirement as per ISO 15848-1 class-C as a minimum. For toxic services, more stringent requirements shall be followed.

4.10.10 Bellows seal shall be used where it is required to isolate the packing from the process fluid or where no leakage to atmosphere can be tolerated like toxic, explosive and precious fluids.

4.10.11 Material used for trim shall be minimum SS 316, with guide bushing of hardened stainless steel like 440 C, 17-4 PH. For higher pressure drops (more than 10 kg/cm^2) or erosive and slurry services and in general for all steam services, flashing and cavitating services, plug and seat shall be stellited.

Special cases may require 17-4 PH seat ring and 440 C solid plugs or other materials like Hastelloy, Monel etc.

4.10.12 Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment including volume bottle necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected.

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For control valves with leakage class IV and below, the actuator shall be sized considering actuator thrust more than 1.5 times the total force induced by shut-off conditions specified in the data sheet and the force required to overcome packing friction.

For control valves with leakage class V and above, the actuator shall be sized considering actual thrust more than 1.7 times the total force induced by specified shut-off conditions in the purchaser's data sheet and the force required to overcome packing friction.

Actuator casing shall be suitable for the maximum Instrument Air supply pressure. Else, Overpressure protection feature shall be available for the same in the valve positioner or safety valve shall be provide at the AFR outlet for actuator casing protection.

4.10.13 Whenever limit switches are specified as inductive proximity type, these shall meet NAMUR (DIN-19234) requirements.

4.10.14 Solenoid valves, wherever used, shall be universal and continuous rated type with class H coil insulation. These shall be SS body as a minimum.

4.10.15 Self-actuating regulators for flow, pressure and temperature shall be used where loads are constant and requirements of precision and accurate controls are not stringent.

4.10.16 The actuator shall be painted as below:

Direct action (open on air failure) valves	-	Green
Reverse acting (close on air failure) valve	-	Yellow

Items like air volume tanks etc., supplied as an accessory along with the actuators, shall be painted as per corresponding actuator.

4.11 ON-OFF VALVE

4.11.1 On-off valves shall be generally full bore ball type. Wherever no specific operating time is specified, the same shall not exceed 1 sec. per inch of valve. On-off valves shall have flanged end connections integral to the valve body. Top entry valve design shall not be offered unless specifically indicated. Body rating of valve shall be minimum 300#.

a) Lug type body design with long studs and bolts shall be considered for butterfly type on-off valves body size up to 6 inches.

b) Above 6", flanged design shall be provided.

4.11.2 For on-off valves with fire safe design, flanged body construction shall only be acceptable.

4.11.3 For all services where full port valves are specified, following shall apply:

a) Port size shall be equal to line size for rating up to ASME Class 1500.

b) Port size shall not be less than one size than the line size for rating ASME Class 2500 and above.

4.11.4 For fully jacketed valves, body and port size of valves shall be same as line size, with end connection one size higher.

4.11.5 On-off valve body, bonnet, bottom flange, line flanges and other pressure containing assemblies shall be of the same material of construction as specified for valve body.

4.11.6 In case of ball-type of on-off valves;

a) The valve design shall ensure valve seat and body protection against thermal expansion of the entrapped fluid when the on-off valve is fully close.

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b) For size up to 4" and rating up to ASME Class 300, the on-off valve shall have floating ball design. For ratings ASME Class 600and above, floating ball is acceptable for sizes less than 2". For higher sizes trunion mounted ball design shall be provided.

4.11.7 Rotary type on-off valves like Ball valves, butterfly valves etc. shall have blow out proof shaft guiding design.

4.11.8 Guide bushing shall be of a sufficiently hard material to resist side thrust on the plug or shaft.

4.11.9 Vendor shall be responsible for trim design and selection of the on-off valve. However, it must meet the following minimum requirements:

a) The valve characteristics shall be quick-opening (on-off) type.

b) Vendor shall select proper material pairs, surface finish, hardness and clearances to avoid galling.

c) Valves operating under extreme temperature conditions, vendor shall consider increased clearances at room temperature and seal welding of threaded seat rings etc whenever required. Hard facing of trim including guide bushing shall be considered for all valves operating at high temperatures (i.e. temperature more than 200°C). For very low temperature application, material used shall have adequate cold impact strength.

d) For all on-off valves including 3-way type of valves, stem and plug shall be detachable and shall be attached together by suitable threaded design secured with a pin to avoid plug rotation during operation.

4.11.10 Trim material shall be as specified in control valve section.

4.11.11 Actuator shall be painted as below :

FO / FC shutdown valves	-	Red
Fail Lock on-off valves	-	Grey

4.11.12 Vendor shall select the soft seat (elastomer) material suitable for the process conditions i.e., shut off pressure, maximum temperature and process fluid. Metal seated on-off valves meeting the leakage class shall also be acceptable. Metal seated on-off valve shall be tested for high pressure closure test.

4.11.13 For application in vacuum service, vendor to provide inverted packing design suitable for vacuum service. For pressure-cum-vacuum service, the on-off valve shall have dual packing design suitable for the application. Dual packing design shall also be provided for on-off valves in toxic / explosive service, with a facility to connect inert fluid between the packing.

4.11.14 Valve actuator shall be designed to move the valve to the failure position as specified. For failure position specified as 'fail-locked', vendor shall provide air reservoir with all required accessories to meet the fail lock position of the valve.

4.11.15 Whenever double acting spring less type of actuator is unavoidable, all accessories like pilot valves, booster relays, non-return valve, pressure gauge, volume tank etc. shall be provided to ensure desired action on air failure.

4.11.16 The volume tank shall be of carbon steel construction and sized as per ASME Section VIII with design pressure of 10kg/cm^{2}g as a minimum.Each volume bottle shall be sized

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for a minimum of 3 valve strokes.Minimum thickness volume tank shall be 6mm with corrosion allowance of 1.4 mm.

4.11.17 The actuator casings and diaphragms shall be designed for minimum twice the maximum pneumatic operating pressure of the on-off valve. Actuator casing shall be suitable for the maximum Instrument Air supply pressure. Else, Overpressure protection feature shall be available for the same in the valve positioner (PST) or safety valve shall be provide at the AFR outlet for actuator casing protection.

4.11.18 Vendor shall be fully responsible for sizing and selection of correct actuator & while sizing the actuator vendor shall consider minimum actuator thrust equal to two times (2) the total force induced by shut off condition and the force required to overcome packing friction.

4.11.19 Wherever the valves are indicated as fire safe, they shall be tested for fire safe as per BS EN 12266 when the valves are supplied with metal-to-metal seats and shall be tested as per API 607 latest edition or equivalent standard when the valves are provided with soft seats.

4.11.20 Wherever fire safe actuator and controls have been asked for, actuators and all accessories such as solenoid valves, air volume bottles etc. shall meet the fire proof requirement to ensure normal valve operation even during and after exposure to fire. Vendor shall clearly define the schemes they propose to achieve the above requirements and ensure that the proposed schemes shall meet the requirement in terms of type of exposure and exposure time of the testing procedure given in BS EN 12266/API 607/ API 6FA.

4.11.21 Vendor shall furnish type test certificate duly witnessed by third party inspection agency like M/S LRIS,BV,DNV,TUV etc. for fire safe testing of valve, actuator and controls for the offered models.

4.11.22 Valves shall meet fugitive emission requirement as per ISO 15848-1 class-C as a minimum. For toxic services, more stringent requirements shall be selected.

4.12 Smart Type and Fieldbus Type Positioners

Digital smart positioners or fieldbus type of positioners with diagnostic capabilities shall be provided as per job specific requirement. These shall meet the following minimum requirements:

a) The positioner sensor and sensing mechanism shall be rugged and shall not be affected by the line/valve vibration. The performance of the positioners shall be immune to above vibration.

b) The positioner's output and input range shall be field adjustable without any hardware modification. The output from the positioners shall be available for both single acting as well as double acting actuator.

c) Each positioner shall be operable, configurable and accessible through HART compatible hand held configurator/fieldbus configurator as applicable. Smart positioners shall also have dedicated buttons for the above functions.

d) Control valve's operating signatures in the form of hard copy and soft copy for each control valve provided with smart positioners shall be supplied. The necessary software for advanced control valve diagnostics like seat ring condition, gland packing condition, actuator leakage etc. shall also be included.

e) Fieldbus positioner shall have the capability to perform functions like PID etc.

f) All positioners shall have metallic casing and cover.

g) On-off valve positioners for partial stroke test shall not cause spurious trips in case of positioner or positioner power failure. The PST positioner shall be reverse port type.

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h) Vendor to provide removable protective caps/ cover on all gauges pertaining to positioners. The material of construction of the gauges on AFR / positioned shall be stainless steel.

4.13 Pressure Relief Valves and Rupture Discs

4.13.1 Pressure Relief Valves

4.13.1.1 All pressure relieving devices shall be designed in accordance with ASME code for 'Boilers and Pressure Vessels', API-521 and Indian Boiler Regulations. The pressure relief valve sizing shall be as per API 520. For mixed phase fluids, sizing shall be as per Leung-Omega method (or Diers) sizing shall be followed. The orifice sizing, area and designation, valve size and rating shall be as per API RP 526.

4.13.1.2 Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.

4.13.1.3 Conventional valves shall be specified for constant back pressure while bellows seal type valves shall be specified for variable back pressure. Pilot operated pressure relief valves shall be used when Back pressure is greater than 50% of set pressure or when the difference between operating pressure and set pressure is within 10% of the set pressure.

4.13.1.4 Lifting lever shall be specified for steam, air or water above 65 degree service. Open bonnet shall be used for steam service.

4.13.1.5 The percentage accumulation in case of pressure relief valves/safety valves shall be as follows:

a)	Steam Service	
	- ASME SEC I(steam generation/consumption)	3%
	- IBR (Before steam let-down station)	5%
	- IBR (Distribution & utilities) and ASME Section VIII	10%
b)	Gas, Vapour or liquid for process service	10%
c)	Liquid for thermal Relief	25/ 10% (as per Process requirement)
d)	Fire exposure on unfired vessels	21%

4.13.1.6 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm^2 orifice size shall be specified for thermal relief. However, if discharge is connected to flare or with variable back pressure more than 10% of set pressure, 1D2 flanged valves as per API-526 as a minimum to be provided.

4.13.1.7 The body material shall, as a minimum, be as per piping specifications. Nozzle and disc material shall be SS316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle designs are unavoidable, body material shall be at-least same as nozzle and disc material.

4.13.1.8 The spring material of pressure relief valves shall be as follows unless otherwise necessary because of process conditions;

(-) 29^{O}C to 230^{O}C	:	Carbon steel with weather protective coating.
above 230^{O}C	:	Tungsten alloy steel.
Below (–) 29^{O}C	:	316 Stainless Steel

4.13.1.9 Flanged connection shall be for standard sizes 1" or larger.

4.13.1.10 Where permissible, screwed connections shall be used on sizes 3/4" and below.

4.13.2 Rupture Disc

4.13.2.1 Rupture discs shall be reverse buckling type, in general and shall be supplied in pre-torqued holder assembly, which shall fit inside the inner diameter of the bolt circle of standard

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flanges. Disc material shall be compatible with the vessel contents and shall be consistent with the bursting requirements. Inconel discs shall be used above 100^{O}C if compatible with the process fluid.

4.13.2.2 When rupture disc is used upstream of a pressure relief valve, a pressure gauge shall be provided on the downstream of the disc to indicate any rupture of the disc in addition to an excess flow check valve. In addition combination capacity factor of 0.9 shall be used for sizing unless the combination has been tested and approved for any other combination capacity factor.

4.13.2.3 The bursting tolerance of the rupture disc shall be 5% of the specified bursting pressure or less, unless otherwise specified. Manufacturing design range shall be 0%.

4.13.2.4 Vendor shall consider 5 nos. rupture discs (1 for testing + 1 for installation + 3 nos. spare) of the same specifications.

4.14 Interlock and Shutdown System

4.14.1 Interlock and Shutdown System shall be an independent system with its own dedicated primary element except for orifice flow measurement. For orifice flow element, separate set of tapping for each flow transmitter for shut down / interlock shall be considered.

4.14.2 The system shall be designed fail safe and shall meet the following requirements, as a minimum:

a) All initiating contacts shall be close (except limit switches for which contact shall close when the limit reaches)under normal conditions and shall open under abnormal conditions.

b) All relays and solenoid valves shall be energized under normal conditions and shall de-energize under abnormal conditions.

c) If desired, because of operational or maintenance requirements, adequate trip by-pass facilities are to be provided with warning lights to indicate that the trip has been bypassed. Trip bypass alarms shall be provided. All such by-pass switches shall be key-operated type.

4.14.3 Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

4.15 Instrumentation for Rotating Equipments

Rotating Equipment vendor shall be completely responsible for providing adequate instrumentation for safe and efficient operation of the machine. The commonly used instruments are being detailed out in the following clauses; however this does not absolve the vendor of providing additional instrumentation, if required.

4.15.1 Anti surge and performance control system (ASC)

a) Vendor shall be fully responsible for the complete design of Anti surge/performance control system (ASC) including selection of type of flow element, controller Algorithm, type of explosion protection, type and operating timings of final control element. Vendor shall guarantee the performance of machine with the offered ASC system. Wherever required, ASC system shall be designed in such a way that it is capable of correcting the compressor operating point so as to avoid surge in order to protect machine from possible damage, to minimize process upsets and to minimize recirculation.

b) ASC system shall typically consist of but not limited to flow element, flow transmitter, differential pressure transmitter, ASC controller, control valve and other accessories as felt necessary by the vendor.

c) Vendor shall supply all the hardware and software related to the operation and safety of the equipment. This shall include but not limited to the following;

i. Design and operation of surge control loop scheme based on offered equipment

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performance.

ii. Supply of all hardwares in antisurge control loop including dedicated controller, transmitters, measuring elements, final control element etc.

iii. Fast response transmitter and control valve etc. as required.

iv. Algorithm required for antisurge/Performance control application.

d) The ASC shall be a dedicated single loop controller on proprietary Hardware Platform or single/multi loop controllers of common hardware platform such as PLC. The single loop controller shall be dedicated controller for each Anti-surge or Performance control application/Tag. Dedicated panel mounted facia shall be provided. The ASC system when provided on common hardware platform shall be with redundant configuration as minimum viz-dual processor, dual input/output, redundant communication & dual power supply system. The multiloop controller/ system shall be dedicated for Anti-surge/ Performance applications/ Tags of each machine/each machine tag. Unless specified otherwise dedicated PC with all software to be mounted in Purchaser's Control Room

e) It should be able to accept 4-20 mA signal from field or from HIC at purchaser DCS or at LCP as a manual override to anti-surge control system with bump less transfer.

f) Auto-manual operation with bump less transfer shall be provided.

g) The controller response time (total time to read input, processing time and output) shall be as per the machine dynamics and safety and shall be of the order of max. 40-milisec. Any faster response required based on machine dynamics shall be considered by vendor. The input sampling interval shall be as per machine dynamics within the controller response time as above. The processor cycle time shall be considered to meet the overall response time.

h) The ASC shall be field proven, specific to the make of machine and for the similar application in hydrocarbon industries. Vendor shall provide the proven track record for the offered ASC meeting the above.

i) The anti surge/ performance control algorithm shall be implemented using standard firmware in the controller/ processor system.

j) The algorithm developed by vendor shall be specific for given application, surge control, performance, load sharing etc. and shall be field proven for the compressor make.

k) The algorithm implemented in the system shall be protected against any modifications/changes.

l) The configuration shall be stored in non-volatile memory or battery back-up for configuration shall be provided (minimum 48 hours) in case of volatile memory along with battery drain indication.

m) In case of ASC on common hardwired platform separate configurator with necessary hard ware/ soft ware shall be provided for application programming.

n) Anti surge controller shall not be used for performing any other machine related inter locks/logics.

o) All the instruments (transmitters, Positioner and temperature elements and / or transmitters) connected with anti-surge control loop shall be flame proof "Exd" type suitable for the area as specified. The suitability of smart transmitter/ Positioner shall be confirmed by vendor and to be provided accordingly.

p) The ASC system vendor shall be fully responsible for the sizing and selection of the anti-surge valve. Vendor to provide the sizing calculations duly vetted by ASC system manufacturer.

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4.15.2 Machine Monitoring System (MMS)

Machine Monitoring system shall be provided for continuous monitoring and indication of machine parameters like vibration & axial displacement, bearing and winding temperature, key-phasor etc. MMS system signals shall be hard-wired to PLC (package PLC or plant PLC as applicable) for interlocks and serially linked to plant DCS for monitoring. Location of Vibration/ Temperature Monitoring racks (Local Panel or Control room) shall decided based on the distance limitations between Probes and Monitors based on API standard.

4.15.2.1 Vibration and displacement monitoring system shall be as per API-670. 4 channel vibration modules, 6 channel temperature modules shall be provided as per requirement. The extent and type of monitoring shall be as defined elsewhere. However, vendor shall furnish any additional requirements for monitoring deemed essential by them with reasons. Two probes at 90 degree apart for each location shall be provided and connected to same dual channel monitor for vibration monitoring.Separate JBs shall be provided for temperature and vibration signals.

4.15.2.2 The machine monitoring system shall be provided with preferably built in intrinsically safe barrier and shall be duly mounted in separate panel. However, separate terminal blocks shall be provided for terminating the field cables for maintenance purpose. Direct cable termination on modules shall not be considered.

4.15.2.3 For MMS the display unit shall be provided at local control panel with necessary statutory certification. Alternatively purged enclosure (suitable for the hazardous area) is also acceptable with necessary certification.

4.15.2.4 The sensing probe shall be accessible for adjustment, repair and replacement without dismantling the machine.

4.15.2.5 Vendor shall provide hardwired Voted contact output of each parameter for Pre trip and trip alarms for alarms/ interlock in purchaser's control system. The alarms/trips of the channels within each monitor/ Module can be grouped together and common pre-trip alarm and common trip contact for each monitor/ Module shall be provided. Each digital output from MMS shall be realized at least through two relay modules configured with same logic and independently hardwired to ESD. 4-20 mA signals from Vibration & Temperature Monitoring System racks to DCS system are not required separately, unless specified and vendor to ensure that all the parameters are available through serial interface. For multi racks, vendor shall provide common serial interface through multi drop link.

4.15.2.6 In addition to this, it shall be provided with necessary hardware (communication gateway module) including the cable for serial data communication from monitoring system to purchaser's DCS for machine monitoring through purchaser's DCS via redundant serial data interface. This serial link shall be either RS 422 / RS 485 with MODBUS RTU protocol or Modbus TCP/IP protocol and shall be specifically indicated as part of offer. Vendor shall furnish all details like pin configuration and tag number wise MODBUS address mapping list etc. for smooth interfacing of this communication link with DCS. Vendor shall also provide necessary hardware and software for providing raw data to conditioning monitoring system for each rack.

4.15.2.7 Vendor shall also supply one common laptop based configuration unit for the package unit with required configuration software (refer clause 4.17) and hardware for configuration of MMS system including the serial communication cable required between configuration unit (laptop) & MMS monitors.

4.15.2.8 Vendor shall ensure the following for connectivity with Condition Monitoring System:

(i) Vendor shall provide hardwares like communication processors in each rack.

(ii) Enabling softwares required if any for connecting to purchaser's condition monitoring system for acquisition of raw data from various monitors with respect to each sensor shall be provided by vendor.

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(iii) Individual monitors shall have provision for giving raw data (buffered output for vibration & key-phasor hardwired from panel rear of each of the monitor) to the condition monitoring system. For vibration signals connected to purchaser's control system, sensor and transmitter with 4-20mA DC output shall be provided by vendor.

4.15.2.9 **Key Phasor**

Key phasor system shall be provided by vendor for performing analysis of vibration signals to determine machine malfunctions. It shall consist of a proximity probe and transmitter, extension cable etc. and other accessories to make the system complete. Vendor shall provide necessary reference on the shaft to determine one-per-turn occurrence.

4.15.2.10 **Vibration and Axial Displacement Monitoring**

Monitors shall be four channel types and shall meet the following specifications as a minimum:

a) Continuous channel monitoring with each channel input from one probe. Readout scale shall read higher of the sensors.

b) Each channel shall have two independent alarm levels one for pre trip alarm and one for each trip and that can be set continuously over measurement range. Two relay contacts for each pre-trip alarm and trip alarm per channel shall be provided.

c) Broken sensor failure detection without causing shut down.

d) LED lamps on monitor front for each channel to indicate pre-trip alarm, trip-alarm and circuit fault conditions.

e) Selector switches on monitor front to read vibration/ displacement pre-trip alarm and trip set points for each channel shall be provided.

4.15.2.11 **Bearing & Winding Temperature Monitoring**

a) Sensor shall be three wires RTD element of platinum having 100 ohms resistance at $0^{O}C$.

b) The temperature sensor, cables, terminal heads, junction boxes etc. shall be capable of withstanding the mechanical vibration and environment of a rotating machinery atmosphere.

c) Bearing and Winding temperature shall be monitored by means of a temperature monitor. It shall meet following requirements:

i. Accept RTD inputs (platinum, 100ohm at $0^{O}C$).

ii. Continuous six channel monitoring check with each channel input from each RTD. Read out scale shall read higher of the six temperatures.

iii. Each channel shall have two independent alarm levels one for pre-trip alarm and one for trip alarm and that can be set continuously over measurement range.

iv. Broken sensor failure detection without causing shut down.

v. Selector switches on monitor front, to read temperature, pre-trip alarm and trip set points for each channel shall be provided.

vi. Analog output 4-20 mA DC isolated signals shall be provided for each channel for remote indication, if specified.

4.15.2.12 Wherever MMS is not specified, vendor shall provide suitable transmitter for all the vibration and axial displacement, temperature, key phasor to provide 4-20mA signal to purchaser's control system.

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4.15.2.13 For reciprocating compressor, where PV analysis is requirement is specified in the equipment data sheets, required cylinder pressure sensors shall be supplied to consider the implementation of PV analysis.

4.15.2.14 All Cables from field mounted MMS probes to MMS System in Control room shall be by vendor.

4.15.3 Speed Governor System

4.15.3.1 Digital microprocessor based system mounted in standalone cabinet and located in rack room shall be provided. Fault tolerant triple modular redundant (TMR) system shall be supplied for special purpose turbine and single for general purpose turbine as per Job Specification.

4.15.3.2 HMI for operator interface shall be supplied loose with all mounting accessories for mounting this HMI in purchaser's hardwired console in general. This shall include all basic features of governor to enable operator to do all control and monitoring operations from console itself.

4.15.3.3 This shall include features like assignable speed range, adjustable speed set point, remote speed set point input, digital speed indication, adjustable speed ramp, override for testing the external over speed trip system etc.

4.15.3.4 It should be able to accept 4-20 mA signal from HIC at purchaser's DCS or LCP as a manual override to governor and pass on the same, after a bump less auto / manual selection and local / remote selector switches configured in speed governor (shall be possible through HMI) to governor valve as manual control.

4.15.3.5 Vendor shall provide all hardware & software in the system (including the cable for serial data communication from system to purchaser's DCS) for serial communication link for all data transfer from governor to purchaser's DCS. This serial link shall be either RS 422 / RS 485 with MODBUS RTU protocol or Modbus TCP/IP as per vendor's recommendation and shall be informed, vendor shall furnish all details like pin configuration and tag number wise MODBUS address mapping list etc. For smooth interfacing of this communication link with DCS.

4.15.4 Accumulator of Lube Oil System

4.15.4.1 If accumulators are used with nitrogen for lube oil dampening at the desired pressure to meet the system requirement the following instrumentation with the accumulator to be provided by vendor:

a) Accumulator shall have charge kit with isolation valves and connection hoses.

b) Standard nitrogen cylinders available in India are at pressure of 140 kg/cm^{2}g with standard connection sizes. Vendor shall provide the complete regulator system with protection for charging nitrogen from nitrogen cylinder to accumulator at the desired pressure. Regulator shall be suitable for the inlet pressure variation of 140 to 150 kg/cm^{2}g while charging with suitable inlet connection to match the Nitrogen cylinder connection. Regulator system shall have pressure indicator, regulator, relief valve, needle valve etc. as a minimum. Material of construction shall be stainless steel.

4.15.5 The compressor loading-unloading scheme for reciprocating compressors shall be provided as per the minimum requirements specified in the job specifications. Manual as well as automatic schemes shall be provided.

4.15.6 Emergency switch shall be provided in the local panel/local. All such switches shall have a protective cover to avoid inadvertent shutdown.

4.15.7 Vendor shall provide the following common alarms for purchaser:

a) Common machine pre-trip alarms.

b) Common machine trip alarm.

4.15.8 Stepless Capacity Control system for reciprocating compressors

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a) Stepless capacity control System shall be a digital microprocessor based system mounted in standalone cabinet and located in satellite rack room or control room.

b) It shall comprise of Hydraulic Unit, Hydraulic Actuator and Compressor Interface Unit (CIU) for the respective compressors along with interconnecting cabling. Stepless Capacity control system for each individual train shall be independent.

c) It shall be provided with necessary hardware & software for serial data communication from capacity control system to purchaser's DCS via redundant serial data interface with either RS 422 / RS 485 with MODBUS RTU protocol or Modbus TCP/IP as per vendor's recommendation and shall be informed.

4.15.9 Overspeed Detection system (ODS)

a) Electronic overspeed detection shall be separate and distinct from the speed control system, with exception of final control elements. Each driving machine requiring overspeed detection shall have its own over-speed system. Combining multiple driving machines into a single ODS shall not be allowed.

b) It shall be provided with necessary hardware & software for serial data communication from ODS to purchaser's DCS via redundant serial data interface for monitoring purpose.

c) Hardwired Trip output for interface with PLC to be provided for interlocks.

d) The design of the electronic ODS shall conform to standards IEC 61508, IEC 61511.

4.15.10 Surge Detection system

a) Surge detection system shall comply API 670. For axial flow compressors, this is mandatory, while for centrifugal, the same shall be provided as specified.

b) It shall be independent of Antisurge control System. The intention of surge detection is to generate an alarm that compressor is experiencing multiple surge cycles. This alarm can indicate the failure of the antisurge control system.

4.16 System Cabinets, Racks and Consoles

4.16.1 All system cabinets, marshalling racks and hardwired consoles shall be free standing and enclosed cubicles type. All these items shall have bottom cable entry.

4.16.2 Cabinets shall be fabricated from cold rolled steel sheet (CRCA) of minimum 1.6 mm thickness for side and top suitably reinforced to prevent warping and buckling. Doors shall be fabricated out of 2.0 mm thick CRCA sheet. Cabinets having modular construction and with basic frame structure of heavy duty aluminium shall also be acceptable.

4.16.3 Cabinet/Console finish shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high-grade lacquer with sanding between coats. Two coats of paint in the cabinet colour and a final coat after assembly at site, shall be given for non-glossy high satin finish.

4.16.4 In order to remove dissipated heat effectively vent louvers backed by wire fly screen shall be provided. Further, ventilation fans shall be provided wherever required. High temperature annunciation shall be provided on operator console.

4.16.5 Illumination shall be provided for all cabinets by fluorescent / LED lamps, which shall be operated by door switch.

4.16.6 All cabinets/racks/consoles shall be adequately sized to avoid any congestion. Wiring shall be done as per guidelines provided in clause 4.2.14 of this specification.

4.16.7 The height and colour of the cabinets shall be inline with other equipments being installed in the control room.

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4.17 System software / License

Systems (like PLC, ASC, Speed Governor etc.) software shall include the operating system and application program. The application program shall include software for performing functions like interlock and shutdown logic, programming/program modification, documentation etc. Two copies of application program and two sets of licensed system software shall be supplied. The program language shall be English.

The licenses and application program shall allow:

- Monitoring of system program for troubleshooting purpose.
- Carrying out any modifications to the PLC/system program if need arises (engineering license with proper validity)
- Troubleshooting of any system related failures.
- Monitoring of the system healthiness

The system shall be supplied with programming tools and related accessories.

4.18 Wireless Monitoring

Wherever wireless monitoring system has been asked in the job specification, the following shall be considered as a minimum

4.18.1 Wireless signal Processing module, Wireless Signal Repeater, Routers, Antennas / Access points, Gateways, interconnecting cables and network switches etc.

4.18.2 All the instruments and electronics supplied which are to be mounted in hazardous area should be suitable for the area classification of its location of installation and minimum IP 65 rated. For wireless instruments non-metallic enclosures are also acceptable.

4.18.3 All wireless devices and its accessories in the network shall comply to WIRELESS HART as per IEC-62591 or ISA100.11a. The Wireless devices network shall be designed in such a way that continuous communications with gateways are established. Adequate amount repeaters infield for wireless network design shall be considered for ensuring multiple communication paths.

4.18.4 Wireless devices shall be power sourced by low powered battery. The shelf life of the battery shall be minimum 5 years. Vendor shall provide calculation for battery life considering 4 sec. Update rate. Battery drain indication / alarm shall be available in Host system as part of diagnostics/ maintenance data.

5.0 LIST OF DOCUMENTS ATTACHED

7-52-0001	Instrument connections on vessels, standpipes and tanks
7-52-0002	Instrument connections on piping.
7-52-0035	Thermowell
7-52-0036	Thermocouple / RTD assembly with thermowell
7-52-0041	Orifice Plates and Flanges -Dimensional details.
7-52-0042	Orifice Plates and Flanges – Dimensional details RTJ Flanges
7-52-0254	Duct Fabrication – Bolted Construction Details

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PART II

SPECIFICATION FOR MATERIAL, INSTALLATION, TESTING AND COMMISSIONING

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1.0 INSTALLATION MATERIALS

1.1 Vendor shall ensure and supply all erection hardware required for the installation of complete instrumentation which form a part of the package unit. This includes items like cables, cable glands, junction boxes, instrument valves and manifolds, mounting accessories, impulse piping/tubing, pipe/tube fittings, pneumatic signal tubes, air line pipes and fittings, filter regulators, steam/electrical tracing, insulation materials, cable duct and trays, conduits, prefabricated canopies for instruments, identification tags, structural material required for instrument supports and trays etc.

1.2 Clause 1.1 above broadly covers the items required for any typical plant, however vendor shall supply all necessary items to make the installation and commissioning work complete in all respect, irrespective of whether these have been explicitly included in their scope or not.

1.3 Salient feature and minimum requirement for some of the main installation materials is being described in the following paragraphs. For items for which no specification has been provided, vendor may follow their own specifications and prevailing international standards.

1.4 Cables

1.4.1 All cables shall have PVC insulated primary insulation of cable shall be 85^{O}C Polyvinyle Chloride type as per IS-5831 and inner and outer sheath of cable shall be flame retardant made of extruded PVC Type ST-2 at 90^{O}Cas per IS-5831. Oxygen index of PVC shall be over 30% at 27 ^{O}C$\pm$2 ^{O}C and temperature index shall be over 250^{O}C. However, Polyethylene (PE) insulation shall be provided in IIC area classification.

1.4.2 In general cables shall be flame retardant as per standard IEC 60332 Part 3Cat.A. However, cables with fire-safe valves shall be fire resistant also as per the following.

1.4.2.1 The insulation grade shall be 500 V as a minimum and shall meet insulation resistance, voltage and spark test requirements as per EN50288-7.

1.4.2.2 All cables shall be twisted and armored. Armor over inner jacket shall be of galvanized steel wire/flat as per IS-1554 part I.

1.4.3 For signal and control cables, inner jacket color shall be black. Outer jacket color shall be light blue for intrinsically safe application and black for others. For thermocouple extension cables the inner and outer jacket color shall be as per IEC.

1.4.4 Maximum DC resistance of the conductor of the completed cable shall not exceed the following:

a) 12.3 ohms/km at 20^{O}C for cables with 1.5 mm2 conductor.

b) 39.7 ohms/km at 20^{O}C for cables with 0.5 mm2 conductor.

1.4.5 The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz whereas the same shall not exceed 100 pF/m for PE insulated cables. The capacitance between any core and screen shall not exceed 400 pF/ m at a frequency of 1 kHz.

1.4.6 L/R ratio of adjacent cores shall not exceed 40 µH/Ω for cables with 1.5 mm^2 conductor and 25 µH / Ω for cables with 0.5 mm^2 conductor.

1.4.7 The drain wire resistance including shield shall not exceed 30 ohms/km.

1.4.8 A pair of communication wire shall be provided for multi-pair/multi-triad cables. Each wire shall be 0.5 mm^2 of plain annealed single or multi-strand copper conductor with 0.4 mm thick 85^{O}C PVC insulation. Insulation shall be green and red color coded.

1.4.9 Each multi-pair / multi-triad cables shall have 20% pairs as spare.

1.4.10 Running length of the cable shall be printed on the outer sheath at least at every 5 meter interval.

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1.4.11 Signal Cables

a) Single pair shielded signal/alarm cables shall be used between field instruments and junction boxes/local control panels.

b) Multi-pair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room, in general.

c) The single pair and triad cables shall be of 1.5 mm^2 conductor size made of electrolytic copper conductor of 7 strands with each strand of 0.53 mm diameter, multipair cables with 0.5 mm^2 conductor size shall have 16 strands of annealed electrolytic grade copper conductor with each strand of 0.2 mm diameter, multi triad cable or multi pair cable with 1.5 mm^2 conductor shall have 7 strands with each strand of 0.53 mm diameter, as per the job specification.

d) Shield shall be aluminum backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25% overlap and 100% coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/traid and 0.075 mm incase of multipair/triad cable.

e) Drain wire shall be provided for individual pair and overall shield which shall be 0.5 mm2 multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminum side of the shield.

f) All multi pair cables shall have 6 pair/12 pairs only while multi-triad cable shall have 6 triads/8 triads only.

1.4.12 Control Cables

a) Single pair control cables shall be used between field mounted solenoid valves and junction boxes/local control panels and shall meet the requirements specified in para 1.4.11 above.

b) Multi-pair control cables shall be used between junction boxes/local control panel and control room mounted devices in general. These cables shall have only overall shielding.

c) These control cables shall have 1.5 sq mm conductor size with 7 stranded conductors of annealed electrolytic grade copper, with each strand of 0.53 mm diameter.

1.4.13 Fieldbus Cables

a) Fieldbus cables shall be 16AWG (1.31 mm^2) for trunk and 18 AWG (0.82mm^2) for spurtwisted in pair individually and overall shielded with aluminum mylar tape with drain wire and armored. Other parameters shall be as per Type A defined in IEC-61158-2.

b) Fieldbus trunk cables shall be two pairs.

c) Fieldbus cable shall be field proven for FF applications.

d) Fieldbus cable shall comply with H1 cable test specification FF844.

e) Outer jacket color shall be orange with 3 longitudinal blue stripes for spur cables and black stripes for trunk cables.

1.4.14 Thermocouple Extension Cables

a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes/ transmitters/local control panel mounted instruments.

b) Multi pair individually and overall shielded thermocouple extension cables shall be used between junction boxes and control room mounted devices.

c) The type of thermocouple extension cables shall be compatible with thermocouple used. In addition the color coding of the primary insulation shall be as per IS-8784.

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d) The cable shall have 16 AWG and 20AWG solid conductors for single and multi-pair respectively.

e) All thermocouple extension cable shall be matched and calibrated in accordance with IEC-60584-2.

f) Shield shall be aluminum backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25% overlap and 100% coverage. Minimum shield thickness shall be 0.05 mm for single pair and 0.075 mm for multi-pair cable. Drain wire shall be similar to individual pair and shall be in continuous contact with the aluminum side of the overall shield.

g) Inductance shall not exceed 4mH/Km.

h) Electrostatic noise rejection ratio shall be over 76dB.

i) All multi-pair cables shall have 6 pairs/12 pairs only.

j) For S type thermocouples, suitable TC compensating cable shall be acceptable in place of extension cables.

1.4.15 Power Supply and Other Cables

a) All power supply cables shall be as per IS-1554 Part I and shall have copper conductors. Minimum conductor size shall be 2.5 mm^2 of copper conductor. All these cables shall be PVC insulated and armored.

1.4.16 Any other special cable required for instruments shall also be supplied as per the requirement. Vendor shall ensure that these cables are armored type and shall meet all other requirements specified in paragraph 1.4.1 through 1.4.10, as applicable.

1.5 Cable Glands

a) Vendor shall supply all cable glands required for glanding the above mentioned cables at field instrument side, local control panel side, junction boxes side and at control room side.

b) All cables glands shall be of nickel-plated brass and shall be double compression type suitable for armoured cables.

c) Flame proof glands wherever required shall be supplied with Ex (d) certification.

d) PVC Cable shrouds shall be provided with all the cable glands.

1.6 Junction Boxes (Non-Fieldbus loops)

a) Vendor shall supply junction boxes as per the cables selected, wherever required. These shall be of Cast Light Metal alloy body and shall be weather proof to IP 65as a minimum All terminals shall be screwless clamp type.

b) These boxes shall have terminals suitable for minimum 4.0 mm^2 cable termination mounted on rails. 20% spare terminals shall be supplied in each junction box.

c) Telephone sockets and plugs shall be provided in junction boxes.

d) Flame proof junction boxes shall be used in explosion proof/ flame-proof instruments circuits and supplied with Ex (d) certification. All such boxes shall be weatherproof also.

e) Each junction box shall have a minimum 12 numbers of entries with 20% or 2 Nos. as spare entries for branch cable and minimum 2 numbers of entries for multipair cable with 1No. spare. All entries shall be provided with suitable plugs.

f) Suitable 3-way power junction box shall be considered for higher size of incomer power cable, which is not matching with the terminals provided in the control panel.

g) Junction Box shall have bottom entry for single pair as well as multi-pair cables.

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1.7 Junction Boxes for Fieldbus Loops

1.7.1 For Fieldbus segment, junction box shall be used for mounting the wiring/ terminal blocks to terminate the trunk and spurs in the fieldbus networks.

Unless otherwise specified, vendor must use the following type of terminal blocks:

For all FISCO signals	:	Weatherproof terminal blocks
For all safe signals	:	Weather proof terminal blocks
For all Explosion proof signals	:	Explosion proof/Flameproof terminal blocks

1.7.2 Junction box for Fieldbus field barrier concept:

Fieldbus junction boxes with field barrier assembly/ assemblies shall be provided. No of Field Barrier assemblies in each junction box shall be suitable for 12 spurs including 25% spare spurs as a minimum.

Each junction box shall not have more than two segments and no. of field barrier assemblies shall be considered accordingly. Field barrier assemblies in a segment shall be multi-dropped (shall not be daisy chained in a trunk). Only one closed loop can be considered per segment. Remaining spur connections in the segment can be used for open loop. For multi field barrier assembly in a junction box, Field barrier assemblies shall be DIN rail mounted. Vendor shall terminate the spare pair of trunk cable in DIN rail mounted terminal in junction box. One field barrier assembly shall contain:

a) Isolation facilities for isolating the field barrier assembly from fieldbus trunk.

b) Not more than one field device in each spur connection.

c) Internal short circuit protection for each spur (short circuit current <= 45 mA)

d) LED indicator for each spur short circuit.

e) Each spur shall be galvanically isolated from trunk.

f) Fieldbus terminator for each segment shall be inside junction box.

1.7.3 Housing of the fieldbus junction boxes shall be electro polished type SS 316.

1.7.4 Surge protectors on the field side shall be provided whenever specifically mentioned in job specification either within the FFJB or along with the instrument.

1.7.5 Sufficient spacing shall be provided inside the Junction Boxes for mounting of field barrier assemblies, termination and routing of Trunk/ Spur cables to the barrier/Megablocks, sufficient space shall be provided for installing terminator etc. inside the Junction Box.

1.7.6 For spur and trunk cables, 20 % addition cable entries must be provided. Unused entries shall be plugged.

1.7.7 Each junction box shall be provided with sufficient entries with weatherproof, flameproof plugs, as required. Trunk and spur entries shall be from the bottom.

1.8 Instrument Valves and Manifolds

a) Vendor shall supply instrument valves (miniature type) and valve manifolds wherever required. The Impulse pipe/tube connection port shall be ½" NPT(F).

b) The hydrostatic test pressure for instrument miniature valves shall be 153 Kg/cm^{2}g for pipe class upto 600 and whereas for Instrument air lines, it shall be 41 Kg/cm^{2}g. All valves and manifolds shall be forged type only.

c) Valve body and trim material shall be 316 SS unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be of PTFE.

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1.9 Impulse Piping/Tubing

a) Vendor shall supply 1/2" OD x 0.065" thick ASTM A 269 TP 316 L stainless steel seamless tubes with Molybdenum content of minimum 2.5% for impulse lines.

b) Where the pressure (operating) exceeds 70kg/cm2g or if piping is specified as impulse line, seamless pipes of size ¾" NB of required thickness shall be supplied with material as per piping class.

c) Seamless tubes shall have a hardness of max 80 RB as typical.

d) Steam tracing shall be 10 mm OD copper tubes of electrolytic grade copper.

e) Hydrostatic test pressure of instrument tubing shall be as per Annexure-III.

1.10 Pipes and Tube Fittings

a) Vendor shall supply flareless compression type of tube fitting and of three piece construction.

b) The fitting/ferrule hardness shall not be less than HRB 90 so as to ensure a minimum hardness difference of 5 to 10 between tube and fittings. The fitting/ferrule shall be of SS316 material.

c) Socket-weld type forged pipe fittings of suitable material and rating shall be supplied for pipe fittings as per Piping Material Specification. The minimum rating shall be 3000 Lbs. Weld neck fittings shall be used where socket weld type are not allowed by piping class.

d) Brass fittings, wherever used as per job specification, shall be suitable for use on copper tubes conforming to ASTM B68/B68M hardness not exceeding RB 50. All fitting parts shall be manufactured from Brass as per IS-319 bar stock or equivalent and shall be nickel plated.

e) All threaded fittings shall have NPT threads as per ANSI/ASME B 1.20.1only.

f) Hydrostatic pressure of tube fittings shall be as per Annexure-III.

1.11 Pneumatic Signal Tubes

a) Vendor shall supply 6mm OD x 1mm thick SS316L tube for pneumatic signal tubes.

b) Vendor shall avoid use of intermediate connections and shall estimate single length for each instrument location.

1.12 Instrument Air Lines Fittings and Valves

a) Stainless Steel (SS 304) pipes and fittings shall used for instrument air distribution.

b) Isolation valves on instrument air service shall be packless gland type full bore ball valves.

c) Instrument Air Manifold 6 way or 12 way shall be provided by vendor for Air distribution within package.

1.13 Air Filter Regulators

a) Instrument air filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument.

b) The body of the filter shall be anodized aluminum with epoxy paint.

c) The filter shall have 5 micron sintered bronze filter element and shall be provided with manual drain and 2" nominal size pressure gauge.

d) Case material of gauges which are part of air filter regulator shall be SS metallurgy.

e) Vendor to provide removable protective caps/ cover on all gauges pertaining to Air filter regulator.

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1.14 Cable Trays and Cable Ducts

a) All cables on the main pipe rack shall be laid in cable duct. Cable ducts shall be of galvanized mild steel with SS bolts and shall be fabricated as per 'Duct Fabrication-bolted Construction Details' standard No. 7-52-0254.

b) All branch cables/tubes shall run on cable trays. Cable trays shall be perforated Cable Trays.

c) These cable trays shall be made out of galvanized mild steel sheets of minimum 2.5 mm thickness. Ladder trays shall be of galvanized mild steel. 50 mm x 50 mm x 6mm thick angle shall be used as a minimum.

d) The width shall be so selected that 50% of tray space is available for future use.

e) Suitable SS wire cable clamps shall be supplied for binding the cables/tubes at every 500 mm. Nuts/Bolts used for cable trays fixing shall be SS.

f) FRP / GRP cable tray with thickness minimum 4 mm shall be provided when specified.

1.15 Instrument Support/Structural Steel

a) Vendor shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments.

1.16 Heat Tracing and Insulation

a) Heat tracing and insulation of line mounted instrument impulse lines shall be carried out as per line specifications. Similar philosophy shall also be followed for equipment mounted instruments. However, impulse lines for instruments/level instrument in congealing, viscous services shall also be stream traced even though the pipe/equipment not traced.

b) Instruments mounted on jacketed lines and jacketed equipments shall be jacketed only. In case the jacketing of any particular instrument item is not possible, heat tracing may be selected after intimation to Owner/ Owner Representative before proceeding ahead.

c) For all steam traced lines and steam jackets, a suitable type of steam trap must be provided for proper and efficient tracing. Separate dedicated steam trap shall be used for each instrument. Steam trap shall preferably be located on ground level with its outlet connected to drain funnel or as advised elsewhere in the package. Each instrument to be traced shall be provided with steam isolation valve.

d) Wherever electric tracing is shown in the approved P&ID and selected for instruments and instrument lines, this must be suitable for the line operating temperature.

e) Steam tracing shall be avoided inside any room/ or shelter. The heat tracing required for analyzers shall be carried out by electrical tracing using prefabricated tube tracers.

f) Insulation of all in-line instruments like control valves, safety valves etc. shall be done as per the line requirements. Also all direct equipment mounted instruments like level gauge, displacer/float type instruments etc. shall be properly insulated as per insulation requirements of the equipment on which these are installed.

g) The insulation with ¾" dia. Sodium silicate inhibited ceramic fiber rope (SS wire braided) by spiral winding in position, wrapping the rope around piping so as to cover the piping completely without leaving any gap, application of two layers of self adhesive aluminum foil tape (min 0.1 mm thick) spirally wound over the rope surface with the joints in two layers staggered. Ceramic fibre rope shall be of minimum density 250 kg/m^3 shall be made up of ceramic fibre insulation with other properties of ceramic fibre rope confirming to specification "6-44-0002 for hot insulation" work.

h) Steam tracing shall be considered for instrument impulse line for cryogenic services (i.e. operating temperature is less than 0ºC).

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2.0 INSTALLATION

2.1 Vendor shall be completely responsible for installation of all instruments within their battery limit, in line with the installation standards (typical) furnished along with package specification.

2.2 Whenever installation is beyond the scope of vendor/contractor, purchaser shall install the instruments as per the details/documents/drawings provided by the vendor/contractor. However, in such a case it must be ensured that complete installation materials shall be supplied.

2.3 All direct mounted instruments like thermocouples, thermowells, temperature gauges, pressure gauges, pressure switches etc. shall be installed in such a way that they have good readability and accessibility.

2.4 The capillary of all capillary type instruments shall be supported properly and shall be protected against mechanical damage.

2.5 All pressure/differential pressure instruments shall be provided with block and bleed/by-pass, drain/vent valves etc as per the installation standards, and shall have accessibility.

2.6 All primary piping/tubing (impulse lines) shall have a slope of 1 in 12 on the horizontal run.

2.7 All welding shall be carried out as per the relevant codes with proper electrodes. Any testing (non destructive) like DP test and radiography on root weld and final weld shall be carried out as applicable. All consumables shall be part of vendor's scope of supply. Any pre/post weld treatment as required by the relevant codes shall be carried out.

2.8 All threaded joints shall be joined with PTFE tapes only.

2.9 All impulse lines shall be supported at regular intervals (minimum 1.5 meter).

2.10 Instrument drain/vent connections shall be piped to safe area like oily water sewer or above pipe racks to avoid accumulation of hazardous fluid in the plant atmosphere.

2.11 Steam tracing wherever required shall be carried out by 10 mm OD x 1 mm thick copper tubes and condensate traps shall be provided to collect all the condensate and shall be piped to the nearest pipe drain funnels.

2.12 All tubes/cables shall be properly laid on cable trays, which shall be supported at regular intervals. SS cable Tags shall be provided for all cable entering in Instruments and in Junction Boxes for branch as well as Multipair cables.

2.13 Separate routing or physical separation shall be maintained between signal, shut down and power cables.

2.14 The cases of instruments having separate UPS power supply shall be earthed by earthing wire to the nearest earth bus bar for safety reasons.

2.15 In case the cables are to be buried or laid in concrete trench the same shall be carried out by vendor. In case civil work is carried out by purchaser, requirement of trenches shall be provided with prior intimation to client.

2.16 Painting of angle trays, instrument supports and all structural supports shall be carried out as under :-

a) The surface to be painted shall be thoroughly cleaned with brush and sand paper to remove all scales. After cleaning, one coat of red oxide zinc chromate primer shall be given conforming to IS-2074 and allowed to dry. One coat of final paint shall be applied.

Second and final coats of paint of final color shall be given before handing over the plant/ commissioning.

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2.17 Installation of Systems (MMS, Analyzers etc.)

2.17.1 The system as applicable shall be installed by the system vendor who would be responsible for installation and termination of interconnecting cables in the system racks/cabinets. All interconnecting cables shall be identified and the individual cores/wires shall be properly identified using ferrules. Direct-cross ferruling method shall be used for identification.

2.17.2 All system communication cables shall be laid in covered GI (galvanized iron) trays away from power cables. Prefabricated cables shall be avoided for interconnection if these are to be routed out side the cabinets. If unavoidable these should be laid in covered GI trays.

2.17.3 All panels/cabinets shall be properly leveled and secured firmly with the base supporting structure. However, the consoles and printer stands need not be secured to base structure.

2.17.4 Grounding

a) Each cabinet, console and other equipment supplied as a part of system shall have earthling lugs which shall be secured to the 'AC mains earthling bus'.

b) All circuit grounds, shields and drain wires shall be connected to the 'system ground' bus which is isolated from 'AC mains earth'. This bus shall typically be 25 mm wide and 6 mm thick of copper.

The total resistance of system ground shall be less than one (1) ohms unless otherwise recommended by system manufacturer.

c) All Junction Boxes shall be earthed to nearest Earthling point available.

2.17.5 All other installation guidelines as recommended by system manufacturer shall be followed.

3.0 TESTING AND CALIBRATION

3.1 All impulse lines shall be tested hydrostatically at 1.5 times the design pressure /maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.

3.2 In case of special instruments/items where hydro testing is not permitted due to service conditions, the impulse lines testing shall be carried out by using air or nitrogen.

3.3 After pressure testing, all these impulse lines shall be drained and dried with dry air for 15 minutes to remove any traces of moisture, oil and dust.

3.4 Instrument air lines shall be duly tested for any leak after pressurizing and isolating the main root valve by soap solution and bubbler unit. After isolation, the rate of fall in pressure shall be less than 1 kPa for every 4.4 metre (1 psi for each 100 feet) of tubing for a test period of 2 minutes.

3.5 All instrument cables shall be tested for continuity and insulation. While meggering the cables for insulation testing, ensure that all instruments and barriers are isolated at both ends. The megger testing at site is not required to be carried out for the field bus cables and thermocouple extension cables. However, for field bus cables and thermocouple extension cables, the loop resistance and capacitance shall be checked by the contractor before and after completion of cable laying. For all cables from field instruments to Junction Boxes and Junction Boxes to Control cabinets, continuity check to be done.

3.6 All instruments supplied by the vendor shall be calibrated using proper test equipment.

3.7 All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.

3.8 All temperature gauges shall be calibrated using temperature baths.

3.9 All thermocouple activated instruments shall be calibrated by generating milli-volts by a potentiometer.

3.10 All transmitters shall be calibrated as per instrument ranges.

3.11 All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.

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3.12 All alarm and trip switches shall be calibrated over the entire range, finally set and checked for alarm/trip points and reset points as per the alarm/trip set point schedule. After setting, these shall be sealed.

3.13 All control valves, prior to stroke checking, shall be externally cleaned thoroughly. The full stroke of valve shall be checked for opening and closing. Any adjustment required for obtaining full stroke and reducing hysteresis shall be carried out. The hysteresis shall not be more than 1% URV (upper range value) with positioners and 5% URV without positioners. Full stroke check shall be done for on-off valves also.

3.14 Solenoid valve shall be checked functionally for its operation and also compatibility with respect to barrier.

3.15 Safety valves and relief valves shall be set/ tested by using dry air/nitrogen. Leakage if any shall be removed by proper lapping of seat and disc.

3.16 All electronic/pneumatic receiver instruments shall be calibrated as per the manufacturer's instructions. Controllers shall be aligned properly.

3.17 All special instruments like analyzer shall be checked and calibrated as per manufacturer's instructions. Prior to testing, all analyzer sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.

3.18 No oil should be used in oxygen and chlorine service lines.

3.19 After performing the calibration of all instruments, the entire loop shall be checked for proper operation.

3.20 The entire shutdown scheme shall be simulated from the process trip switches/ control system and the scheme shall be tested for its proper operation prior to start up of the unit.

3.21 If no instrument air is available vendor shall provide necessary nitrogen cylinders with suitable regulators to carry out the above activity.

3.22 The delivery of calibration gas cylinders having shelf life shall be staggered in such way that the composition and stability of gas do not deteriorate. Date of supply shall be intimated to the vendor and shall be prior to commissioning.

3.23 Testing Of Systems

3.23.1 All the system functions shall be checked thoroughly for proper functioning. These shall include but not limited to the following tests:

a) Visual and mechanical.

b) Complete system configuration loading.

c) Demonstration of all system functions.

d) Checking of all systems displays.

e) Checking of correct functioning of all keyboards.

f) Demonstration of all system diagnostics.

g) Checking of proper functioning of all printers, hardcopy unit and printing of all reports.

h) Checking of all disc drives.

i) Complete checking of logic system, loading of user's program and checkout of results.

j) Checking of correct changeover of the back-up/redundant units in case of failure of main units.

Vendor shall also carryout the system checks as per respective items specifications wherever provided along with package.

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3.23.2 The input signals shall be simulated by disconnecting the field wires for all inputs. Wherever control room mounted Transmitters/Converters/Receiver switches are used, the functioning of same shall also be checked.

3.24 Loop Checking

3.24.1 Loop checking shall be carried out by vendor, which shall include proper functioning and interconnection of all items in the loop.

3.24.2 All input signals shall be generated in the field and corresponding reading shall be checked at all corresponding displays.

All the outputs shall be checked in the field, by physical verification of valve stroke or operation of solenoid valve/pick-up of electrical contactor.

3.24.3 After loop checking is completed, vendor shall connect back any terminals and connections removed during loop checking.

3.24.4 For fieldbus loops, the segment verification shall be carried out by DCS vendor. Any field side modifications required shall be carried out by vendor.

4.0 COMMISSIONING

4.1 This activity shall be carried out in a systematic manner so as to avoid any accident to plant and operating personnel.

4.2 During the plant start up all the instruments calibration, controller alignment, trip point settings shall be trimmed so as to meet the operation requirements.

4.3 Prior to guarantee run of any package unit, the vital instruments as required by vendor have to be recalibrated and the results recorded.

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1.0 GENERAL

1.1 Material selection chart defines the base material requirements for major instrument items. The materials have been specified as per 'piping class' in which these instruments are installed. Additional requirements like stelliting etc. shall be selected based on process conditions.

1.2 Although materials as specified in Material Selection Chart shall be acceptable, in general, this does not absolve vendor of the responsibility of proper selection of material as per the fluid being handled and process conditions.

1.3 For all instruments in sour service requiring NACE as per Piping class, all materials of construction shall meet the requirements specified in NACE MR 01-03 latest edition. In addition, any other requirements if specified in respective piping class, shall also be complied.

1.4 Impulse pipe material shall be as per the corresponding piping class. However, for Impulse tubing material shall be 316L SS, as a minimum. Better material shall be selected wherever required.

1.5 This gives details of selection criteria for most of the common EIL Piping Classes. However, variations may exist from these in jobs and also new piping classes may arise. In those circumstances, the material selection shall be based on the relevant job piping classes and evaluation of actual requirements**.**

1.6 For testing requirement like Radiography, IBR, NACE, Hydrogen testing, Post weld heat treatment, etc shall be followed as per piping material specification for the respective piping class.

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SL. NO	PIPING CLASS	CONTROL VALVE		PRESSURE RELIEF VALVE		
		Body	Trim	Body / Bonnet	Nozzle / disc	Bellow
1.	A1A, A3A, A5A, A6A, A8A, A9A, A10A, A14A, A19A, A22A, A28A, B1A, B5A, B6A, B9A, B13A, B19A, B28A	A216 Gr. WCB	SS 316	A216 Gr. WCB	SS 316	SS 316L
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A	A216 Gr. WCB *	SS 316L*	A216 Gr. WCB *	SS 316L *	Inconnel *
3.	D23A, D26A	A216 Gr. WCB *	SS 316L Stellited*	A216 Gr. WCB *	SS 316L *	Inconnel *
4.	A2A, B2A, B21A, D1A, D9A, D19A, D2A, D5A, E1A, E2A, F1A, F2A, F5A	A216 G.r. WCB	SS 316 Stellited	A216 Gr. WCB	SS 316	SS 316L
5.	A4A, B4A, D4A	A352 Gr. LCB	SS 316	A352 Gr. LCB	SS 316	SS 316L
6.	A1B, B1B, D1B, D2B	A217 Gr. WC1	SS 316 Stellited	A217 Gr. WC1	SS 316 stellited	SS 316L
7.	A1D, B1D, B5D, D1D, D2D, F2D	A217 Gr. WC6	SS 316 Stellited	A217 Gr. WC6	SS 316 stellited	SS 316L
8.	A4F, B3F, B4F	A217 Gr. C5	SS 321	A217 Gr. C5	SS 321	SS321
9.	A4G, B4G	A217 Gr. C12	SS 321	A217 Gr. C12	SS 321	SS 321
10.	D4G	A217 Gr. C12	SS 321 Stellited	A217 Gr. C12	SS 321	SS 321
11.	A1H, B1H, D1H	A352 Gr. LC3	SS 316 Stellited	A352 Gr. LC3	SS 316 stellited	SS 316L
12.	A1K, A2K, A3K, A22K, B1K, B2K, D2K	A351 Gr. CF8	SS 316	A351 Gr. CF8	SS 316	SS 316L
13.	D2K	A351 Gr. CF8	SS 316 Stellited	A351 Gr. CF8	SS 316	SS 316L
14.	B25K	A351 Gr. CF3	SS 316L Stellited	A351 Gr. CF3	SS 316L stellited	SS 316L
15.	B18K, D18K	A351 Gr. CF8	SS316	A351 Gr.CF8	SS316	SS 316L
16,	A1M, B1M	A351 Gr. CF8M	SS 316	A351 Gr. CF8M	SS 316	SS 316L
17.	A1N, B1N, B6N	A351 Gr. CF3M	SS 316L	A351 GrCF3M	SS 316L	SS 316L
18.	A26N	A351 Gr. CF3M*	SS 316L*	A351 GrCF3M*	SS 316L*	Inconnel*
19.	D26N	A351 Gr. CF3M*	SS 316L Stellited*	A351 GrCF3M*	SS 316L*	Inconnel*
20.	B4K, B5K	A351 Gr. CF10M	SS 304H Stellited	A351 Gr. CF10M	SS 316	SS 316L
21.	A70M, A74M, B70M, B74M	A351Gr. CF8C	SS 321	A351Gr. CF8C	SS 321	SS 321
22	D25M	A351Gr. CF8C	SS 347 Stellited	A351Gr. CF8C	SS 347 Stellited	SS 347
23.	A11K, B11K	A351Gr. CF3	SS316L	A351Gr CF3	SS316L	SS 316L

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S. NO	PIPING CLASS	ORIFICE/SENIOR ORIFICE		FIELD TRANSMITTER	
		Flange/Body	Plate	Body	Sensor
1.	A1A, A3A, A6A, A8A, A9A, A10A, A14A, A19A, A22A, B1A, B21A, B6A, B9A, B13A, B19A, D1A, D9A, D19A, E1A, F1A,	A105	SS 316	SS 316	SS 316L
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105 *	SS 316L*	SS 316*	SS 316L*
3.	A2A, B2A, D2A, E2A, F2A,	A105	SS 316	SS 316	SS 316L
4.	A4A, B4A, D4A	A350 GrLF2	SS 316	SS 316	SS 316L
5.	A1B, B1B, D1B, D2B	A182 GrF1	SS 316	SS 316	SS 316L
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	SS 316	SS 316	SS 316L
7.	A4F, B3F, B4F	A182 GrF5	SS 321	SS316	SS321 or Hastelloy-C
8.	A4G, B4G, D4G	A182 GrF9	SS 321	SS316	SS321 or Hastelloy-C
9.	A1H, B1H, D1H	A350 GrLF3	SS 316	SS 316	SS 316L
10.	A1K, A2K, A3K, A22K, B1K, B2K, D2K	A182 GrF304	SS 316	SS 316	SS 316L
11.	B25K	A182 GrF304L	SS 316L	SS 316	SS 316L
12.	B18K, D18K	A182 GrF304	SS 316	SS 316	SS 316L
13.	A1M, B1M	A182 GrF316	SS 316	SS 316	SS321 or Hastelloy-C
14.	A1N, A26N*, B1N, B6N, D26N*	A182 GrF316L	SS 316L	SS 316	SS 316L
15.	A5A, B5A, D5A, F5A, F25A Note-1	A105	SS316	SS 316	SS316L with gold plated
16.	B4K, B5K	A182 GrF304H	SS 316	SS 316	SS 316L
17.	A70M, A74M, B70M, B74M	A182GrF321	SS321	SS316	SS321 or Hastelloy- C
18.	D25M	A182GrF347	SS347	SS316	SS316L with gold plated
19.	A11K, B11K	A182GrF304L	SS316L	SS316	SS316L

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S. NO	PIPING CLASS	THERMOWELL		LEVEL INSTRUMENT
		Flange	Well	Cage/ Chamber
1.	A1A, A3A, A6A, A8A, A10A, A14A, A19A, A22A, B1A, B21A, B6A, B9A, B13A, B19A, D1A, E1A, F1A, A5A, B5A, D5A, D9A, D19A, F5A	A105	SS 316	A106 Gr. B
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105 *	SS 316L	A106 GrB*
3.	A2A, B2A, D2A, E2A, F2A	A105	SS 316	A106 GrB
4.	A4A, B4A, D4A	A350 GrLF2	SS 316	A333 Gr6
5.	A1B, B1B, D1B, D2B	A182 GrF1	SS 316	A335 GrP1
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	SS 316	A335 GrP11
7.	A4F, B3F, B4F,	A182 GrF5	SS 321	A335 GrP5
8.	A4G, B4G, D4G	A182 GrF9	SS 321	A335 GrP59
9.	A1H, B1H, D1H	A350 GrLF3	SS 316	A333, Gr3
10.	A1K, A2K, A22K, A3K, B1K, B2K, D2K	A182 GrF304	SS 316	A312 GrTP304
11.	B25K	A182 GrF304L	SS 316L	A312 GrTP304L
12.	B18K, D18K	A182 GrF304	SS 316	A312 GrTP304
13.	A1M, B1M	A182 GrF316	SS 316	A312 GrTP316
14.	A1N, B1N, B6N, A26N*, D26N*	A182 GrF316L	SS 316L	A312 GrTP316L
15.	B4K, B5K	A182 GrF304H	SS 304H	A312 GrTP304H
16	A70M, A74M, B70M, B74M	A182 GrF321	SS321	A312 GrTP321
17.	D25M	A182 GrF347	SS347	A312 GrTP347
18.	A11K, B11K	A182 GrF304L	SS316L	A312 GrTP304L

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SL. NO	PIPING CLASS	LEVEL GAUGE			PRESSURE, DIFFERENTIAL PRESSURE AND VACUUM GAUGE	
		Chamber	Cock Body	Cock Trim	Sensing Element / Socket	Diaphragm
1.	A1A, A3A , A6A, A8A, A10A, A14A, A19A, A22A, B1A, B6A, B9A, B13A, B19A, B21A, D1A, D9A, D19A, E1A, F1A, A5A, B5A, D5A, F5A	A105	A105	SS 316	SS 316	SS 316
2.	A16A, A23A, A26A, A68A, B16A, B23A, B24A, B26A, B68A, D23A, D26A	A105*	A105*	SS 316L*	SS 316*	SS 316L*
3.	A2A, B2A, D2A, E2A, F2A	A105	A105	SS 316	SS 316	SS 316
4.	A4A, B4A, D4A	A350 GrLF2	A350 GrLF2	SS 316	SS 316	SS 316
5.	A1B, B1B, D1B, D2B	A182 GrF1	A182 GrF1	SS 316	SS 316	SS 316
6.	A1D, B1D, B5D, D1D, D2D, F2D	A182 GrF11	A182 GrF11	SS 316	SS 316	SS 316
7.	A4F, B3F, B4F	A182 GrF5	A182 GrF5	SS 321	SS 316	SS 321 or Hastelloy or Inconel
8.	A4G, B4G, D4G	A182 GrF9	A182 GrF9	SS 321	SS 316	SS 321 or Hastelloy or Inconel
9.	A1H, B1H, D1H	A350 GrLF3	A350 GrLF3	SS 316	SS 316	SS 316
10.	A1K, A2K, A22K, A3K, B1K, B2K, D2K	A182 GrF304	A182 GrF304	SS 316	SS 316	SS 316
11.	B25K	A182 GrF304L	A182 GrF304L	SS 316L	SS 316	SS 316
12.	B18K, D18K	A182 GrF304	A182 GrF304	SS 316	SS 316	SS 316
13.	A1M, B1M	A182 GrF316	A182 GrF316	SS 316	SS 316	SS 321 or Hastelloy or Inconel
14.	A1N, B1N, B6N, A26N*, D26N*	A182 GrF316L	A182 GrF316L	SS 316L	SS 316	SS 316L
15.	B4K, B5K	A182 Gr. F304H	A182 GrF304 H	SS 304H	SS 316	SS 316
16.	A70M, A74M, B70M, B74M,	A182Gr. F321	A182Gr F321	SS321	SS 316	SS 321 or Hastelloy or Inconel
17.	D25M	A182Gr. F347	A182Gr F347	SS347	SS 316	SS 347 or Hastelloy or Inconel
18.	A11K, B11K	A182Gr. F304L	A182Gr F304L	SS316L	SS 316	SS 316L

Notes:

* Material shall be hardness controlled and shall comply with NACE MR-0103 latest edition.

1. For Hydrogen service wetted part material for switches, transmitters shall be SS 316L gold plated, base material Hastelloy shall be avoided

2. SS 316L, SS 316Ti are also acceptable in place of SS316.

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ANNEXURE-II

1. Format of Instrumentation Index
2. Format of Point Data Base
3. Format for Functional Schematics
4. Format For cable Schedule (Non-FF)
5. Format For cable Schedule (FF)
6. Format for Logic Diagram
7. Format for Electrical/Instrumentation interface
8. Format for FF instrument details

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Instrument Index

Tag no.	Fluid	Description	Location- Line No. Equipment No.	P&ID No.	Data Sheet No.	P.R. No.	Inst. Loc. Drawing No.	Installation Std. No.	Tubing Hook up No.	Steam Tracing Std. No.	Bill of Material No.	Functional / Loop Schematic No.	Remarks

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EIL-1651-599 REV.1 A4-210X297

POINT DATA BASE FOR

LOCATION : LOOPTYPE :

Tag Number		PID	Service	System	MCC	INPUT SIGNAL TYPE	Loop Type	Min Inst Range	Max Inst Range	Engg Unit	Control Action	Fail Position	SET POINT FOR ALARM				TEMP SENSOR		Contact_Status on Actuation	FS/ LOGIC DWG	IS/ NON-IS	Interlock No.	REMARKS	Note ID
Tag_Number	System Tag												HIGH	LOW	HIGH_HIGH	LOW_LOW	Type	Burnout Status						

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REV.	DATE				

FIELD

CONTROL ROOM

TAG NUMBER	AL	AH	ALL	AHH	REMARKS

SV2FS1

EIL ENGINEERS INDIA LIMITED
NEW DELHI

PLANT –
UNIT–
CLIENT–

DRAWING NUMBER | REV
FUNCTIONAL SCHEMATIC
SHEET 1 OF 1

Signal/Alarm/Control Cable Schedule

Junction box location Col.- Grid-
Ref. Inst. Location Plan No.-

Multicable _____ Length _____ Type _____ Size _____ Overall Dia. _____

Drum No. _____ Colour _____

Local					Multi Cable Pair No.	Control Room / Satellite Rack Room												Remarks
						Barrier/Marshalling Cabinet No.			I/O Cabinet No.			HW Console / HW Panel No.			System Cabinet No.			
From	To	Jn.Box Terml	Type	Length m		Terml. No. (H)	Barrier No.	Terml. No. (S)	Terml. No. (I)	Module No.	Terml. No. (O)	Terml. No.	Inst. No.	Terml. No.	Terml. No.	Module No.	Pre Fab Cable No.	

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NEW DELHI

PLANT-

CLIENT- UNIT-

REV	DATE	BY	CHK`D	APPD		DRAWING NO.

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Fieldbus Signal Cable Schedule

FFJB NO.:- **Trunk Length** Mtrs. **Type** Size Dia-

Segment No. Drum No. Control Room JB Location:

Local					Control Room				
					Marsh. Cabinet:			Sys. Cabinet	
Tag No.	**Barrier no.**	Terminal No.	**Spur Length m**	**Spur Cable Type**	**Terminal No.**	**Surge Protector**	**FFPS NO.**	**H1 Card No.**	**Remarks**
		1 +							
		1 -							
		S							
		2 +							
		2 -							
		S							
		3 +							
		3 -							
		S							
		4 +							
		4 -							
		S							
		1 +							
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		S							
		3 +							
		3 -							
		S							
		4 +							
		4 -							
		S							

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Project:					Document No.
Unit:-					
Client:					
Unit no:-	Rev	Prep. By	Checked by	Appd	SHT. ___ OF __

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EIL – 1641–505 A3–297 x 420

TAG NO.	ACTUATING DEVICE					LOGIC DESCRIPTION	FINAL CONTROL ELEMENT					
	SERVICE ABNORMAL CONDITION	LOCATION	CONTACT STATUS BENCH	CONTACT STATUS NORMAL	SYMBOL		SYMBOL	ELEMENT	ACTION	LOC.	SERVICE	TAG NO.

ENGINEERS INDIA LIMITED
NEW DELHI

PLANT:–
UNIT:–
CLIENT:–

DRAWING NO.	REFERENCE DRAWING	NO.	DATE	REVISIONS	BY	CH.	APPROVALS

LOGIC DIAGRAM

DRAWING NO.	REV.

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

Document No.
XXXX-XX-16-51-ED55 Rev.0

EI interface details

	1	2	3	4	5	6	7	8	9	10	11	12	13
Sl. no.	Equipment tag no.	Equipment description	Motor/ Electrical heater rating (kW)	Electrical Location	Signal tag no.	Description	P&ID NO	Interlock No	Command (C) / Status (S)	Analog (4-20mA) / Contact (Pot-free) / Serial	Control system	Sub-System	Control system location
1	110-PA-101A	BFW PUMP	100	SS# 01	1110-XL-1011	PUMP RUNNING	1101		S	S	DCS	1	SRR #01
					1110-XL-1011	PUMP RUNNING			S	C	RIO-PLC	1	SRR #01
					1110-PA-101ASTP	PUMP STOP			C	C	RIO-PLC	1	SRR #01
					1110-PA-101ASTR	PUMP START			C	C	RIO-PLC	1	SRR #01
					1110-PA-101ASTRP	START PERMISSIVE			C	C	RIO-	1	SRR #01
					110-PA-101AREM	PUMP IN REMOTE				C	DCS	1	SRR #01
					110-SY-1011	SPEED CONTROL TO VFD			C	A	DCS	1	SRR #01
					110-SI-1011	SPEED INDICATION			S	A	DCS	1	SRR #01
					110-HS-1011A	START PUSH BUTTON ON DCS CONSOLE			Note-2.4		DCS	1	SRR #01
					110-HS-1012B	Stop PUSH BUTTON ON HWC			Note-2.4			1	SRR #01
					110-HS-1012C	LCP STOP			Note-2.4		LCP	1	DIERCT TO SS
					11-HS-1012D	FIELD STOP (15m AWAY)			Note-2.4		PLC	1	SRR# 01

Legend

EI interface	Electrical - Instrumentation interface signals	SRR	Satellite Rack Room
MCC	Motor Control Center	CR	Control Room
VFD	Variable Frequency Drive / Variable Speed Drive	S/S	Sub-station (Electrical)
DCS	Distributed Control System	CCR / MCR	Central Control Room / Main Control Room
PLC	Programmable Logic Controller	MOV	Motor Operated Valve
LCS	Local Control Station (Electrical)	RIO	Remote IO cabinet of DCS/PLC located in Electrical sub-station
P&ID	Piping and Instrument Diagram	DC	Data concentrator
LCP	Local Control Panel	C&E	Cause & Effect diagram

Note - Tag numbers have been provided in this document for vendor's understanding. While preparing the EI interface details, vendor shall fill the table using tag numbers relevant to the package.

EI interface philosophy

1 **Unit wise allocation of Control Room (CR) / Satellite Rack Room (SRR) and Sub-Stations (S/S)**

Unit no.	Unit name	CR / SRR	S/S no.

2 **Interface signals and cabling philosophy**

2.1	All signals shall be hardwired or serial as identified in E&I interface column-10
2.2	Following cable segregation to be ensured: i. Between DCS and PLC ii. Between Commands and Status Iii. Between Analog (AI/AO) and Contact (DI/DO) type signals
2.3	Separate cable shall be used for package vendor supplied control systems (as identified in E&I interface document).
2.4	Wherever there are both manual stop from DCS/PLC and a logic trip, the manual stop shall be clubbed with the logic trip at DCS/PLC end and only one contact (common) shall be provided to Electrical. However, licensor specifications / P&ID requirements (if any) shall govern & same be indicated in E&I interface document.
2.5	Unless otherwise indicated in E&I interface, Instrumentation's stop command for all motors, drives, etc shall be stay-put type. Electrical's circuit shall be designed to inhibit the motor / drive from starting as long as stop command is maintained / active.

3 **Interface signal ratings *(kW/Voltage rating indicated is in general rating, however actual kW rating shall be as per approved EDB (Elect))**

3.1	Instrumentation's contact ratings for discrete outputs from Inst. (i.e. commands): LT (contactor feeder): 240 VAC, 5A (motor rating ≤ 55kW) LT (breaker driven): 220 VDC, 2A/ 110 VDC, 0.1A (55kW < motor rating ≤ 160kW) HT (breaker driven): 220 VDC, 2A/110 VDC, 0.1A (motor rating > 160kW) For these above commands, Instrumentation's contact shall be potential-free.
3.2	Electrical's contact ratings for discrete inputs from Elect. (i.e. status / indications) shall be 24 VDC, 2A, i.e. Instrumentation shall interrogate by 24VDC.
3.3	All 4-20mA 2-wire isolated signals suitable for 600Ω load shall be provided for current, voltage, power, speed, etc. for commands/feedbacks. Such motors shall be identified in the E&I Interface.

4 **Type of start / stop signals**

	Type of signal	Type of contact	Remarks
4.1	Start command	NO (All drives)	Close to start, pulse of 2s duration
4.2	Stop command	NC (up to 55 kW)	Open to stop, stay-put type
4.3	Stop command	NO (above 55 kW)	Close to stop, stay-put type
4.4	Status Indication	NO	Close to indicate running status
4.5	Start Permissive	NO	Close to permit start, stay-put type
4.6	VFD	Shall be as per vendor's requirement which shall be intimated by Electrical	

5	**Local / Remote (L/O/R) selector switches on LCS**
5.1	Wherever electrical equipment is being remotely-started from control room as indicated in EI-interface document above, L/O/R shall be provided in LCS by Electrical. Instrumentation may not explicitly identify L/O/R in EI interface document. This L/O/R along with the default LCS start/stop shall be directly wired to MCC / PCC / HT switchgear by Electrical. These switches may also be indicated as H-O-A (Hands-Off-Auto) for some units based on licensors' terminology / P&ID depiction.
5.2	Remote starting from control room shall only be possible when L/O/R switch is in 'R' position.
5.3	Stop / trip command from control room shall be possible irrespective of L/O/R switch's position.
5.4	Electrical shall consider L/R switch in LCS as defualt. Instrumentation shall use remote start as per P&ID / C&E diagram
6	**Auto / Manual (A/M) selection**
6.1	Wherever A/M selection is required, it shall be in the control system with no separate contact to Electrical.
6.2	For VFD controlled motors, the A / M selector switch shall be provided in VFD. In case of 'A' mode, the speed control shall be through the 4-20mA signal from DCS; In case of 'M' mode the speed shall be adjustable from VFD / LCS. The VFD / LCS selector switch shall be located in VFD panel unless otherwise specified as per Client's philosophy.
7	**Variable speed drives**
7.1	Separate 4-20 mA hardwired signal (isolated) for feedback of speed, current, power, etc from VFD to DCS/PLC shall be provided for drives identified in E&I Interface. Cable by Elect
7.2	Separate 4-20 mA hardwired signal for speed reference from DCS to VFD shall be provided for drives identified in E&I Interface. Cable by Elect
7.3	Serial interface shall be provided, wherever required. Instrumentation will identify all such drives in E&I Interface document. Serial interface Cable by Inst
8	**Motor operated valves**
8.1	MOV status: Potential-free contacts (NO type, 24 VDC, 2A) from field (MOV limit-switches) for open and close
8.2	MOV command: Potential-free contacts (NO type, 24 VDC, 2A) to field (MOV actuator) for open, close and jog.
8.3	Supply, routing and laying of cables up to respective control room for all status and commands shall be by Electrical.
9	**RTD/BTD**
9.1	Electrical to provide list of motors that require RTD/BTD to be connected to DCS in the motor list provided to Instrumentation
10	
10.1	"contact" and "Analogue" are all hardwired signals and "serial" interface is soft signal.
10.2	"Contact" & "Analogue" signal cabling shall be by Elect while Serial interface cabling shall be by Instrumentation
11	**Soot blower PLC**
11.1	Signal cable to PLC and PLC to DCS, Field to SRR will be by INST. All other cables from Field to Substation by ELECTRICAL

Sl.No	Make (Vendor Name)	Model no	Device ID	Device Tag	Node Address	Device Type	Device Class	Device Revision	DD Revision	CFF Revision	PID function required (yes/no)	FF transducer HI	FF transducer LO	FF transducer Unit	L- Type	Downloadable file
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

Note : - **Node Address data will be communicated to the Device vendor after finalization of segment loading.It is Device Vendor's responsibility to incorporate this data in the device before Supply**

Device Type :- Manufacturer's model number associated with the resource - used by interface devices to locate the DD file for the resource

Device Revision :- Manufacturer revision number associated with the resource - used by an interface device to locate the DD file for the resource

DD Revision : - Revision of the DD associated with the resource - used by an interface device to locate the DD file for reference.

L-Type : - Determines if the values passed by the transducer block to the AI block may be used directly (**Direct**) or if the value is in different units and must be converted linearly (**indirect**) , or with square root (**IND Sqr Root**), using the input

Transducer HI,LO Scale & Unit :- The high and low scale, engineering units code, and the number of digits to the right of the decimal point used with the value obtained from the transducer for a specified channel.

ANNEXURE-III

1. Hydrostatic Test pressure for Instrument Tubing
2. Hydrostatic Test pressure for Instrument Tube Fittings

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1. Hydrostatic Test Pressure for Instrument Tubing

Sr. No.	Size of Tube (OD)	Material	Line Pressure Class (lbs per sq. inch)	Thickness	Maximum Working Pressure	Hydrostatic Test Pressure
1	1/8", 3mm	Stainless Steel	≤ Class 600	0.028" (0.8mm)	102 Kg/cm^2g	153 Kg/cm^2g
2	¼", 6mm	Stainless Steel	≤ Class 600	1.00mm	102 Kg/cm^2g	153 Kg/cm^2g
			≥ Class 900 to ≤ Class 1500	0.065" (1.65mm)	253 Kg/cm^2g	383 Kg/cm^2g
3	5/16", 8mm	Stainless Steel	≤ Class 600	0.049" (1.2mm)	102 Kg/cm^2g	153 Kg/cm^2g
4	3/8",10mm	Stainless Steel	≤ Class 600	0.049"(1.2mm)	102 Kg/cm^2g	153 Kg/cm^2g
5	½",12mm	Stainless Steel	≤ Class 600	0.049" (1.2mm)	102 Kg/cm^2g	153 Kg/cm^2g
			≥ Class 900 to ≤ Class 1500	0.065" (1.65mm)	253 Kg/cm^2g	383 Kg/cm^2g
6	¾", 20mm	Stainless Steel	≤ Class 600	0.049" (1.2mm)	102 Kg/cm^2g	153 Kg/cm^2g
			≥ Class 900 to ≤ Class 1500	0.065" (1.65mm)	211 Kg/cm^2g	317 Kg/cm^2g
7	1", (25mm)	Stainless Steel	≥ Class 900 to ≤ Class 1500	0.095" (2.5mm)	211 Kg/cm^2g	317 Kg/cm^2g
8	3/8",10mm	Copper	≤ Class 300	0.049"(1.2mm)	53 Kg/cm2g	80 Kg/cm2g
9	¼", 6mm	Copper	≤ Class 300	1.00mm	53 Kg/cm2g	80 Kg/cm2g

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2. Hydrostatic Test Pressure For instrument Tube Fittings

Sr. No.	Size of Tube Fittings	Material	Line Pressure Class	Maximum Working Pressure	Hydrostatic Test Pressure
1	6mm and ½"	Stainless Steel	≤ Class 600	102 Kg/cm^{2}g	153 Kg/cm^{2}g
2	6mm and ½"	Stainless Steel	≥ Class 900 to ≤ Class 1500	253 Kg/cm^{2}g	383 Kg/cm^{2}g
3	¼" and 3/8"	Brass	≤ Class 300	53 Kg/cm^{2}g	80 Kg/cm^{2}g

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इंस्ट्रूमेंटेशन इरेक्शन वर्क्स के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR INSTRUMENTATION ERECTION WORKS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	19.03.24	Revised and Reissued as Standard Specification	AT/RS	AJS	MN	MN
3	17.01.19	Revised and Reissued as Standard Specification	HMX	MN	RG	RKT
2	25.04.13	Revised and Reissued as Standard Specification	MA	RG	RP/JMS	DM
1	16.10.07	Revised and Reissued as Standard Specification	RP	TGM	HCJ	VC
0	17.07.97	Issued as Standard Specification	RK	BRS	RB	AS

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Abbreviations:

ERTL	Electronics Regional Testing Laboratory
FRP	Fiberglass Reinforced Plastics
GRP	Glass Reinforced Plastics
HDPE	High Density Poly Ethylene
IDEMI	Institute for Design of Electrical Measuring Instruments
MCT	Multi Cable Transit
MS	Mild Steel
SS	Stainless Steel
NABL	National Accreditation Board for Testing and Calibration Laboratories
NPL	National Physical Laboratory
PMI	Positive Material Identification
PTFE	Poly Tetra Fluoro Ethylene
PVC	Poly Vinyl Chloride

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
Mr. Arupjyoti Saikia
Mr. Sachin Garg
Ms. Rimpa Saha Chakraborty
Mr. Ankit Tiwari
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Mr. Gaurav Kumar
Mr. Ravindra Kumar Gupta (Projects)

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1.0 GENERAL

1.1 This standard specification covers in general the scope of work, scope of supply, execution methodology and criteria for handling scrap and excess material and various other requirements, which are required to be met during the course of execution of instrumentation works.

1.2 Instrumentation works shall be performed in accordance with this technical specification and various other drawings and documents supplied during the execution of work and instructions of Engineer-in-charge or his authorized representative(s) from time to time during the progress of the work.

1.3 Standards

The instrumentation erection and calibration works shall be carried out in accordance with various National, International and Indian Standards for instrumentation listed below but not limited to the following. The standards referred to herein and mentioned below shall be of the latest editions unless otherwise specified:

API	American Petroleum Institute	
	MPMS	Manual of Petroleum Measuring Standards
	RP	Recommended Practices
	RP 551	Process Measurement Instrumentation
	RP 552	Transmission Systems
	RP 554	Process Instrumentation and Control
ASME	American Society of Mechanical Engineers	
	B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
	B16.11	Forged Fittings, Socket-Welding and Threaded
	B16.20	Ring Joint Gaskets and Grooves for Steel Pipe Flange
	B16.47-B	Large diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard
	B31.1	Power Piping ASME Section 1 Boiler and Pressure Vessel Power Boilers
	B31.3	Process Piping
	B1.20.1	Pipe Threads General Purpose, Inch
BS	British Standards	
	6739	Code of practice for instrumentation in process control systems: installation design and practice
EN	European Standard	
	10204	Inspection Documents for Metallic Products
ISA	International Society of Automation	
	Standards, Recommended Practices and Technical Reports	
	RP 7.1	Pneumatic Control Circuit Pressure Test
	ISA S5.1	Instrument Symbols and Identification

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IS/IEC	Indian Standards/International Electro Technical Commission
	IS/IEC 60079 Electrical Apparatus for Explosive Gas Atmospheres
	IS/IEC 60529 Degree of protection provided by Enclosures (IP code).
	IEC 60028 International Standard of Resistance Cooper
	IEC 60085 Electrical Insulation — Thermal Evaluation and Designation
	IEC 60228 Conductors of Insulated Cable
	IEC 60331 Fire Resisting Characteristics of Electric Cables
	IEC 60332 Tests on electric and optical fibre cables under fire conditions Part 1-1: Test for vertical flame propagation for a single insulated wire or cable - Apparatus Parts and Sections
ISO	International Standards Organization
	ISO 9001 Quality Management Systems
7-52-0253	Duct Fabrication – Welded Construction Detail
7-52-0254	Duct Fabrication – Bolted Construction Detail
7-52-xxxx	Instrumentation Installation Standards and Instrumentation Supports Standards attached with the tender
	Manufacturer's standards and practices
6-44-0016	Specification for Non-Destructive Examination requirements of Piping
6-77-0001	Welding Specification for Fabrication of piping
6-77-0005	Welding Specification Charts for piping classes
6-79-0020	Standard Specification for Surface Preparation and Protective Coating (New Construction)
6-82-0001	Standard specification for health, safety and environmental management at construction sites
6-82-0002	Standard Specification for Positive Material Identification (PMI) at Construction Sites
6-82-3400	Inspection and test plan (ITP) for field instrumentation works (item rate contracts-with categorization)
6-82-6100	Standard quality assurance plan (for item rate contracts)

2.0 DEFINITIONS

2.1 Close coupled Installation

The installations where the distance of the instrument is within 600 mm from the primary tapping are termed as close coupled installations.

2.2 Remote Installation

The installations where the distance of the instrument is more than 600 mm from the primary tapping are termed as remote installations.

2.3 Pre-fabricated Hook-up Installation

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The installation hook-up shall be standard bought-out complete engineered, integrated and pre-hydro tested assembly, consisting of isolation / block valves, fittings, 2-valve/ 3 valve/ 5 valve manifolds in 316 SS metallurgy as a minimum and ready to install at site by welding with pipe/flange assemblies having different material like Carbon Steel etc.

2.4 Manifold

2.4.1 For close coupled installation, 'Manifold' shall mean complete piping of instruments after first block valve upto the instruments.

2.4.2 For remote installation, 'Manifold' shall mean the assembly of nipples, pipes, valves and fittings after the first block valves upto the instrument. Wherever the instruments are installed with integral 2-way, 3-way or 5-way valve manifold, the definition shall not be applicable as they are considered part of the instrument.

2.5 Instrument Impulse Line

Instrument impulse line shall mean piping and/or tubing from the first block valve upto the instrument including for drains and vent as applicable for an installation.

2.6 First Block Valve

First block valve shall mean the valve/valves, which are generally mounted directly on equipments, columns, vessels, pipes, standpipes etc. and shall be operated to isolate the instrument and interconnected instrument impulse lines.

2.7 Supports

Supports shall mean the Mild Steel angles, flats, channels which are generally provided to support the main cable trays, cable ducts, junction boxes, angle trays, perforated trays, instrument piping, signal tubing, instrument air supply lines, steam tracing tubing, diaphragm seal capillary tubing etc., at specified intervals from the instruments, concrete columns etc., to keep all items firmly secured against vibration, warping, bending etc.

2.8 Instrument Stanchion

Instrument stanchion shall mean the mounting arrangement necessary for the installation of one or more instruments and junction boxes. This shall consist of pipes, supports, clamps and fasteners as per applicable standards.

2.9 Scrap

2.9.1 Salvageable Scraps

Salvageable scrap shall mean the cut piece lengths recovered after consumption of tubes, pipes, single pair/multipair cables, other cables etc. that can be used one time or the other at a later date.

2.9.2 Non Salvageable Scrap

Non-salvageable scrap shall mean the cut piece lengths recovered after consumption of tubes, pipes, single pair/multipair cables, cables etc. that cannot be used at all, at any time.

3.0 SCOPE OF WORK

3.1 Contractor's scope of work shall include the following:

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3.1.1 Complete instrumentation erection works with details as listed under schedule of quantities attached elsewhere in the tender document.

3.1.2 Supply of all hardware such as lugs, ferrules, U-clamps, washers, nuts, sealant, sealing tape, anchor fasteners, welding electrodes/filler wires, NDT test materials/Dye penetrant spray etc and carry out all residual activities not listed specifically in schedule of quantities but are necessary to ensure proper execution and completeness of instrumentation works.

3.1.3 Supply of all items specifically listed in the schedule of quantities as per specifications attached elsewhere in the tender document.

3.1.4 As-built construction drawings and documents as detailed out in this specification

3.1.5 Arranging all necessary test and calibration equipments as per the details provided in this specification.

3.1.6 To ensure proper execution and completeness of works, any or all, of the following activities, as necessary, shall also form part of the contractor's scope of work. The price of all such activities shall be covered in the rates quoted against the various activities covered under schedule of rates.

3.1.6.1 Fabrication of pipe nipples, as necessary, from the running pipe including cutting of pipes and making threads as necessary, as per installation standards.

3.1.6.2 Drilling of holes in blind flanges including threading, bolt tensioning as necessary, as per installation standards, wherever required.

3.1.6.3 Filling of seal pots and/or impulse lines, as applicable, with filling liquids as per the instructions of engineer-in-charge including supply of seal fill liquid.

3.1.6.4 Seal welding of screwed fittings and screwed connections as required by standards or as per the instructions of Engineer-in-charge. This may involve welding of dissimilar materials using appropriate electrodes/filler wires.

3.1.6.5 Dye penetration/magnetic particle test shall be carried out for all weld joints irrespective of their pipe classes and the charges for the same shall be included in the quoted rates of instrument installation.

3.1.6.6 Installation of devices like purge rotameter, restriction orifice plate, pressure gauge etc, as applicable for purged installation, for instruments, instrument systems and pipelines as per installation standards.

3.1.6.7 Civil works including casting of foundation as required for instrument supports, stanchions etc, where paved surfaces do not exist and supply of anchor bolts/ fasteners.

3.1.6.8 Minor civil works like chipping of pavement, grouting of instrument panels/supports/stanchions on the pavement, laying of conduits below pavement after chipping and refinishing of pavement as necessary. Contractor's scope shall include making holes in the RCC for fixing up of supports for instrumentation items, trays, JB frames etc.

3.1.6.9 Sealing of cables/tubes entries into the control room after laying and testing of all cables/ tubes by filling with sealing compound including supply of sealing compound. Wherever the sealing of cables/tubes entries into the control room is through MCT frame/blocks, fixing of MCT frame and blocks shall be also carried out by contractor as covered in the schedule of quantities.

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3.1.6.10 Degreasing of handwheels of control valves, stud bolts, nuts of side and bottom flange of control valves, stud bolts and nuts of orifice flanges/ or other primary elements and degreasing of any other instrument as per manufacturer's instructions or as required by Engineer-in-charge.

3.1.6.11 Degreasing of impulse lines, instrument valves, instruments and other instrument items in oxygen and chlorine service as per manufacturer's instructions or as required by engineer-in-charge.

3.1.6.12 Rotation of top works of displacer type level instruments, wherever required.

3.1.6.13 Rotation of control valve and on-off valve/shutdown bonnet etc, wherever required.

3.1.6.14 Reversing the action of control valves either by replacement of actuator springs and accessories or positioner, wherever required, as per manufacturer's instructions.

3.1.6.15 Minor modifications/repairs required to be carried out on the instruments namely, replacement of dial and/or glass for pressure gauges/temperature gauges or any other similar instruments, replacement of rotameter tubes and level gauge glasses, replacement of damaged signal tubes on control valves, rectification/ replacement of tubes in fire-safe boxes, rectification in fire jacket enclosures, canopies for transmitters & JB, instrument air manifolds etc., tapping of damaged threads on couplings, tees and other fittings, cleaning of nozzles and relays in pneumatic instruments.

3.1.6.16 Painting of all structural supports required for trays, pipes, junction boxes, instruments, ducts as per painting specification or as instructed by Engineer-in-charge.

3.1.6.17 Identification of instruments/impulse lines/manifold connected with trip circuit in red color of paint or as per painting/colour philosophy of the project.

3.1.6.18 Punching of tag numbers and supply of stainless-steel tag plates wherever required as per instructions of Engineer-in-charge.

3.1.6.19 Fabrication and installation of pipe stanchion as per instrument support standards including casting of concrete pedestal, grouting, welding etc. as necessary. The type of instrument stanchions shall be at the discretion of Engineer-in-charge. Contractor's scope shall include installation of ISMC for Junction box installation, wherever any column/structure not available. This includes providing anchor/ fasteners/ welding of base plate etc.

For installation of instruments on Pre-fabricated hookups, Contractor's scope shall include erection of supports on the main pipeline wherever required, as per the respective installation standards and as per the instruction of Engineer-in-charge. Field transmitter supports should be properly clamped to the pipe for prefabricated and closed couple installation wherever required. No air gap shall be kept between support clamp and pipe.

3.1.6.20 Drilling holes in the gland plate for providing glands/grommets on panels/ cabinets, local control panels, pneumatic enclosures, junction boxes etc., wherever required for cables/multitubes entry and sealing of spare holes.

3.1.6.21 Grounding the shields of shielded cables to respective instrument earth bus- bar provided in the control room/local control room/local panel/analyzer shelter/thermocouple head etc. as required and instructed by Engineer-in-charge.

3.1.6.22 Laying and termination of earth cable at instrument earth bus-bar provided in the control room/local control room/local panel to instrument earth pits provided by other contractors unless specified otherwise.

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3.1.6.23 Grounding of one of the thermocouple lead in the head using 10K ohm resistance including supply of resistance for grounded thermocouples.

3.1.6.24 Loop validation of all temperature elements (Thermocouples/RTDs) up to control room/ transmitters including verification of element integrity, i.e. element open or element short and shall be included in the installation of temperature element.

3.1.6.25 Supply of all types of consumables required for the execution of the job without any exception.

3.1.6.26 Sealing of safety valves with standard lead seals after final setting and fixing of blind tapes in inlet/outlet of safety valves to prevent dust, in the presence of Engineer-in-charge.

3.1.6.27 Coordination during installation, pre-commissioning and commissioning with mechanical and other sub-contractors for proper installation including verification of location and flow direction of line mounted instruments like control valves, on-off/shutdown valves, orifice assemblies, turbine meters, positive displacement meters, magnetic flowmeters, mass flowmeters, ultrasonic flowmeters etc. This shall also involve removal of instruments, disconnection of tubes/cables, reconnection of the same for alignment and proper installation.

3.1.6.28 Coordination during pre-commissioning/commissioning with mechanical and other sub-contractor for proper installation of vessels/equipment mounted instruments like level transmitters, level gauges, level switches etc. which involves removal of instruments, disconnection of tubes/cables, reconnection of the same for alignment and proper installation.

3.1.6.29 Coordination with control system vendors (Distributed Control System/Programmable Logic Controller/Analyser system/Tank farm automation/Fire and Gas detection system/Machine Monitoring System/Terminal Automation etc.), as necessary, during installation, loop checking and commissioning as per instructions of Engineer-in-charge including handing over of all types of cables laid up to designated cabinets to system vendor with proper tag identification. Contractor shall also coordinate with DCS vendor for all arrangements and facilities required in the field during the testing of fieldbus instruments like signal level, noise, waveform etc., including mobilization of necessary test equipments in field.

3.1.6.30 Coordination with tank fabricator during installation of still well, mechanical float type, Vibration Tuning Fork Level Instrument, Servo type and radar type Tank Level instruments,

3.1.6.31 Removal of false floor slabs and re-fixing, as required, for laying of cables below false floor inside control room/rack room. Cable routing in the cable cellar area where applicable in coordination with DCS Vendor.

3.1.6.32 Shifting of instruments and materials from owner' warehouse/designated place to the work spot, providing suitable storage space and keeping the materials in safe custody and identification of special materials like alloy steel with proper color coding as per instructions of engineer-in-charge. Contractor shall also return the un-used materials including scrap to the owner's warehouse/designated place as per instruction of Engineer-in-charge.

3.1.6.33 Insulation of cable duct and cable trays for fire safety, as per project philosophy. Coordination with mechanical contractor during fire insulation of cable duct and cable trays.

3.1.6.34 Contractor shall also check & report to the Engineer-in-Charge for advising the Piping erection team for the correct orientation of pressure taps of orifice flanges/Venturi/Flow-nozzle prior to welding of the first isolation valves. In case of any discrepancy, the same shall be reported to the Engineer-in-Charge immediately for rectification.

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3.1.6.35 Grinding of thermowell collar, Lapping and greasing of RTJ flanged thermowell, wherever required, shall be carried out by Contractor and rate is deemed to be included by contractor in the SOR clause of thermowell/ temperature instruments Installation.

3.1.6.36 For corrosion coupons and probe, tapping with flanged end shall be by piping and Installation of Probe and coupon shall be by Instrumentation. The rate is deemed to be included by contractor in the SOR rate for corrosion transmitters.

3.1.6.37 Submission of monthly material appropriation statements for instruments, cables, tubes, piping materials and fittings, indicating the quantity issued and consumed in standard Performa.

3.1.6.38 Incorporation of all information in owner's drawings/documents, as per actual execution of work at site including preparation and submission of as-built drawings.

3.1.6.39 Start-up and commissioning assistance as required and agreed upon with Engineer-in-charge.

3.1.6.40 Submission of final material appropriation statements for all the materials issued by the owner.

3.1.6.41 Where requested by owner/engineer-in-charge or his authorised representatives, all or any of the works detailed above and in schedule of quantities shall also be performed on package units, local panels/cabinets/gauge board installed by owner or by others.

3.1.6.42 Any other work, not specifically listed, but necessary for the successful completion of instrumentation erection works defined in this specification or the schedule of quantities.

3.2 Work Excluded

3.2.1 Installation of main panels, cabinets and consoles supplied by control system vendor inside control room unless specified otherwise.

3.2.2 Installation of line mounted instruments like control valves, on-off/shutdown valves orifice plates and flanges, variable area flowmeters (excluding rotameters for purged installation as defined in clause 3.1.6.6), magnetic flow meters, ultrasonic flow meters, turbine flow meters, mass flow meters, PD meter, vortex flow meter etc.

3.2.3 Mechanical installation of tank level instruments except servo/ radar gauges.

3.2.4 Installation of safety valves, breather valves, flame arrestors, rupture discs.

3.2.5 First block valve for instrument tapping points on piping and equipments except pre-fabricated hook-ups where first block valve is part of pre-fabricated hook-up assembly.

3.2.6 Insulation of steam traced instrument primary impulse lines unless otherwise specified.

3.2.7 Painting of impulse lines.

4.0 EXECUTION METHODOLOGY

4.1 Instrument Impulse lines

4.1.1 All impulse lines shall be installed as per applicable installation standards attached with tender with a best workmanship. In case, the installation standard of any instrument in any package unit is different from the installation standard attached with tender, the nearest corresponding standard attached with tender as decided by Engineer-In charge shall be considered and followed.

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4.1.2 Horizontal and vertical lines shall be installed using levels and plumb bobs.

4.1.3 Unless otherwise specified in the drawings, impulse lines shall have a slope of not less than 1 in 12 on the horizontal runs.

4.1.4 All welding shall be carried out as per codes and after approval of welding procedures and electrodes by Engineer-in-charge. Only qualified welders approved by Engineer-in-charge shall carryout welding. The following activities shall be part of contractor's scope of work.

4.1.4.1 Welder qualification including supply of any materials required like electrodes, equipments, consumables, testing charges for various tests etc., required for initial qualification and subsequent validation till the completion of the job.

4.1.4.2 Welding procedure qualification including supply of any materials required for the qualification like electrodes, equipments, consumables, testing charges for tests etc. Contractor scope includes welding procedure qualification for welding of dissimilar materials as envisaged for any process hookup, wherever applicable.

4.1.4.3 The charges towards Positive Material Identification (PMI) shall be quoted as per the schedule of quantities attached elsewhere in tender document. However, Contractor's scope shall include the PMI (Positive material Identification) test for all the pipe and fittings of instrument impulse line hook-ups of Alloy steel (AS) and stainless steel (SS) material as applicable. The cost of the above is deemed to be included by the Contractor in the rate quoted for all impulse line installations in Stainless steel (SS) and Alloy steel (AS). The equipment required for PMI testing shall be arranged by the contractor.

4.1.4.4 The charges towards non-destructive testing like radiography and post weld heat treatment shall be quoted as per the schedule of quantities attached elsewhere in tender document. The contractor is required to carry out 100% radiography of all the butt weld joints indicated in the installation standards which are covered in schedule of quantities of tender document.

For all other installations involving butt weld joints, not covered under 100% radiography as above, radiography shall be carried out by the contractor as per Non-Destructive Examination Requirement (6-44-0016) attached elsewhere in the tender. The charges for these shall be included in the quoted rates of installation of instrument, covered under schedule of quantities.

4.1.5 Welding and Non-Destructive testing shall be carried out by the contractor as per the following specifications or their respective job specifications.

4.1.5.1 Welding Specification for Piping Classes (6-77-0005)

4.1.5.2 Welding Specification for fabrication of piping (6-77-0001)

4.1.5.3 Standard Specification for Surface Preparation and Protective Coating (6-79-0020)

4.1.5.4 Specification of Non-Destructive Examination Requirement of piping (6-44-0016) to carry out the radiography, stress relieving, dye penetration test, magnetic particle test, wet fluorescent magnetic particle test etc.

4.1.6 During fabrication/installation of Impulse pipes, elbows shall be used as required. In unavoidable circumstance, pipe benders shall be used with instructions of Engineer-In Charge. Hot cutting/bending shall not be allowed. Pipes shall be cut using pipe cutting device

4.1.7 Piping/tubing for steam tracing shall be installed according to the standards without any pocket so as to avoid formation of the condensate pockets.

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4.1.8 All threaded joints shall be jointed with PTFE tape only. No other pipe jointing compound shall be used except on high temperature (> 200 deg C) service where graphite sealing compounds shall be used.

4.1.9 All impulse lines shall be properly supported at regular intervals of 1 meter. Wherever insert plates are not available, supports on concrete structures or on ceilings shall be fixed with a minimum of 10 mm expansion bolts. Angle supports shall be fabricated from 40 mm x 40 mm x 5 mm MS angles, as a minimum.

4.1.10 For Impulse line of diaphragm seal flow instruments, proper support with channel/ angle shall be provided as per direction of engineer-in-charge.

4.2 PVC Covered/Bare Tube (Copper/SS/Aluminium)

4.2.1 Single copper/SS/Aluminium tubes shall be laid as per standards on perforated trays or in angle trays of size 25x25x4 mm. The width of the perforated trays shall be selected as per the number of tubes laid. Tubes shall be clamped to the trays at every 300 mm using clamps made of aluminium strips. The practice of flattening tubes for clamping purposes shall not be permitted. In case of PVC covered tubes, any exposed portion at ends and connection shall be neatly taped to appropriate thickness. Open ends shall be covered to prevent ingress of moisture, dust, vermin etc. Plugs should be removed only when final connection is made. Proper clamping of PVC covered tubes, to be done with packing/gasket to avoid PVC tube damage.

4.2.2 Trays shall be properly supported either from any rigid steel structure or concrete member as detailed in clause 4.7.4 of this specification under trays and supports.

4.2.3 All threaded ends of male/female tube connectors shall be installed with PTFE tape only. Identification tag plates/ferrules shall be provided on either side of copper tubing as per tubing/junction box schedules. Ferrules shall be single sleeve type with letters and numbers neatly printed.

4.3 Installation of Multitubes and Multicables

4.3.1 Multicables/multitubes in above ground shall always be installed on ducts/trays and shall be properly clamped. At every vertical drop to junction boxes, they shall be clamped at more frequent intervals (maximum of 300 mm). They shall be connected inside junction boxes with proper glanding. At bends minimum radius shall be maintained as per manufacturer's standard. The angle tray for multicable cables/multi tubes shall be fabricated from 50 mm x 50 mm x 6 mm angles, as a minimum.

4.3.2 All multitubes/multicable cables shall be cut after the exact site measurements are taken between ends. The tube/cable drums shall be selected before cutting the lengths so as to avoid any wastage. Contractor shall maintain the records of cable/tube cutting quantity.

4.3.3 All multicables and multitubes laid in ducts shall be properly dressed and tied with stainless steel wire of 3 mm diameter.

4.3.4 Laying of cables and tubes in field shall be through ducts and trays as per layout drawings. Cables shall be buried underground or taken in concrete trenches, wherever required.

4.3.5 The grounding of shields for shielded cables shall not be carried out at field instrument and junction box end. The shields at these ends shall be suitably insulated from the body of the instruments/junction boxes.

4.3.6 In control room, all cables shall be laid in concrete trenches, cable duct in cable cellar area or below false flooring. When laid below the false floor, the cables shall be properly dressed

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and tied as per the instructions of Engineer-in-charge. In control room where the cables are required to enter through Multi Cable Transit, the MCT frames shall be installed by contractor.

4.4 Installation of Instruments

4.4.1 All instruments shall be generally installed on supports as per installation standards, instrument location plan and instructions of Engineer-in-charge. All the instruments installed shall be accessible for ease of operation and maintenance.

4.4.2 Receiver gauges shall be mounted on instrument support itself, as far as possible, as per tubing hookup standards.

4.4.3 Filter regulators shall be mounted on the instrument support below the instruments or on the control valve yoke, as far as possible.

4.4.4 Contractor to ensure that installation of Instrumentation items shall not block the platform walkways and equipment access.

4.4.5 Prefabricated FRP canopy Canopies for Instrument/JB shall be as per EIL standard for canopy (EIL Std. 7-52-0105)

4.5 Instrument Air Supply

4.5.1 The main instrument air header in each area is laid by other contractor. Further distribution of instrument air supply from the main air header take off valve to Air Distribution Manifold and from Air Distribution Manifold to individual instruments shall be through stainless steel pipe and PVC covered copper tube or stainless steel tubes as per the Instrument air distribution schematic and Bill of Material. The threading in pipes/nipples shall be carried out by contractor as per requirement.

4.5.2 Individual take off valves shall generally be located on top of the main air header. Unions shall be provided at convenient locations. There shall be one isolation valve at each instrument end. The pipe shall be supported at a minimum interval of 1.5 meters with 40 mm x 40 mm x 5 mm MS angles. Final connection to the instrument shall be copper/ stainless steel tubing as per tubing hookup standards.

4.6 Instrument Steam Tracing

4.6.1 The main steam header in each area is laid by other contractor. From the main steam header take off valve, steam to individual instruments shall be taken through carbon steel pipes supported at regular intervals. Steam tracing around individual instruments shall be by copper tubes/stainless steel tubes, in general. After steam tracing, the line is connected to the drain funnel through individual steam trap/condensate return header/tapping point as the case may be.

4.6.2 Electrical heat tracing shall be done by others. Assistance, if required, shall be provided by the contractor as per instructions of Engineer-in-charge.

4.7 Cables Ducts/Ladder trays/perforated trays/angle trays and supports

4.7.1 Cable duct, perforated trays shall be generally prefabricated and ladder trays shall be site fabricated as per standard /drawings.

4.7.2 Cable ducts and ladder trays/ angle trays shall be laid as per layout drawings and as per instructions of engineers-in-charge. Contractor shall finalize the installation plan and routing of cable trays for branch cables as per location of instruments, junction boxes and site

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conditions. Ducts shall be fabricated as per the drawing attached elsewhere in the Tender. All the accessories like tee, bends shall be calculated and provided as required.

4.7.3 Generally heavy structural supports for cable ducts, are provided by other agency. However, in critical areas, where additional supports are required to be provided in the opinion of the Engineer-in-charge, the same shall be provided by the contractor.

4.7.4 The perforated trays/angle trays shall be properly supported at a regular interval of maximum of 1 metre from insert plates or steel structures. Wherever insert plates are not available, supports on concrete structures and ceiling shall be fixed with minimum 10 mm diameter expansion bolts. Angle supports for perforated trays/angle trays shall be fabricated from 40 mm x 40 mm x 5 mm MS angles as a minimum.

4.7.5 All supports shall be cut with hacksaw only. Any work executed by gas cutting for making holes and cutting pieces will be totally rejected. Free ends of angle support shall not have sharp edges and shall be properly rounded off.

4.7.6 Perforated trays/angle trays shall be used for branch cables and tube from duct/trays, as per EIL standard drawing of cable trays. Width of trays shall be selected according to number of tubes and cables. Trays shall be laid generally as per site conditions with the approval of Engineer-in-charge. Overfilling of trays to be avoided.

4.7.7 No welding on galvanised trays/perforated trays shall be allowed in general. In specific cases where welding is unavoidable, this shall be carried out as per instructions from engineer-in-charge. For welding, if required, following procedure shall be followed as a minimum:

a) Remove galvanisation thoroughly from the portion to be welded.

b) After welding, clean the welded portion for any slug, sharp edge.

c) Welded portion shall be painted as per procedure described under clause 4.10.

4.7.8 In case of Mild Steel cable ducts, ladder type angle trays, perforated trays and their supports shall be painted as per painting specification detailed in clause 4.10.

4.7.9 Each individual cable routed through trays must be clamped or tied using SS wires/ Nylon Cable Ties as per project specification. The overall clamping shall be with aluminium clamp instead of tying with cable armour. Nuts/Bolts for cable tray fixing shall be SS.

4.7.10 Cleat out of 50mm x 50mm x 6mm angle at 2-meter interval shall be provided to prevent lateral movement of ducts and the same including supply of angles shall be deemed to be included against duct installation clause in the SOR.

4.7.11 Galvanising thickness for ducts shall be as per duct installation drawing. Galvanising thickness for GI angles/ channel cable trays shall be as per ASTM standard A123.

4.7.12 In order to prevent galvanic corrosion, direct contact of trays, supports etc. to non-ferrous metal shall be avoided by applying suitable insulation methods.

4.8 Laying of Cables

4.8.1 All cables shall be laid in accordance with installation drawings and cable schedules. Before laying, cable/multicable on drums shall be meggered (with 500V megger for instrument cables and 1000V megger for power cables) and tested to ensure no damages to cables. The megger testing at site is not required to be carried out for the field bus cables and thermocouple extension cables. However, for field bus cables and thermocouple extension

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cables, the loop resistance and capacitance shall be checked by the contractor before and after the completion of cable laying.

4.8.2 Prior to commencement of cable laying, contractor shall submit a detailed planning/programme with drum cutting plan along with details of drum number, cable number, actual cable length etc. to Engineer-In-Charge for approval.

4.8.3 Cable drum schedule shall be provided with approximate lengths. All cables shall be cut after the actual site measurement including cable length required for termination at both ends. Extra length of cables shall be kept at the glanding/termination end as per the directions of Engineer-In Charge. This portion of the extra cable shall be protected against mechanical damage by a flexible metal conduit if the cable is unarmored. Cables shall have complete uncut lengths from one termination to the other.

4.8.4 All cables laid shall be glanded in junction boxes/ instruments/ panel etc. as applicable with suitable cable glands. The cable glands shall be fixed with PVC shrouds where the same is supplied along with cable glands. An engraved identification SS tag plate shall be provided close to the glanding/termination point for all the cables with cable number. The identification tag plate for cables shall be securely fastened with stainless steel.

4.8.5 All temporary ends of cables shall be protected against dirt and moisture. For this purpose, ends of all cables shall be taped with an approved PVC or rubber insulating tape or end caps.

4.8.6 All cores/pairs numbers of cables shall be identified by means of ferrules. The numbering and identification ferrules shall be as per cable schedules and control room termination drawings. The ferrules shall be screen printed on single sleeve to identify the source and/ or destination as per the instruction of Engineer-in-charge.

4.8.7 The cores of cables shall be terminated at the termination points using proper lugs. However, lugs shall not be used for compensating cables. For field bus applications, tool-torque screw drivers are to be used for termination of field bus cables in the terminals with the torque force of 5 inch- pounds.

4.8.8 The bending radius of cables shall be maintained as per manufacturers' recommendation.

4.8.9 Cables installed above ground on exposed walls, ceilings, structures (where applicable) shall be rigidly supported individually or in groups as required using PVC covered galvanised clips or cable trays. Cable shall be supported at every 500 mm intervals.

4.8.10 All special cables and power supply cables shall be laid direct to the field instrument without any junction boxes, unless otherwise specified.

4.8.11 While laying cables in ducts/trenches care shall be taken to ensure that low signal cables like alarm, analyser cables, special cables from turbine meters, compensating cable etc. are separated from other power supply cables.

For the cable laying in HDPE conduit, contractor shall consider all the required equipments like blowing machine, compressor etc. and the price for the same shall be deemed to be included in the SOR of respective cable laying in HDPE conduit.

For Optical fiber cable laying, Contractor shall consider all associated activities for cable splicing, light testing etc for each core of the FO cable.

4.8.12 Each underground cable (either in concrete trenches or buried) shall be provided with identifying tag of lead securely fastened every 50 m of its underground length with at least one tag at each end before the cable leaves/enters the ground.

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4.8.13 Cables shall be laid in directly buried cable trenches wherever specified in the layout drawings. Contractor shall ensure that buried trenches shall have sufficient depth and width to accommodate all cables correctly spaced. Pipe sleeves, if required, for cross overs other than roads like drains etc. shall be provided by the contractor as per the instructions of Engineer-in-charge. Before cables are placed, the trench bottom shall be filled with 100 mm layer of sand and leveled. Each layer of cables shall be covered with 150 mm of sand on top and sand shall be lightly pressed. A protective covering of 75 mm thick second class red bricks shall be placed flat on the final layer of sand and cable. The remaining portion of the trench shall be then back filled with soil compacted and leveled. On completion of every group of cable laying and before sand filling, every cable shall be given insulation test in the presence of Engineer-in-charge. Any cable proved to be defective shall be replaced before the next group of cables is laid. Cable route markers indicating number of cables, depth and direction will be placed enroute, on crossovers/turnings etc. to mark the cable route.

4.8.14 At each road crossings/culverts and other places, where cables enter pipe sleeves, adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after back filling. After laying, the pipe sleeves shall be sealed using sealing compounds. Each cable shall have one tag at each end before the cable enters/leaves conduit pipes

4.8.15 After laying of all the cables and multitubes, the cable entry to control room shall be suitably filled and sealed using sealing compound or by installing MCT blocks, dummy blocks, stay/end plates, etc, so as to achieve a positive seal against the entry of gas/water.

4.8.16 On completion of cable laying in concrete trenches, the trenches shall be filled with sand and pre-cast concrete slabs/ chequered plates shall be placed on the trench. Similarly, on completion of cable laying in cable ducts, it shall be fixed with duct cover with fasteners.

4.9 Earthing

4.9.1 Earthing of instruments, analysers, junction boxes, local panels/cabinets and shelters shall be carried out as per the documents and instructions from Engineer-in-charge.

4.10 Painting

4.10.1 This part of the specification is applicable to MS cable ducts, cable trays, angle trays, instrument supports/perforated trays, all structural supports for the above items, etc.

4.10.2 The painting shall be carried out as per procedure and the methodology provided in the standard specification attached elsewhere in tender with the approval of Engineer-In Charge.

4.10.3 It shall be noted that final coating of painting for the external surfaces shall be applied just before handing over the plant or commissioning of the plant as per instructions of Engineer-in-charge.

4.10.4 The name of manufacturer, colour and quality of all types of primer and final paint shall be subject to approval of Engineer-in-charge, in line with project paint philosophy.

4.11 Testing

4.11.1 Electrical cables for signal, power supply, alarms and shutdown shall be checked for megger values and continuity before final termination and ferruling.

4.11.2 Testing shall be carried out after the installation of instrument with primary piping/tubing complete in all respects and approved by Engineer-in-charge.

4.11.3 Instrument impulse piping/tubing shall be tested hydraulically or pneumatically to 1.5 or 1.1 times respectively, of the design/maximum pressure after isolating the instruments. Flushing

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of piping shall be carried out as per instructions of Engineer-in-charge. Lines shall be blown after hydro-testing. All external type level instruments with chamber/cage and level gauges shall also be tested as per instructions of Engineer-in-charge at site.

4.11.4 Instrument air manifolds (wherever applicable) Tubes and air line shall be tested with compressed air to 7 Kg/cm^2 upto the filter regulator. The downstream side of the filter regulator shall be tested for 1.5 Kg/cm^2. The lines shall be blown with the instrument air upto the regulator for 15 minutes to remove any traces of oil, dust and moisture. All lines shall be checked with soap solution and bubbler unit for possible leak at joints. After pressurising, source shall be cut off and rate of fall in pressure shall be less than 1 PSI (Pounds per Square Inch) for each 100 ft. of copper tubing for a test period of 2 minutes as per ISA RP 7-1 `Pneumatic control circuit pressure test'.

4.11.5 All the test results shall be recorded in the approved format.

4.12 Calibration

4.12.1 All instruments shall be calibrated strictly as per manufacturer's instructions prior to installation. The scope of calibration includes all field and control room instruments of all types namely, pneumatic, electronic, electrical etc.

4.12.2 Contractor shall use his own oil free instruments air compressor for calibration purposes.

4.12.3 Conversion from one unit to another for the purpose of calibration is not allowed.

4.12.4 The procedures for calibration of different items are as outlined below. However, the detailed procedure shall be submitted to Engineer-in-charge for approval before proceeding with calibration.

4.12.5 All types of transmitters, including SMART/FIELDBUS/WIRELESS type, shall be calibrated to the ranges specified in the respective instrument data/specification sheets using suitable test equipments/kits including the verification of the configuration parameters

4.12.6 All thermocouple receiver instruments shall be calibrated by generating millivolt signals suitable for span and the type of thermocouple specified.

4.12.7 Receiver instruments programmed shall be calibrated and aligned using test hook-up as per instructions from manufacturer/engineer-in-charge.

4.12.8 Filled type temperature instruments/temperature gauges shall be calibrated for 0%, 25%, 50%, 75% and 100% of the range using standard thermo-oil.

4.12.9 Pressure transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice versa of range using dead weight tester/hydraulic pumps with master gauges/pressure calibrators.

4.12.10 DP transmitters shall be calibrated at 0%, 25%, 50%, 75% and 100% and vice versa of range using standard gauges or squeeze bulb type of flow calibrators.

4.12.11 Rotameter transmitters shall be calibrated by moving pointer 0%, 25%, 50%, 75%, 100% and vice versa of the range and monitoring the output at the respective flow range.

4.12.12 The external displacer type of level instruments shall be dry calibrated as per manufacturer's instructions or wet calibrated by filling the displacer chamber with water for level 0%, 25%, 50%, 75% and 100% and draining the water at 100%, 75%, 50%, 25% and 0% of the ranges after applying suitable specific gravity corrections of the process fluid as per data sheets.

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4.12.13 The internal displacer/float type level instruments shall be dry calibrated as per manufacturer's instruction or using calibration chamber fabricated out of steel pipes and filling the same with water after applying specific gravity corrections of process fluid as per data sheets.

4.12.14 The level switches (external cage type) shall be set by filling the cage with water to the desired alarm/trip level. While setting the switches, it shall be ensured that the micro switches do not reset for full rated travel of the float.

4.12.15 Tank level indicators shall be calibrated by manually lifting the float at 0%, 25%, 50%, 75% and 100% and vice versa of the ranges.

4.12.16 Control valves and positioners of all types (Pneumatic / SMART / Fieldbus) shall be checked for hysteresis and linearity and shall be calibrated for rated strokes. The valves shall be checked for hysteresis to the accuracy of 1% full scale with Fieldbus / SMART / Pneumatic positioner and 5% full scale without positioners. Stroke speed has to be evaluated for trip/shutdown valves as per safety requirements identified by Engineer-in-charge.

4.12.17 All calibration readings shall be recorded in the enclosed format and submitted to engineer-in-charge for approval. Where significant deviations from specifications are obtained, the matter shall be brought to the immediate notice of the Engineer-in-charge for corrective action.

4.12.18 Furnished hereunder is a list of recommended calibration and test equipments required as a minimum for calibration work. The contractor shall provide the complete list of calibration and test equipments along with the range, accuracy and quantity which he proposes to use for this job. Contractor should also ensure that any equipment not listed below but required at the time of calibration shall be made available at his own cost. All the instruments are to be calibrated using the test equipments and kits approved by NPL/IDEMI/ERTL authorities or by any laboratory accredited by NABL having valid calibration report at the time of calibration. In the event, any test equipment is sent to a laboratory for enhancing validity, it shall be contractor's responsibility to arrange alternate test equipments, duly meeting the above criteria, to carry out calibration/loop checking activities.

a)	Controller test stands	Mfr. Standard
b)	Indicator/Recorder test stands	Mfr. Standard.
c)	Squeeze bulb (Flow calibrator) Range: 0 to -10,000 mm wg.	-
d)	Dead weight testers for ranges upto 350 kg/cm^2	± 0.05 %
e)	Gauge comparator for pressure gauges Rating: upto 350 kg/cm^2	± 0.2 %
f)	Oil bath for temperature instrument calibration Max. temperature 350°C (suitable upto immersion length of 500 mm)	Mfr. Standard
g)	Standard mercury in glass thermometers Range: -50 to + 50°C, 0 to 100°C (NPL certified) 0-250°C.	± 0.25 %
h)	Standard gauges for Ranges upto 350 kg/cm^2	± 0.1 %

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i)	Multimeters	± 0.05mV
j)	Potentiometer/Direct digital calibrator (capable of generating and measuring mV& Resistance)	-
k)	Meggers 500v/1000v	-
l)	Air hydro pump/hydraulic pump	-
m)	Vacuum pump	-
n)	Instrument air compressor with filters and regulators and deoilers.	-
o)	Current generator (Instrument checker) 4-20mA DC with 24VDC power source	-
p)	Fieldbus calibrator	-
q)	Safety valve test jig for sizes from ¾″ to 10″ (up to 600#)	

4.13 Loop Checking

4.13.1 Loop checking shall be performed after calibration, installation, interconnection, continuity check and leak/hydraulic testing of instrument impulse lines for all instruments. Loop checking is conducted to verify the functional performance of all elements comprising the loop, thereby ensuring proper interconnections and operation. The results of various activities completed like calibration, installation, interconnection, loop checking and logic checking shall be recorded in the loop checking report format, which is attached as Annexure 1 (4 sheets).

Any punch points observed while carrying out loop checking or activities required as pre-requisite to loop checking shall be recorded in the loop check/ logic check punch points format attached as Annexure 2. The loop checking shall be performed only after the resolution of the punch points.

4.13.2 Before proceeding for loop checking, the calibration results of individual elements shall be separately recorded on the calibration reports and shall be approved by Engineer-in-charge for correctness of calibration results.

4.13.3 Loop checking of various types of loops shall be performed as follows, however, detailed procedure shall be submitted to the engineer-in-charge for approval before proceeding with the loop checking;

a) The loop checking of all the open loops with smart or field bus shall be performed using hand held communicator / field bus calibrator by simulating 0%, 25%, 50%, 75% and 100% of full scale input in the field. The tests shall also include the verification of tag configuration parameters e.g. ranges etc as per instrument data sheet.

However loop checking of conventional (non-SMART & non-FIELDBUS) transmitter in open loop shall be performed by physically applying 0%, 25%, 50%, 75% and 100% of process parameters as per instrument data sheet in the field.

b) The loop checking of all close loops with conventional (non-SMART & non-FIELDBUS) / SMART / Fieldbus transmitters shall be carried out by physically simulating the process conditions for at least 0%, 25%, 50%, 75% and 100% of full-

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scale input and verifying the values in receiver instruments/operator station in the control room. Similarly, the control valves operation shall be verified by feeding 0%, 25%, 50%, 75% and 100% output from the operator stations/controllers in the control room.

c) In case of shutdown systems, field switches/receiver switches/field transmitters shall be simulated for abnormality by disconnecting the wires at terminals in case of switches and physically simulating the process for the corresponding trip point signal in case of transmitters and the function of all associated systems are checked including performance of solenoid valves, on-off type control/shutdown valves including proper functioning of limit switches and other accessories. Adjustment of limit switches wherever necessary shall also form part of checking of the loop.

d) Loop checking of Temperature transmitter shall include loop checking from the respective RTD/Thermocouple.

4.13.4 Performance of individual loops shall be accepted for an overall accuracy of ± 1.5%. Where deviation is found to exist more than the specified limit, contractor shall recalibrate the instruments which shall also form part of loop testing wherever required, at no extra cost.

4.13.5 After the loop test is complete, the contractor shall connect back any terminations and connections removed for loop checking.

4.13.6 A loop shall be considered as handed over only when the loop checking of that particular loop is complete in all respects and the loop checking report is completely filled in all respects, approved and accepted by Engineer-in-charge and Client. In case of loops in which certain instruments of the loops are calibrated by other agency, loop checking shall be performed in coordination with the agency involved. If a defect in the calibration of the instruments in contractor's scope is observed, same shall be rectified to the satisfaction of the Engineer-in-charge. However, if defect is detected in the calibration of the instruments in the scope of other agency, same shall be rectified by the agency involved. After the calibration has been rechecked by other agency/agencies, the loop checking would be performed to the satisfaction of Engineer-in-charge. This is part of the contractor's scope of work.

4.13.7 The loop checking results shall be recorded in Annexure 1 referred at clause 4.13.1 above.

4.13.8 Whenever the installation of central control system like Distributed Control System/Programmable Logic Controllers/Terminal automation system etc in control room is carried out by any other agency, contractor's scope of work for the loops connected to these systems shall include the following:

a) Laying of all related cables upto the designated panels/cabinets/consoles, dressing of cables including inside control room, identification of cables and cores/pairs of each cable, coordination with control system vendor during glanding and termination.

b) Calibration of all field instruments independently.

c) Providing all assistance to control system vendor during loop checking. This shall include physical simulation of signals from the field instruments through approved test equipments and checking the control valve operation with the output provided from control system to enable control system vendor to verify loop performance.

d) Coordination with control system vendor to meet loop-checking schedule. It shall be contractor's responsibility to demonstrate/prove measuring signal levels of field instrument output in control room in the respective identified pair in case of any problem.

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e) Rectification/recalibration of field instruments if found defective during loop checking.

However, the glanding and termination of field cables, checking of interconnection between instrument/equipments within control room, ferruling/tagging of interconnecting cables inside control room shall all be in the scope of control system vendor.

4.13.9 It shall be contractor's responsibility to complete all entries in the 'Loop Checking Report' attached as Annexure 1, related to field instrumentation and loop checking results, including calibration, installation checks, interconnection of tubing and cabling, hydrotest etc. and get it duly signed by the Engineer-in-charge. The final certified loop sheets shall be submitted as per tender requirement.

4.14 Cable Duct/ Tray Fire protection requirements

4.14.1 Contractor shall be responsible for providing fire protection system wherever specified in the tender document, for all cable ducts & cable trays carrying multipair cables / FF trunk cables and angles carrying multipair cables / FF trunk cables to ducts, using flexible ceramic fiber blanket system. Quantity shall be as per the quantity mentioned in SOR.

The system provided shall be readily removable and re-installable type on-line without the use of any elaborate procedure, need of structure and damaging the blanket used.

4.14.2 The system shall typically utilise compressed layers of asbestos free, non-toxic, non-fumble ceramic fibre blanket. The design selected should be able to prevent any ingress of water and dust into the system.

4.14.3 The system supplied shall be able to provide fire coverage of minimum half an hour of hydrocarbon fire to cable ducts / trays without damaging the cables. Contractor to ensure that the blanket thickness and fibre density is selected to meet the temperature in the unexposed portion of coverage to less than 100°C, which is the tolerance temperature of PVC cable.

Contractor to ensure that the selected system should have undergone type fire test as per UL1709 / ASTM E 1529 for hydrocarbon fire. The type testing should have been carried out / witnessed either by any recognized testing authority or test house such as Under Writers Lab. Certification of the same shall be provided as per UL 1709 / ASTM E 1529 fire test standard as part of pre-bid requirements.

4.14.4 Contractor shall decide the number of layers of blanket required, longitudinal and transversal overlap and the clamping procedure for the desired fire rating, in line with project specifications. The blanket shall be removable from the duct / tray top side and shall be reusable. Metallic cladding shall be provided over the blanket with clamps. All clamps shall be reusable and easily removable type. The material of construction of clamps shall be minimum SS304.

4.14.5 Contractor shall provide drawings showing the typical installation details, procedure and methodology used for installation of such a system.

4.14.6 Contractor shall furnish calculations for actual thickness, density and the number of layers of blanket provided to meet the fire coverage requirement as per point no. 3 and 4 above.

4.15 General

4.15.1 The fieldwork shall be carried out under strict safety regulations and work permits as laid down by the client. The Contractor shall take extreme care in ensuring the safety and all safety gear like helmets, belts, safety shoes etc., for the Contractor's personnel.

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4.15.2 Contractor shall ensure adequate monsoon protection while carrying out instrumentation work stipulated under the Contract. Also ensure that all spare cable entries of Instruments/JBs/LCPs are plugged for weather protection and hazardous area protection where applicable.

5.0 DRAWINGS AND DOCUMENTS TO BE SUPPLIED FOR EXECUTION BY OWNER/ENGINEER-IN-CHARGE

5.1 General layout plan for all units, showing all information like location of field instruments, junction boxes, indicative routes of cables, main duct/ cable trays.

5.2 Cable schedules for alarm/ signal/ shutdown and power supply

5.3 Termination details/drawings for connecting at control room end.

5.4 Individual instrument specifications/ Data sheets.

5.5 Bill of Materials

5.6 Installation standards/hook up.

5.7 Manufacturer's hand books with instruction for installation and calibration wherever necessary, for reference.

6.0 DRAWINGS AND DOCUMENTS TO BE PROVIDED BY CONTRACTOR

6.1 The drawings for materials those are included in contractor's scope of supply namely local control panel, junction boxes and local cabinets, as applicable.

6.2 The detailed engineering drawings wherever such work is assigned.

6.3 Hard copies (4 sets) and soft copies (uploaded in the web-portal) of as-built drawings consisting of instrument layout drawings, instrument index, installation standards, bill of material, cable schedules etc. duly incorporating the changes/ modification carried out during the course of execution of works. The drawings/ documents shall be provided by the owner for the above purpose.

6.4 Final material appropriation statement for all the free issue materials as well as materials issued on chargeable basis, indicating shortages if any, in the Performa duly approved by Engineer-in-charge.

6.5 Indicative cable tray routing details for approval by Engineer-in-charge.

7.0 SCOPE OF SUPPLY FOR MATERIALS

7.1 Materials to Be Supplied By the Owner Free Of Cost

7.1.1 All pipes, tubes and piping materials such as fittings, steam traps, valves, flanges, gaskets, bolts and nuts for flanges necessary for primary piping, air supply and steam tracing.

7.1.2 Tubes, tube fittings, polyethylene tubes and fittings.

7.1.3 All field mounted instruments like pneumatic, electronic and analyser instruments, pressure gauges, temperature elements, dial thermometers, thermowells, switches and accessories like air filter regulators, receiver pressure gauges, solenoid valves etc.

7.1.4 Pneumatic and electric junction boxes for field mounting.

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7.1.5 Single pair/Single triad/multi-pair/multi triad shielded cables/thermocouple extension cables for signal/alarm/temperature signals and any other special cable specifically indicated in Schedule of Quantities.

7.1.6 Two-core/three core power cable.

7.1.7 All electrical conduits, fittings, cable glands and cable accessories unless otherwise specifically indicated.

7.1.8 Local panels.

7.2 Materials to be supplied by the contractor at his own cost, as part of this specification

7.2.1 The procurement and supply in sequence and at the appropriate time of all materials and consumables except for the materials specifically enlisted under owner's scope of supply shall be entirely the contractor's responsibility and his rates for execution shall be inclusive for all these items. These are as, but not limited to, the following:

a) All industrial gases like oxygen, acetylene or inert gases, compressed air and all types of electrodes, filler wires, brazing rods, flux etc. for welding purpose, with necessary facilities for testing the welded joints.

b) PTFE tape and other pipe jointing compounds for threads and material for sealing of cable entries to control room, local panels, insulation tapes, sealing compounds for flame proof conduit fittings.

c) Bolts and nuts for supports, U-bolts with nuts, clamps for tubes and pipes, anchor bolts for panels, expansion bolts (pinch anchor/raw bolts) of various sizes for fixing to concrete structures.

d) Polythene bags with Nylon Ties for protection of instruments against rain.

e) Paints, primers and solvents.

f) Plastic tags for identifications of tubes/wires at panel/junction boxes.

g) All materials for minor civil works like grouting etc.

h) Structural steel, MS Plates, GI plates, flats, pipe etc. required for fabrication of instruments supports and tray supports wherever required.

i) All accessories for electrical wiring like cable lugs, ferrules for identification etc.

7.2.2 Prefabricated main cable ducts and perforated/ladder trays with necessary accessories like tees, bends, crosses etc. as specified in schedule of quantities.

7.2.3 Mounting accessories for the above like bolts, supports etc.

7.2.4 Spool pieces and blinds for testing wherever required.

7.2.5 Any other item not specified, but required for the completion of the job.

Note: The contractor shall submit in sealed cellophane packets samples of all consumables like bolts, nuts, lubricants, ferrules, lugs and any other material included in their scope of supply for approval of engineer-in-charge which then forms the standards for erection work.

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8.0 SCRAP AND EXCESS MATERIAL

8.1 Every month, the contractor shall submit an account for all the materials issued to him by the owner in the standard Performa prescribed for this purpose by the engineer-in-charge.

8.2 On completion of the work, the contractor shall submit 'material appropriation' statements for all the materials issued by the owner in the Performa prescribed by the Engineer-in-charge.

8.3 The following scrap allowances are permissible:

	Non salvageable	Unaccountable
Length below 0.5 metres Steel pipes, SS tubes	2%	0.5%
Length below 2.0 metres Single pair, Single triad, two core/ three core cables	2%	0.5%
Length below 15 metres Multitube, Multicables	2%	0.5%

8.4 All excess materials and scrap shall be returned after duly accounting for, to the storage points designated by the owner. Where materials are to be weighed before return, the contractor shall be responsible for making the necessary arrangements for weighing etc. The contractor shall not use scrap section obtained during the course of construction for fabricating temporary supports or other items without prior permission of the Engineer-in-charge.

8.5 If the contractor fails to return the surplus material as aforesaid, the owner will charge the contractor for such unreturned material at penal rates, which will be deducted from whatever amount is due to the contractor. In case any material issued by the owner deteriorates during storage by the contractor, new material will be issued to him at penal rates, but the delay in procuring such materials will be to the contractor's account only.

8.6 Radioactive element safe storage.

Use of radioactive sources must be in accordance with the recommendations of the International Commission on Radiological Protection (ICPR) and AERB (Atomic Energy Regulatory Board) requirements. The source holder is to be fully protected, leaving no possibility to be physically damaged by mechanical impacts.

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CALIBRATION REPORT

LOOP NO: _____ **CALIBRATION COMPLETED ON:** _____

CL1 TAG NO: TYPE: TRANSMITTER
RANGE:

INPUT		OUTPUT		MEAN	% ERROR
%	ACT.	INC	DEC		
0					
25					
50					
75					
100					

REAMARK:

CL2 TAG NO: TYPE: CONTROL VALVE

INPUT	MEAN VALVE POSITION		MEAN LIFT	REMARKS
%	INC	DEC		
0				
25				
50				
75				
100				

REMARK:

CL3 TAG NO: TYPE: TRANSMITTER
RANGE:

INPUT		OUTPUT		MEAN %	% ERROR INC
%	ACT.	INC	DEC		
0					
25					
50					
75					
100					

REMARK:

CL4 TAG NO: TYPE: CONTROL VALVE

INPUT	MEAN VALVE POSITION		MEAN LIFT	REMARKS
%	INC	DEC		
0				
25				
50				
75				
100				

REMARK:

CL5 TAG NO TYPE: TRANSMITTER
RANGE:

INPUT		OUTPUT		MEAN %	% ERROR INC
%	ACT.	INC	DEC		
0					
25					
50					
75					
100					

REMARK:

CL6 TYPE: SWITCH

TAG NO	SET POINT	CONTACT TYPE NO/NC	ALARM TYPE TRIP/L/H	SET POINT		DIFF
				INC	DEC	

REMARK:

BLOCK NO	CL1	CL2	CL3	CL4	CL5	CL6
CONTRACTOR						
EIL						
CLIENT						

INSTALLATION CHECK REPORT

INSTALLATION CHECK COMPLETED ON : _____

A	MOUNTING (LINE MOUNTING)	B	MOUNTING (TEMP ELEMENT)	C	MOUNTING (FIELD INST/GAS DET)	D	IMPULSE PIPING	E	CABLING
1	STUD BOLTS/NUTS □	1	ELEMENT TYPE □	1	STANCHION INSTN □	1	INSTALLATION □	1	CABLE TYPE &SIZE □
2	GASKETS □	2	'U' LENGTH □	2	CALIBRATION □	2	SUPPORTING □	2	CABLE TAG □
3	ALIGNMENT □	3	CABLE COLOUR □	3	INST. INSTALLATION □	3	HYDROTEST □	3	DRESSING □
4	RATING □	4	POLARITY □	4	CANOPY □	4	RADIOGRAPHY □	4	MEGGERING □
5	MATERIAL □			5	STANCHION TAG NUMBERING □	5	DP/MP TESTING □	5	CONTINUITY □
						6	PWHT	6	FERRULING □
								7	LUGS □
								8	SHIELD CONNECTION □

F	AIR SUPPLY DISTRIBUTION	G	JUNCTION BOX	H	POWER SUPPLY DISTRIBUTION	I	CONTROL VALVE/ ON-OFF VALVE	J	I/P CONVERTER
1	PIPE/TUBE ROUTING □	1	TYPE (WP/EP) □	1	SUPPLY TYPE □	1	STUD BOLTS/NUTS □	1	STANCHION INSTN □
2	SUPPORTS □	2	INSTALLATION □	2	GLANDING & TERMINATION □	2	GASKETS □	2	CALIBRATION □
3	TAG PLATE □	3	GLANDING, FERRULING & TERMINATION □	3	MEGGERING □	3	RATING □	3	INST. INSTALLATION □
4	TAP-OFF IDENTIFICATION □	4	GROUNDING □	4	CONTINUITY □	4	MATERIAL □	4	AIR SUPPLY SET □
		5	TAG NUMBERING □	5	FUSE RATING □	5	PORT CONFIGURATION □	5	PNEUMATIC TUBING □
		6	COLOUR □	6	CABLE TAG □	6	SIGNAL TUBING □	6	GLANDING & TERMINATION □
						7	AIR TUBING & AFR □		
						8	SUPPORT/CLAMPING □		

K	CONTROL VALVE / ON OFF VALVE ACCESSORIES			L	HEAT TRACING & INSULATION	M	FLOW ELEMENT CHECK
1	POSITIONER □	<u>CABLE TERMINATION</u>		1	INSTALLATION □		<u>CHECK, ORIFICE PLATE / FLOW NOZZLE</u>
2	SOLENOID VALVE □	1) GLANDING □		2	STEAM TRAP □	1	BORE VERIFICATION □
3	LIMIT SWITCH (OPEN) □	2) FERRULING □		3	ELECTRIC TRACER □	2	NOZZLE/PLATE DIRECTION ☑
4	LIMIT SWITCH (CLOSE) □	3) LUGS □		4	INSULATION TYPE □		
5	AIR FILTER REGULATOR □	4) CONTINUTY □		5	INSULATION CLADDING □	3	TAP ORIENTATION □
6	VOLUME TANK WITH ACCESSORIES	5) SHIELD CONNECTION □		6	DRAIN □		<u>AVG PITOT TUBE</u>
7	ACTUATOR FIREBOX □					1	ELEMENTT LENGTH □
8	PNEUMATIC TUBE □					2	ELEMENT ORIENTN □

CLIENT: _____ EIL: _____ SYSTEM VENDOR: _____ CONTRACTOR: _____

PROJECT: _____ JOB NO: _____ SHT__OF___

FIELD BUS INSTRUMENTS TESTING RESULTS

Segment No:	**Device No:**
Cal Equipment used:	**Validity Date:**

Sr No	Test input	Resistance Measurement		Capacitance Measurement	
		Expected	Actual	Expected	Actual
1a	(+) to (-) signal	> 50 KΩ		1 µF ±20 %	
1b	(+) to shield	> 20 MΩ		< 300 nF	
1c	(-) to shield	> 20 MΩ		< 300 nF	
1d	(+) to ground bar:	> 20 MΩ		< 300 nF	
1e	(-) to ground bar	> 20 MΩ		< 300 nF	
1f	Shield to ground bar	> 20 MΩ		< 300 nF	

Type of Power supply: **FISCO** ☐ **FINICO** ☐ **Field Barrier** ☐

Sr No	Measurement Location	DC Voltage Measurement (in DC Volts)					
		FISCO		FINICO		Field barrier	
		Expected	Actual	Expected	Actual	Expected	Actual
2a	Power supply conditioner voltage input, (+) to (-) signal	12.4		12.4		14.7	
2b	Power supply conditioner field side output, (+) to (-) signal	20∽30		20∽30		16∽32	
2c	Field barrier input, (+) to (-) signal	-		-		16∽32	
2d	Field barrier output, (+) to (-) signal	-		-		10	

Sr No	Measurement Location	Signal Level Measurement	
		Expected(in DC mV)	Actual (in DC mV)
3a	At Marshalling end(*), signal level from FB Monitor, (+) to (-) signal	350 to 700	
3b	At Field end(**), Signal level from FB Monitor, (+) to (-) signal	350 to 700	

Sr No	Measurement Location	Noise Level Measurement	
		Expected (in DC mV)	Actual (in DC mV)
4a	At Marshalling end(*), Noise level from FB Monitor, (+) to (-) signal	< 25	
4b	At Field end(**), Noise level from FB Monitor, (+) to (-) signal	< 25	

(*) At Marshalling end means power supply conditioner output to H1 module.
(**) At Field end means power supply conditioner output to field.

LOOP CHECKING REPORT

LOOP NO: _____ **LOOP CHECK COMPLETED ON:** _____

PROCESS SIMULATION DONE BY: ACTUAL ☐ **BY HART COMMUNICATOR** ☐

BL 1 TAG NO. TYPE: TRANSMITTER
RANGE.: SET POINT: L/LL H/HH

INPUT		TRANSMITTER OUTPUT		LOOP INDICATOR READING		DCS READING		DCS MEAN
%	ACT.	INC	DEC	INC	DEC	INC	DEC	
0								
25								
50								
75								
100								
H								
HH								
L								
LL								

BL 2 TAG NO. TYPE: CONTROL VALVE

CONTROLLER OUTPUT (%)	INPUT		POSITIONER OUTPUT		CONTROL VALVE LIFT		MEAN
	INC	DEC	INC.	DEC	INC	DEC	
0							
25							
50							
75							
100							

BL 3 TAG NO. TYPE: TRANSMITTER
RANGE.: SET POINT: L/LL H/HH

INPUT		TRANSMITTER OUTPUT		LOOP INDICATOR READING		DCS READING		DCS MEAN
%	ACT.	INC	DEC	INC	DEC	INC	DEC	
0								
25								
50								
75								
100								
H								
HH								
L								
LL								

BL 4 TAG NO. TYPE: CONTROL VALVE

CONTROLLER OUTPUT (%)	INPUT		POSITIONER OUTPUT		CONTROL VALVE LIFT		MEAN
	INC	DEC	INC.	DEC	INC	DEC	
0							
25							
50							
75							
100							

BL 5 TAG NO. TYPE: TRANSMITTER
RANGE.: SET POINT: L/LL H/HH

INPUT		TRANSMITTER OUTPUT		LOOP INDICATOR READING		DCS READING		DCS MEAN
%	ACT.	INC	DEC	INC	DEC	INC	DEC	
0								
25								
50								
75								
100								
H								
HH								
L								
LL								

BL 6 TAG NO. TYPE: SWITCH
RANGE: SET POINT: L/LL H/HH

TAG NO	SET POINT	CONTACT TYPE NO/NC	TYPE TRIP L/H	SET POJINT		DIFF
				INC	DEC	

NOTES:

BLOCK NO	BL1	BL2	BL3	BL4	BL5	BL6
CONTRACTOR						
SYSTEM VENDOR						
EIL						
CLIENT						

CLIENT: _____ EIL: _____ SYSTEM VENDOR: _____ CONTRACTOR: _____

PROJECT: _____ JOB NO: _____ SHT__OF___

LOGIC CHECKING REPORT

INTERLOCK NO: _____ **LOGIC VERIFICATION IN:** **DCS** ☐ **PLC** ☐

LOGIC INPUT (TAG NO)	TYPE (TRANSMITTER / SWITCH)	CALIBRATED	SET POINT FOR TRIP	ON/OFF VALVE / CONTROL VALVE		MCC OUTPUT		REMARK
				TAG NO	ACTION	TAG NO	ACTION	
			SET					
			RESET					
			SET					
			RESET					
			SET					
			RESET					
			SET					
			RESET					
			SET					
			RESET					
			SET					
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			RESET					
			SET					
			RESET					
			SET					
			RESET					

INTERLOCK CHECK COMPLETED SUCCESSFULLY : YES ☐ **NO** ☐

CONTRACTOR:_____ SYSTEM VENDOR:_____ EIL: _____ CLIENT:_____

CLIENT: _____ EIL:_____ SYSTEM VENDOR: _____ CONTRACTOR:_____

PROJECT:_____ JOB NO:_____ SHT__OF___

(A) CALIBRATION RESULTS PUNCH POINT

SL NO	LOOP NO/TAG NO	PUNCH POINT	ACTION REQUIRED	BY

CONTRACTOR:_____ EIL : _____ CLIENT:_____

(B) INSTALLATION CHECK PUNCH POINTS:

SL NO	LOOP NO/TAG NO	PUNCH POINT	ACTION REQUIRED	BY

CONTRACTOR:_____ EIL : _____ CLIENT:_____

(C) LOOP CHECKING PUNCH POINTS:

SL NO	LOOP NO	PUNCH POINT	ACTION REQUIRED	BY

CONTRACTOR:_____ SYSTEM VENDOR: _____ EIL : _____ CLIENT:_____

(D) LOOP CHECK PUNCH POINTS:

SL NO	LOOP NO	PUNCH POINT	ACTION REQUIRED	BY

CONTRACTOR:_____ SYSTEM VENDOR: _____ EIL : _____
CLIENT:_____

CLIENT: _____ CONTRACTOR:_____ SYSTEM VENDOR:_____

PROJECT:_____ JOB NO:_____ SHT____OF ____

वाल्व प्रवर्तक और सहायक उपकरणों के अग्नि सुरक्षा एन्कलोजरके लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR FIRE PROTECTION ENCLOSURE OF VALVE ACTUATOR AND ACCESSORIES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
2	19/03/2024	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	BC	AJS	MN	MN
1	04/01/2019	REVISED & RE-ISSUED AS STANDARD SPECIFICATION	MG	SMK	RG	RKT
0	01/11/2013	ISSUED AS STANDARD SPECIFICATION	SMK	RG	RP/JMS	SC

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Abbreviations:

AFR	:	Air Filter Regulator
SOV	:	Solenoid Operated Valve
PVC	:	Poly Vinyl Chloride

Instrumentation Standards Committee

Convener:	Mr. Mainak Nandi
Members:	Mr. Arupjyoti Saikia
	Mr. Sachin Garg
	Ms. Rimpa Saha Chakraborty
	Mr. Ankit Tiwari
	Mr. Bharath Chandrasekar
	Mr. Gaurav Kumar
	Mr. Ravinder Kumar Gupta (Projects)

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4.0 INSPECTION AND TESTING 6

5.0 SHIPPING 7

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of Fire Protection Enclosure System.

1.1.2 The standards referred to herein and mentioned below shall be of the latest editions prior to the date of the purchaser's enquiry:

API	American Petroleum Institute	
	RP 2218	Fireproofing Practices in Petroleum and Petrochemical Processing Plants
BS	British Standard	
	476 Part-20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles)
EN	European Standard	
	10204	Metallic materials: Types of Inspection documents
UL	Underwriters Laboratory	
	1709	Rapid Rise Fire Test of Protection Materials for Structural Steel

1.1.3 In the event of any conflict between this specification, job specification/ data sheets, statutory regulations, related standards, codes etc., the following order of priority shall govern:

a) Statutory Regulations

b) Job Specification/Data sheets

c) Standard specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specification in totality, vendor's extent of responsibility includes the following:

a) Purchaser's data sheets indicate the extent of Fire Protection Required. Vendor assumes complete responsibility for proper selection of offered materials, their density, thickness and no. of layers based on the conditions specified in the purchaser's data sheets.

b) Coordination and approvals from statutory authorities like UL, Lloyds Register etc, wherever required.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to vendor attached with the Material Requisition.

1.2.2 Whenever a detailed technical offer for each item is specifically indicated, vendor's quotation shall include the following:

a) Compliance to the specifications

b) A detailed specification sheet for Fire Protection system, which shall provide information, described as under. All the material specifications shall be to the same standards as those indicated in the purchaser's data sheets.

i) Details regarding type of fire proofing material and its density, thickness and number of layers.

ii) Details about cladding/jacketing & weather resistant layer

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iii) Methodology of thickness calculations and calculation sheets.

iv) Certified simulation tests approved by competent authorized agency.

c) Proven references for the offered model in line with clause 1.2.3 of this specification.

d) Overall dimensions in millimetres of the Fire Protection system after Installation.

e) Type test certificate from accredited laboratory.

f) Deviations on technical requirements shall not be entertained. In case vendor has any valid technical reason, they may include a list of deviations tag number wise, summing up all the deviations from the purchaser's data sheets and other technical specifications along with the technical reason for each of these deviations.

g) Catalogues in English giving detailed technical specifications; model decoding details and other information for the type of Fire protection system covered in the bid.

1.2.3 All items, as offered, shall have been in use for a period of minimum 1 year without any degradation of the system due to weathering or any other effects as on bid due date in similar application with the design and ambient conditions similar to those specified in the purchaser's datasheets. Items with prototype design or items not meeting proveness criteria specified above shall not be offered.

1.2.4 Vendor shall also quote for the following:

a) Any special tools needed for removal/installation of the Fire Protection System. Vendor must confirm in their offer if no special tools are needed for the offered Fire Protection System.

b) Assistance in installation and commissioning of Fire Protection System, if required, as per job specifications.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the Purchaser in vendor data requirement sheets. The required number of prints and soft copies should be despatched to the address mentioned, adhering to the time limits indicated.

1.3.2 Final documentation consisting of design data, installation manual, operational and maintenance manual etc., submitted by the vendor after placement of purchase order, shall include the following, as a minimum:

a) Specification sheet for each Fire Protection System including density, thickness and number of layers of fire proofing material used.

b) Weight in kilograms of each Fire Protection System.

c) Certified drawings for each Fire Protection System which shall provide dimensional details, internal construction details, material of construction, space requirement etc.

d) Copy of type test certificates.

e) Installation/removal procedure.

f) Maintenance procedure including replacement of its internal parts, wherever applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 The fire protection system shall be provided for each valve actuator assembly covering actuator and accessories using ceramic fiber supported by steel substrate or equivalent material. The system provided shall be fully jacketed and secured by either PVC coated Stainless Steel wire lacing or stainless steel Buckles through the full jacket for all joints. The complete exterior shall be covered by non-fire rated weather resistant layer.

2.2 System shall be flexible/ modular in construction, self-supported, easily removable and re-installable without need of special tools and personnel. Suitable inspection hatches shall be provided for components requiring inspection and maintenance.

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2.3 Unless specified otherwise, the system supplied shall be able to provide fire coverage of minimum 60 minutes of hydrocarbon pool fire to protect the components i.e. Valve positioner, actuator and accessories like air tank, limit switch, SOV, AFR etc. Vendor to ensure that the thickness and density of fiber is selected to meet the temperature in the unexposed portion of coverage to less than 70°C, which is the tolerance temperature of components of valve.

2.4 The density of the fire proofing material selected shall be such that water absorption is limited to less than 2.5% increase in weight as per BS 2972.

2.5 Vendor to ensure that the selected system should have undergone type test as per UL1709 (Hydrocarbon fire exposures) and BS 476 Part 20 for hydrocarbon fire. The type testing should have been carried out/ witnessed either by any recognized testing authority or test house such as Underwriters Lab. Certification of the same shall be provided as per UL 1709/ BS 476 fire test standard as part of requirements along with the offer.

2.6 Vendor shall decide the number of layers of insulation fiber required, longitudinal and transversal overlap and the clamping procedure for the desired fire rating. Thermal insulation thickness, density and number of layers are to be determined by vendor and any software used for determining the Insulation thickness shall be independently registered by competent authorized agency. The calculations used to compute the thermal insulation thickness are to be submitted for approval during design stage to meet the fire coverage requirement as per clause no. 2.3 and 2.4 above.

2.7 Vendor shall provide drawings showing the installation details, procedure and methodology used for installation of such a system.

2.8 The installation of the fire protection system shall be totally independent of the valve components and shall not require any design modification or provision of permanent support from the valve components.

3.0 NAMEPLATE

3.1 Each Fire Protection System shall have a Stainless Steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's data sheet.

b) Manufacturers serial no. and model no.

c) Manufacturer's name/trade mark.

d) Fire Proofing material.

e) Design conditions & Insulation thickness.

4.0 INSPECTION AND TESTING

4.1 Unless otherwise specified, purchaser reserves the right to test and inspect all items at vendor's works.

4.2 Vendor shall perform all standard tests to maintain quality control procedures. These test certificates shall be submitted for review before starting inspection by Purchaser. Vendor shall be responsible for testing and complete integration of the system. Detailed procedures of test and inspection shall be submitted by the vendor for purchaser's review and mutually agreed upon.

4.3 Vendor shall submit following test certificates and test reports for purchaser's review:

a) Material test certificates as per EN 10204 clause 3.1B for metallic products

b) Type test reports as per UL1709/BS 476 Part 20

c) Dimensional test reports for each Fire Protection System

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5.1 All Items shall be suitably packed and protected to prevent entry of foreign material. Suitable moisture absorbent shall be provided.

5.2 Vendor to provide suitable arrangement so that fire protection material is not damaged during transportation to site. As a minimum, the material shall be suitably enclosed & securely fastened in wooden crate with all necessary sheathing, lining, paddings, bubble sheets etc as required.

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विशेषस्तरीययन्त्रों के लिए मानकविनिर्देशन

STANDARD SPECIFICATION FOR SPECIAL LEVEL INSTRUMENTS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
5	09.02.22	Revised and Reissued as Standard Specification	PR/MK	SMK	MN	SM
4	27.03.17	Revised and Reissued as Standard Specification	JT	MN	RG	RN
3	18.04.11	Revised and Reissued as Standard Specification	MN	RG	RP/ JMS	DM
2	07.03.06	Revised and Reissued as Standard Specification	AM	TGM	PM	VJN
1	01.10.96	Revised and Reissued as Standard Specification	RK	BRS	RB	AS

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
AC	:	Alternating Current
DC	:	Direct Current
DPDT	:	Double Pole Double Throw
FISCO	:	Fieldbus Intrinsic Safety Concept
HART	:	Highway Addressable Remote Transducer
LCD	:	Liquid Crystal Display
NPS	:	Nominal Pipe Size
NPT	:	National Pipe Thread
RAM	:	Random Access Memory
SPDT	:	Single Pole Double Throw
TDR	:	Time Domain Reflectometery
WC	:	Water Column

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
Mr. Mayank Kaushik
Mr. Sourav Mukherjee
Ms. K.Pratheepa
Mr. R.K Gupta (Projects.)

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2.0 DESIGN AND CONSTRUCTION 6

3.0 NAME PLATE 11

4.0 INSPECTION AND TESTING 11

5.0 SHIPPING 11

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets, covers the requirements for the design, materials, nameplate marking, inspection, testing and shipping of special level instrument.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of purchaser's enquiry;

ASME	American Society of Mechanical Engineers	
	B 1.20.1	Pipe Threads, General Purpose (Inch)
	B 16.5	Pipe Flanges and Flanged Fittings NPS½ through NPS24
	B 16.20	Metallic Gaskets for Pipe Flanges, Ring Joint, Spiral wound and Jacketed.
	B31.1	Power Piping Code
ASME	BPVC-I	Rules for Construction of Power Boilers
	(PG 60.1)	Design and Application Requirements for Miscellaneous Pipe, Valves and Fittings (Water Level Indicators)
EN	European Standards	
	10204	Inspection Documents for Metallic Products
IS/IEC	Indian Standards/International Electro Technical Commission	
	IS/IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres.
	IS/IEC 60529	Degree of Protection Provided by Enclosures (IP Code).
	IEC 60587	Electrical insulating materials used under severe ambient conditions-Test methods for evaluating resistance to tracking and erosion
	IEC-61000-4	Electromagnetic Compatibility (EMC)-Testing and measurement techniques.
	IEC 61158	Industrial communication networks - Fieldbus specifications
ITK	Interoperability Test Kit (Latest Version)	

1.1.3 In the event of any conflict between this standard specifications, data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

a) Statutory Regulations

b) Data Sheets

c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendors' extent of responsibility shall include the following:

a) Purchaser's data sheets specify the minimum acceptable materials of body measuring element and accessories. Alternate superior material of construction shall also be acceptable provided vendor assumes complete responsibility for the selected materials for their compatibility with the indicated fluid and its operating conditions.

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b) Selection of proper level instrument from the vendor's standard manufacturing range, which is compatible with the process fluid and its operating condition.

c) Selection of proper type of wave-guide for guided wave radar type of instruments suitable for the specified application.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached with the material requisition.

1.2.2 Whenever a detailed technical offer is required, vendor's quotation shall include the following:

a) Detailed specification sheet for each item, which shall provide information regarding type, material of construction, performance specification, model number etc. of the offered special level instrument. The material specification and the units of measurement for various parts in vendor's specification sheets shall be to the same standards as those indicated in purchaser's data sheets.

b) Electrical wiring diagram, mounting details and earthing requirements for the offered level instruments.

c) Type of cabling required and the maximum permissible cable length between the sensor and remote electronics.

d) Proven references for each offered model number in line with clause 1.2.3 of this specification.

e) A copy of approval from local statutory authority, as applicable, such as Petroleum and Explosives Safety Organisation (PESO) Nagpur or Director General of Mines Safety (DGMS) in India, for the electronic instruments installed in electrically hazardous area along with;

i) Test certificate from recognised house Central Institute of Mining and fuel Research (CIMFR) / Electronics Regional Testing Laboratory (ERTL) etc. for flameproof enclosure and/or intrinsic safety, as specified in the datasheets, for the specified hazardous protection class as per relevant Indian standard for all Indian manufactured equipments or equipments requiring Director General of Mines Safety (DGMS) approval.

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Physikalisch-Technische Bundesanstalt (PTB), Canadian Standards Association (CSA), Underwriter's Laboratories (UL), Factory Mutual (FM) for compliance to ATEX or other equivalent recognised standards for all equipments manufactured outside India.

f) Deviation on technical requirements shall not be generally entertained. In case vendor has some valid technical reason for not complying with the specific requirements due to superior alternatives and materials, tag wise deviation list must be provided along with the technical justification.

g) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of special level instrument covered in the bid.

h) Two years operational spares for each model of instruments offered in the bid, which shall include sensor, electronic module, local indicator, o-ring/gasket set etc. as a minimum.

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i) Any special tools and tackles required for maintenance work. In case no special tools are necessary for the offered instruments, vendor must certify the same in their offer.

1.2.3 All items, as offered, shall be field proven and should have completed operation for a period of minimum 6 months on the bid due date in the similar application with process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Whenever specified, vendor must furnish tested values of failure rates, probability of failure on demand and test interval for the safety integrity level analysis in line with SIL level specified in datasheet.

1.2.5 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation, operation and maintenance manuals, etc shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required shall be submitted by the vendor as per vendor data requirement sheets attached with the requisition.

1.3.2 Final documentation consisting of design data, installation, operation and maintenance manual etc submitted by the vendor after placement of purchase order as per vendor data requirement shall include the following, as a minimum:

a) Specification sheet for each special level instrument (including probe insertion length) and its accessories.

b) Certified drawing for each instrument, which shall provide dimensional detail (probe, remote electronics etc.), internal construction, part list and material of construction etc.

c) Wiring diagram and earthing details for each level instrument.

d) Mounting details for probe unit and remote electronics.

e) Calibration procedures including replacement of its internal parts.

f) Copy of type test certificates

g) Copy of test certificates for all the tests indicated in clause 4.0 of this specification

2.0 DESIGN AND CONSTRUCTION

2.1 Sensor/probe

2.1.1 Vendor shall select the probe length and diameter based on the application and process parameters. The type and material of construction of special level instrument shall be as specified in purchaser's datasheet.

2.1.2 Probe shall be of flanged construction with material of construction of flange as specified in purchaser's data sheet. In case of welded flanged connection design, the weld joint shall be of radiography quality.

2.1.3 Probe shall be of rugged construction without any mechanical moving part and shall not be affected by abrasion because of fluid turbulence. The probe design shall ensure that the

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deposits, dust, noise, foam or turbulence in the fluid shall not affect the performance of the offered level instruments.

2.1.4 In case of internal probes, the accessories like Centering weight etc. shall be provided by vendor.

2.1.5 Unless otherwise specified, the following shall govern:

a) Threaded end connections shall be to NPT as per ASME B1.20.1.

b) Flanged end connections shall be as per ASME B 16.5.

c) Flange face finish shall be as per ASME B16.5. The face finish shall be as follows:

125 AARH : 125 to 250 micro inch AARH

63 AARH : 32 to 63 micro inch AARH

d) Grooves of ring type joint flanges shall be octagonal as per ASME B 16.20.

2.1.6 Sensor/Probes installed in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or equivalent non-toxic reagent. End connection shall be blinded/plugged after the degreasing process in order to avoid entrance of grease or oil particles.

2.2 Instrument Electronic

2.2.1 Special level Instrument electronics shall be compatible with the associated level probe and shall comprise of pre-amplifier, converter, transmitter, switching amplifier etc. as applicable for the specified application. Vendor shall ensure that the input/output signals and performance characteristics of individual item supplied as a part of each special level instrument are compatible with each other.

2.2.2 The instrument electronics shall be integral with the probe. Where remote mounted converter/transmitter is offered in place of integral electronics a minimum of 10 meters of interconnecting cable shall be included.

2.2.3 Instrument electronics shall be of microprocessor based state-of-the-art technology, which shall be capable of being configured locally, either using an integral keypad or through a universal handheld configurator.

2.2.4 Instrument electronics shall be in compliance with the electromagnetic compatibility requirements specified in IEC 61000-4 standard.

2.2.5 Whenever specifically indicated in purchaser's datasheets, the meter electronics shall be provided with in-built lightning and power supply surge protectors. The transient protection shall meet the requirements specified in IEC 60587.

2.2.6 Power Supply

a) Two wire transmitters shall be preferred, wherein no separate power feeder shall be considered. However, if separate power supply is required, purchaser will provide one number of power supply feeder e.g. 110V/240V AC,50 Hz. as specified in datasheet, at the transmitter. Further distribution if any shall be taken care of by vendor. Accessories like cable glands, conduits and junction boxes as required to interconnect transmitter signal cables and power supply cables etc., shall be supplied by the vendor.

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b) Supply voltage fluctuation of ±10 percent from the specified value and supply frequency fluctuation of ±3 Hz from the specified value shall not affect the instrument performance.

2.2.7 Terminals and Enclosure

2.2.7.1 Proper terminal blocks shall be provided in the transmitter unit for the termination of purchaser's cables. Flying leads shall not be provided. Separate terminal blocks shall be provided for power and signal connections.

2.2.7.2 All terminals shall be clearly identified and polarity shall be permanently marked.

2.2.7.3 Separate cable entries shall be provided for signal and power cables. The cable entry sizes shall be ½" NPT (F) for signal and ¾" NPT (F) for power.

2.2.7.4 The instrument/ Illuminator enclosure, housing the electrical parts shall be certified for the area classification indicated in the purchaser's data sheets. Unless otherwise specified, the enclosure shall conform to the following standards, as a minimum;

Weatherproof housing	IP 65 as per IS/IEC-60529.
Flameproof housing	Flameproof/ Ex(d) as per IS/IEC-60079.

Flameproof housing shall also be made weatherproof.

2.2.8 Converter/Transmitter

2.2.8.1 Electronic transmitter shall generally operate at nominal voltage of 24V DC and shall be protected against short circuit and reverse voltage.

2.2.8.2 Electronic transmitters with two-wire system shall be suitable for delivering rated current to an external loop resistance of at least 600ohm when powered with 24 V DC.

2.2.8.3 The span of the transmitter shall be field adjustable. In case separate device is required to make such a change, the same shall be included as per clause 2.2.3 of this specification.

2.2.8.4 Integral output meter with LCD display shall be provided for all transmitters/convertors. Local indication of the output meter must be digital and in engineering units.

2.2.8.5 Smart and Fieldbus based Transmitters.

a) Smart and fieldbus-based transmitters shall be two wire microprocessor-based type. These shall have a non-volatile memory, storing, complete sensor characterization and configuration data of the transmitter. All necessary signal conversions and output generation with the required protocol shall be carried out in the transmitter electronics.

b) The configurational data of the instruments shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case vendor standard instrument has battery backed RAM, vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

c) Transmitter shall also run complete diagnostic subroutines and shall provide diagnostic alarm messages for sensor as well as transmitter healthiness.

d) Transmitter protocol shall ensure the following features:

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i) It shall allow multi masters (two for example, primary and secondary) for configuration, calibration, diagnostics and maintenance. The primary could be the control system or host computer and the secondary could be the hand-held communicator or integral facia.

ii) It shall be capable of implementing universal commands from either of these locations.

e) In addition to the requirements specified above, fieldbus-based transmitter shall meet the following requirements:

i) All instruments must satisfy the requirements of the fieldbus registration laboratory with applicable checkmark like foundation fieldbus, profibus PA, or as specified in the purchaser's data sheets.

ii) All instruments shall have two analog input blocks, as a minimum. In addition, when specified the transmitter shall also have PID controller block.

iii) All instruments must be interoperable and shall have valid interoperability test clearance like ITK latest version for foundation fieldbus or equivalent for profibus PA as applicable, or as specified in the purchaser's data sheets.

iii) The fieldbus instruments shall support peer-to-peer communication.

iv) The field bus instruments in hazardous area shall be certified as per entity concept or shall be FISCO approved as per the requirements specified in the purchaser's specification.

v) All instruments shall support EDDL or FDT/DTM requirements, as specified in data sheets.

vi) Internal Software shall be configured by the vendor including the following information.
- Serial Number
- Device Tag (Tag No.)
- Process Description

vii) All instruments shall be capable of supporting incremental Device Descriptor (DD) for extra functionality and/or software revisions in Device Memory.

2.2.9 Switching Amplifier

a) The switches shall have DPDT (or two SPDT) contact unit each rated to 24VDC, 2A, 110VDC, 0.2A and 240V AC, 5A. Contacts used in intrinsically safe application shall be certified for these applications. Separate cable entry shall be provided for the Switching Amplifier.

b) The unit shall have repeatability better than ± 1.0%.

2.3 Guided Wave Radar type Level Instrument

2.3.1 The instrument shall work on TDR principle and shall be capable of measuring level of process fluid of dielectric constant as low as 1.9.

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Wherever dielectric constant is not specified in the datasheets, vendor supplied instrument shall be suitable for dielectric constant of 1.9 and minimum difference of 10 in dielectric constants of both medium in interface application.

2.3.2 The type of wave guide i.e. coaxial/twin rod/single rod shall be selected by the vendor based on the specified application, unless otherwise specific type is asked in the requisition.

2.3.3 The instrument probe length shall be selected based on the minimum and maximum levels indicated in the purchaser's data sheet.

2.3.4 External type guided wave radar instrument shall have external chamber/cage with 2" flanged end connections. The chamber/cage shall also have ¾" NPT vent and drain connection.

2.3.5 The instrument shall meet the following performance requirement:

a) Accuracy inclusive of linearity, repeatability and hysteresis shall be better than ±3.0 mm.

b) Repeatability of level instrument shall be better than ±3.0 mm.

c) Response time (i.e. 63.2% response) shall be better than 1 second.

2.4 Ultrasonic Type Level Instrument

2.4.1 Probe shall be selected to ensure that distance between the probe and the maximum level of interest specified in the data sheet is more than the blocking distance of the probe.

2.4.2 The instrument shall meet the following performance requirements:

a) Accuracy inclusive of linearity, repeatability and hysteresis shall be better than ±0.25% of measuring range.

2.5 Radio-Frequency / Capacitance Type Level Instruments

2.5.1 The type of probe shall be selected by vendor based on the specified application.

2.5.2 The instrument probe length shall be selected by vendor based on the specified level measurement range.

2.5.3 The instrument shall meet the following performance requirements:

a) Accuracy of the instrument inclusive of repeatability, linearity and hysteresis shall be ± 0.5% of the specified level measurement range.

2.5.4 The material of construction of the probe shall be stainless steel 316/ 316L with insulation of PTFE as a minimum. Insulation material shall be selected by vendor based on the specified process conditions.

2.5.5 For non-metallic equipment or equipment lined internally with insulation material, probe having suitable ground reference shall be provided.

2.6 Steam Drum Level Instruments

2.6.1 **Conductivity Type Level Instrument -Electronic Water Level Indicator (EWLI)**

a) Water Column along with the Probe Assembly shall be designed for steam drum design pressure and design temperature.

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b) The Water column shall be equipped with Conductivity level probes installed on the Water column, covering the entire Steam Drum Liquid Level range as specified in datasheet with a Probe pitch / resolution of 50mm of total range or better. Vendor to select and engineer the number of probes required accordingly. However, probes must be available on the water column at the trip levels and alarm levels.

c) Water column shall be a high volume column made from thick-walled extruded section to minimise fluid temperature loss so as to consequently minimise the error between actual drum level and indicated column level as a result of density error. Maximum observed error shall be 1.5" or less under all operating conditions without any level compensation.

d) The probe seats shall be machined into the column. Probes shall be fitted and sealed to the Water Column by a proven method. The Probe construction shall be blowout proof.

e) The material of construction of the probe shall be stainless steel 316/ 316L as a minimum to minimize corrosion.

f) Probes shall be able to detect water of extremely low conductivity (of the order of less than 1 μmho/cm) and shall be able to operate at low voltages (≤ 10 V) to permit checking of the probes without disconnecting the electronics.

g) Variation in conductivity w.r.t change in drum pressure from start-up to operation and shutdown shall not affect the probes ability to detect the presence of water or steam.

h) The detection module shall be designed so that each probe is equipped with its own individual detection circuit. Failure of one probe or one circuit in the system shall result in the loss of only that particular circuit/ Probe and not affect the other circuits or probes.

i) For each Conductivity Level Instrument, one no. Electronic Bi-colour Level Indicator shall be supplied along with the electronic Level detection module located at field near water column and another electronic Bi-colour Level Indicator shall be supplied for mounting at Control Room.

j) The electronic Level detection module shall be able to provide stepped 4~20mA DC output covering the specified level range which can be used by the purchaser for generating the bi-colour level indication graphic in DCS.

k) All cables between probes, electronic level detection module and local Bi-colour EWLI shall be in the scope of vendor.

2.6.2 Bi-Color Level gauge

a) Bicolor level gauges shall be in accordance with ASME BPVC-I, PG 60.1. Gauge shall be supplied fully assembled with illuminator, bi-color gauge chamber, power supply, gauge cocks, circulating tie-bar assembly, nipples, valves and fittings.

b) Gauge and cock shall utilize only asbestos free gaskets, which are suitable for the process fluid and its operating condition.

c) Gauge Cocks shall be of quick closing, offset type with bolted bonnet, outside screw and with renewable seats.

d) Unless otherwise specified, all moving and wetted internals like ball check seat, stem etc. shall be SS 316 Stainless Steel, as a minimum.

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e) Top and Bottom connection shall be Expansion Contraction type and shall be provided with an expansion loop at the top.

f) Gauge Glasses shall be of the mechanical and thermal shock resistant type. Glass material shall be toughened borosilicate or equivalent with mica shield for protection against erosion.

g) Illuminator shall consist of vertical row of reflector type spotlights (LED or high intensity lamps) and a colour screen containing two strips of red and green glasses.

h) Illuminator lamps shall operate on 240 V, 50Hz, Non-UPS single phase supply. The incoming power terminals shall be suitable for cable connection upto 4.0 mm2 size.

3.0 NAME PLATE

Each special level instrument shall have a stainless-steel nameplate attached firmly to it a visible place, furnishing the following details:

a) Tag number / Item Description as per purchaser's data sheet.

b) Manufacturer's serial number and model number.

c) Manufacturer's name/trade mark

d) Nominal end connection size and rating.

e) Body material.

f) Calibrated range.

g) Area classification in which the instrument can be used.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan and approved quality documents. All these tests shall be completed by the vendor and test reports shall be submitted to purchaser for scrutiny.

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.2 Instruments shall be supplied individually, in sealed plastic bags.

5.3 Proper care shall be taken in shipping instrument probe/sensor. All such items shall be suitably protected to avoid damage.

5.4 All special level instruments in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE', as applicable.

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STANDARD SPECIFICATION FOR MASS FLOW METER

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	02.08.21	Revised and Reissued as Standard Specification	SG	SB	MN	SM
4	24.06.16	Revised and Reissued as Standard Specification	SB	AR	RG	RN
3	14.12.10	Revised and Reissued as Standard Specification	MN	RG	TGM/JMS	ND
2	03.05.05	Revised and Reissued as Standard Specification	RSD	TGM	PM	VJN
1	01.10.96	Revised and Reissued as Standard Specification	RK	BRS	RB	AS

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Abbreviations:

AARH	:	Arithmetic Average Roughness Height
FISCO	:	Field Bus Intrinsically Safety Concept
HART	:	Highway Addressable Remote Transducer
NPT	:	National Pipe Thread
PID	:	Proportional, Integral and Derivative
RAM	:	Random Access Memory
EMI	:	Electromagnetic Interference
RFI	:	Radio Frequency Interference

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
Mr. Mayank Kaushik
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Mr. Sourav Mukherjee
Mr. R.K.Gupta(Projects)

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1.0 GENERAL

1.1 Scope

1.1.1 This specification, together with the data sheets covers the requirements for the design, materials, inspection, testing and shipping of mass flow meter.

1.1.2 The related standards referred herein and mentioned below shall be of the latest edition of the following codes, standard practices and publications, unless otherwise specified:

ASME	American Society of Mechanical Engineers.	
	B 1.20.1	Pipe Threads General Purpose -Inch
	B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS24 Metric/Inch Standard
	B 16.20	Metallic Gaskets for Pipe Flanges.
	B16.34	Valves- Flanged, Threaded and Welding End
API	American Petroleum Institute	
	MPMS 5.6	Chapter 5, Section 6 Measurement of Liquid Hydrocarbons by Coriolis Meters
EN	European Standards	
	10204	Inspection Document for Metallic Products
IS/IEC	Indian Standards/ International Electrotechnical Commission	
	IS/IEC 60079	Electrical Apparatus for Explosive Gas Atmosphere.
	IS/IEC 60529	Classification of degree of protection provided by enclosures
	IEC 60068	Environmental Testing
	IEC 60587	Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion
	IEC 61000-4	Electromagnetic Compatibility for Industrial Process Measurement and Control Equipment
	IEC 61158	Industrial Communication Networks – Fieldbus Specification.
	IEC 61158-2	Physical Layer Specification and service definition for field bus.
	IEC 61508	Functional Safety of Electrical / Electronic / Programmable Electronic safety related system.
	ISO/IEC17025	General requirements for the competence of testing and calibration laboratories.
	ISO10790	Guide to Selection, Installation and Use of Coriolis Mass Flow Meters
OIML	International Organisation of Legal Metrology	
	R 117-3	Dynamic measuring systems for liquids other than water Part-3: Test Report Format

1.1.3 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

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a) Statutory Regulations

b) Job Specification/ Data Sheets

c) Standard Specification

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendor's extent of responsibility shall include the following:

a) Purchaser's data sheets specify the material for the body and sensor tube of mass flow meter. Alternate superior material of construction shall also be acceptable provided, vendor assumes full responsibility for the selected material for the indicated fluid and its operating conditions.

b) Sizing and selection of mass flow meter suitable to measure the specified fluid flow rate with the stated accuracy.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached with the Material Requisition.

1.2.2 Vendor's quotation shall include the following;

a) Detailed specification sheet for each item, which shall provide information, described as under. The material specifications and the units of measurement for various parts in vendor's specification sheet shall be to the same standard as those indicated in purchaser's data sheets.

i) Type of element and material of construction of various parts and its accessories.

ii) Accuracy of flow measurement at the specified minimum, normal and maximum flows with pressure drop not exceeding the maximum allowable pressure drop indicated in the purchaser's data sheet.

iii) Pressure drop across the mass flow meter at the maximum flow specified in the data sheet.

iv) Special cable required, if any, cable specification and the maximum permissible cable length between the flow meter and its associated receiver instruments and unit rate.

b) Mass flow meter sizing calculations for each meter considering accuracy and pressure drop requirements specified in the purchaser's data sheets.

c) Effects of variations in density, viscosity, temperature and pressure on the measurement.

d) Proven reference for each offered model number in line with clause 1.2.3 of this specification, whenever specifically indicated in purchaser's data sheets.

e) A copy of approval for installation of mass flow meters in electrically hazardous area, wherever specified, from local statutory authority, Petroleum and Explosives Safety Organisation (PESO)Nagpur in India along with;

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i) Test certificate from recognised house CIMFR (Central Institute of Mining and Fuel Research) / ERTL (Electronics Research & Test Laboratory) etc. for flameproof enclosure / intrinsic safety, as per relevant standard for all Indian manufactured equipment .

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Physikalisch-Technische Bundesanstalt (PTB), Canadian Standards Association (CSA), and Underwriter's Laboratory (UL) for compliance to ATEX or other recognised standards for all equipments manufactured outside India

f) Deviation on technical requirements shall not be generally entertained. In case vendor has some valid technical reason for not complying with the specified requirements due to superior alternatives and materials, tag wise deviation list must be provided along with the technical justification.

g) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of mass flow meter covered in the bid.

h) Safety barriers whenever offered sensors are certified intrinsically safe with external barriers.

i) Two years' operation spares for each mass flow meter and its accessories covered in the bid, which shall include the sensor, pre-amplifier, and converter electronics etc. as a minimum.

j) Any special tools and tackles needed for maintenance work on the mass flow meter and its accessories. In case no special tools are necessary for the offered mass flow meters, vendor must certify in their offer.

1.2.3 All items as offered shall be field proven and should have completed operation for a period of minimum 6 months on the bid due date in the similar application with process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Whenever specified, vendor must furnish tested values of failure rates, probability of failure detection and test intervals for the safety integrity level analysis.

1.2.5 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation manual, operation and maintenance manuals etc shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required shall be submitted by the vendor as per Vendor data requirement attached with the requisition.

Final documentation consisting of design data, installation manual, operation and maintenance manual etc. shall be submitted by vendor after placement of purchase order, as per vendor data requirement, which shall include the following as a minimum:

a) Certified drawing for each mass flow meter, which shall provide:

i) Dimensional details in mm.

ii) Weight of the flow meter in kilogram.

iii) Material of construction.

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iv) Wiring and termination details.

b) Maximum and minimum supply voltage required for the instrument to function within the stated performance characteristics.

c) Clearance required for maintenance work

d) Installation procedures for mass flow meter.

e) Calibration and maintenance procedures for mass flow meter.

2.0 DESIGN AND CONSTRUCTION

2.1 Flow Meter

2.1.1 Flow meter shall be of in-line mounting design with flow direction clearly marked on the flow meter body to ensure correct installation.

2.1.2 Flow meter design shall ensure that the location and / or orientation of installation of mass flow meter in the line shall not affect the calibration, accuracy and performance of the meter.

2.1.3 The material of construction of mass flow internals and body shall be as specified in the respective data sheets, as a minimum.

2.1.4 The mass flow meter shall be provided with the external flow tube housing wherever specifically indicated in the data sheet. The flow Tube orientation with respect to the meter body shall be 'below' for liquids and 'above' for gases unless any specific orientation is required by vendor or purchaser.

2.1.5 The mass flow meter shall have high vibration immunity. The meter output shall not be affected by the pipeline vibration where the meter is installed.

2.1.6 **End Connection**

2.1.6.1 Flow meter shall be of flanged body construction with material of construction as specified in purchaser's data sheet. In case of meter design where end flanges are welded to the meter body all weld joints shall be of radiography quality.

2.1.6.2 Unless otherwise specified, the following shall govern:

a) Threaded end connections shall be to NPT as per ASME B1.20.1.

b) Flanged end connections shall be as per ASME B 16.5.

c) Flange face finish shall be as per ASME B16.5. The face finish as specified in data sheets shall be as follows:

125 AARH : 125 to 250 micro inch AARH
63 AARH : 32 to 63 micro inch AARH

2.1.6.3 Whenever steam jacketing requirement is specified in requisition, the steam inlet and outlet flange connection shall be as per respective datasheets of the requisition.

2.1.7 **Terminal Housing**

2.1.7.1 Following shall apply for both integral as well as for remote meter electronics:

a) All connections shall be terminated on the terminals brought out in the terminal housing located on the flow meter body. Flying leads shall not be provided.

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b) All intrinsically safe terminals shall be properly identified and shall be separate from the non-intrinsically safe terminals.

c) Separate cable entry shall be provided in the terminal housing for power and intrinsically safe signals.

d) The flow meter enclosure, housing the electrical parts shall be suitable for the area classification indicated in the purchaser's data sheets. Unless otherwise specified, the enclosure shall conform to the following standards, as a minimum:

Weatherproof housing	-	IP 65 to IS/IEC-60529
Flameproof housing	-	Flame proof / Ex (d) as per IS/IEC-60079

Flameproof housing shall also be made weatherproof.

2.2 Meter Electronics

2.2.1 Flow meter electronics shall be microprocessor based and shall include pre-amplifier, converter, transmitter electronics and integral output meter. The indication on the output meter shall be digital with engineering units.

2.2.2 The mass flow meter transmitter shall be smart type and shall provide 4-20mA analog output superimposed with digital signal for meter diagnostics (HART Output). When specified, flow meter shall provide Fieldbus output conforming to the standard specified in the purchaser's specification sheets.

2.2.3 The mass flow meter shall be capable of computing field density and shall incorporate temperature sensor flow fluid temperature measurement. Separate 4-20mA DC outputs shall be available for temperature and density when specified in Purchaser's data sheets. Whenever specified in the purchaser's data sheets, the flow meter electronics shall have capability to compute volumetric flow rates.

2.2.4 The meter electronics shall be protected against transients induced by lightning and power supply surges. Transient protection electronics shall preferably be provided in the terminal block. The transient protection shall meet the requirements specified in IEC-60587.

2.2.5 The configurational data of the instrument shall be stored in a non-volatile memory such that this remains unchanged because of power fluctuations or power off condition. In case, vendor standard instrument has battery backed RAM vendor to ensure that battery drain alarm is provided as diagnostic maintenance message.

2.2.6 For smart transmitters or for field bus based transmitter the following features must be ensured;

a) It shall allow multi master (primary and secondary) for configuration, calibration, diagnosis and maintenance. The primary could be the control system or host computer, and the secondary could be the hand held communicator.

b) It should be capable of implementing universal command.

2.2.7 In addition to the requirements specified above, fieldbus based transmitter shall meet the requirements;

a) All instruments must satisfy the requirements of the fieldbus registration laboratory with applicable checkmark like foundation fieldbus, profibus PA, or as specified in the purchaser's data sheets.

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b) All instruments shall have two analog input blocks, as a minimum. In addition, when specified the transmitter shall also have PID controller block.

c) All instruments must be interoperable and shall have valid interoperability test clearance like ITK 4.6 for foundation field bus or equivalent for profibus PA, as applicable.

d) The fieldbus instruments shall support peer-to-peer communication.

e) Field bus instruments as offered shall not be polarity sensitive.

f) The fieldbus instruments in hazardous area shall be certified as per entity concept or shall be FISCO approved as per the requirements specified in the purchaser's specification.

g) For Fieldbus instruments to be connected in intrinsically safe loops, the bus terminals shall be suitable for intrinsically safe fieldbus segment i.e, the bus terminals must remain passive (shall not be a source of energy to the system except for a leakage current not greater than 50 micro A).The bus terminals must be galvanically isolated from power supply.

2.2.8 Meter electronics shall also be provided with security lockout feature to disable access to configuration modification features.

2.2.9 Flow meter electronics shall be either integral to flow meter or shall be remote mounted type. Where remote mounted electronics is offered a minimum of 10 metres of interconnecting cable shall be included. The remote mounted transmitter shall be suitable for mounting on 2" NB pipe. Vendor shall provide mounting accessories for the same.

2.2.10 Flow meter electronics shall have enclosures suitable for the hazardous area classification indicated in purchaser's data sheets. When area classification is specified as electrically hazardous, flow meter shall have flameproof enclosure with intrinsically safe circuitry for sensor connectivity. Safety barrier if required for the sensors shall be part of transmitter enclosure.

2.2.11 The meter electronics along with flow meter shall be pre-calibrated at vendor's works with calibration factor duly established for the flow meter.

2.2.12 The meter electronics shall be immune to RFI and EMI radiation and shall be in compliance with the electromagnetic compatibility requirement as per IEC 61000-4.

2.2.13 Purchaser will provide one no. of feeder for 110/240 V AC ± 10%, 50 Hz power supply at the transmitter. Further distribution if any shall be taken care of by vendor. Accessory like cable gland, conduit and junction box as required to interconnect sensor, transmitter signal cable etc., shall be supplied by the vendor. Power TBs shall be suitable for cable sizes upto 6 mm^2 core diameter.

Supply voltage fluctuation of ± 10 percent from the specified value and supply frequency fluctuation of ± 3 Hz from the specified value shall not affect the meter performance.

2.2.14 Meter electronics housing shall meet the terminal housing requirements specified in clause 2.1.7 of this specification.

2.2.15 Instruments supplied shall be able to communicate to Universal Hand Held communicator.

2.3 Meter Sizing

The meter shall be sized considering the following guidelines;

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a) Minimum flow, Normal flow, maximum flow and meter maximum as specified in the purchaser's data sheet at the operating pressure and temperature conditions. However, meter shall be suitable for the design pressure and temperature.

b) Flow accuracy between the minimum and maximum flow specified in the data sheet. Where only normal flow is specified, the maximum and minimum flows considered for the purpose of sizing shall be;

Maximum flow = 1.4 times the normal flow

Minimum flow = 0.4 times the normal flow

When only maximum flow is specified minimum flow shall be considered as 0.2 times the maximum flow for sizing the meter.

b) Meter range shall be 1.1 times the maximum flow or as indicated in Purchaser's data sheet. The meter shall be selected such that both accuracy and maximum allowable pressure differential across the meter are complied for all cases of flow .

c) Meter size shall not be less than 50% of line size indicated in Purchaser's datasheets. However, end connection size of the Mass Flow meter shall be same as the Line size specified in Purchaser's datasheet.

2.4 Performance Requirements:

Unless specified otherwise in the purchaser's data sheets, the performance requirements for the mass flow meter shall be as follows;

1. For Process Application:

a) Flow meter accuracy: ± 0.2% of flow rate for liquid service.
± 0.5% of flow rate for gas / vapour service

b) Flow meter repeatability: ± 0.1% of flow rate for liquid service
± 0.25% of flow rate for gas / vapour service

2. For Custody Transfer Applications (Liquid):

a) Flow meter Accuracy: ±0.1% of flow rate
b) Repeatability: ±0.02% of flow rate

The performance requirements specified above includes the effect of zero stability of the flow meter on these parameters.

2.5 Certification and flow calibration for custody transfer mass flow meters:

a) The mass flow meters and flow computers shall have custody transfer approvals (for mass flow measurement and volumetric flow measurement) as per OIML R117 from OIML approved Laboratories or from a suitable authority of the country of origin such as NMI /PTB etc.

b) The mass flow meter shall also have custody transfer approvals from Weights and Measures authorities at India for mass flow measurement and volumetric flow measurement.

c) Each mass flow meter shall be sealed/ stamped by W&M Department, for custody transfer applications.

d) In case approval from State W&M is required for the location in which the system would be installed, the same shall be carried out by vendor

e) The supplied mass flow meter shall have facility for W&M hardware lock and software lock

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2.6 Mass flow meters calibration/ proving at manufacturer's works for custody transfer:

a) Each mass flow meter shall be calibrated at a calibration facility accredited by the national metrology authority of the manufacturing country in accordance with ISO/IEC17025. A copy of the ISO/IEC 17025 accreditation certificate of the calibration facility/calibration rig shall be submitted along with the offer.

b) Each mass flow meter shall be calibrated as per OIML R 117, performance tested and certified in combination with its companion electronics like pre-amplifier / transmitter. Flow test data at six points covering the minimum to the maximum flow rate shall be obtained for ascertaining the meter linearity and repeatability within the specified limits and error curve shall be obtained. The testing medium shall be water. The certified Calibration reports from recognized test facility shall be provided during inspection and testing.

2.7 Jacketing requirement:

Wherever steam Jacketing has been specified in the datasheet, the jacketed Mass Flow meter shall be provided by vendor. Connection for steam in & steam out shall be 1/2", 300# flanged RF 125-250AARH unless otherwise specified in the purchaser's datasheet.
The steam jacketing provisions should be fitted in the factory of manufacture of the mass flow meter. An overall Stainless Steel cover shall be provided by vendor for the steam jacket/insulation.

2.8 Electrical tracing requirements:

Electrical tracing with insulation along with all necessary accessories wherever required as per datasheet shall be provided in completely installed condition from the factory of manufacturer. The same shall be suitable for the specified area classification indicated in the datasheet along with necessary weather protection. Purchaser will provide one no. of feeder for 240 V AC±10%, 50Hz±3Hz Non-UPS power supply wherever electrical tracing is required.

3.0 NAMEPLATE

Each mass flow meter and its accessories shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following details as applicable.

a) Tag number as per purchaser's data sheets.

b) Manufacturer's model number and serial number.

c) Manufacturer's name/trade mark.

d) Nominal end connection size in inches and rating in ASME B16.5 class.

e) Body and trim material.

f) Area classification in which the equipment can be used.

g) Standard for body/trim materials (eg. ASTM)

h) Enclosure type

i) Calibrated range and unit of measurement of flow.

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4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

5.2 The mass flow meter remote electronics and its accessories shall be packed separately.

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STANDARD SPECIFICATION FOR SELF ACTUATED CONTROL VALVES/REGULATORS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	09.08.21	Revised & Reissued as Standard Specification	MK	AA	MN	SM
4	01.04.16	Revised & Reissued as Standard Specification	SMK	RK	RG	RN
3	29.11.10	Revised & Reissued as Standard Specification	MN	RG	TGM/JMS	ND
2	03.05.05	Revised & Reissued as Standard Specification	RG	RKA	PM	VJN
1	10.06.97	Revised & Reissued as Standard Specification	RK	BRS	RB	AS

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Abbreviations :

AARH	:	Arithmetic Average Roughness Height
C_V	:	Valve Coefficient
NPT	:	National Pipe Threads
SORF	:	Slip On Raised face

Instrumentation Standards Committee

Convener: Mr. Mainak Nandi

Members:
Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
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Mr. Sourav Mukherjee
Ms. K. Pratheepa
Mr. R.K. Gupta (Projects)

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1.0 GENERAL

1.1 Scope

This standard specification, together with the data sheets forms the requirements for the design, materials, nameplate marking, inspection and testing and shipping of self actuated control valves/ regulators.

1.1.1 The related standards referred to herein and mentioned below shall be of the latest edition prior to of the following codes, standard practices and publications, unless otherwise specified:

ANSI / FCI	American National Standards Institute/ Fluid Controls Institute	
	70.2	Control Valve Seat Leakage Classification
ANSI / NACE	American National Standards Institute / National Association of Corrosion Engineers	
	MR0175 / ISO-15156	Petroleum and natural gas industries-Materials for use in H_2S-containing environments in oil and gas production
ASME	American Society of Mechanical Engineers.	
	B 1.20.1	Pipe Threads, General Purpose, Inch
	B 16.5	Steel Pipe Flanges and Flanged Fittings. NPS ½ through NPS 24
	B 16.20	Metallic Gaskets for Pipe Flanges
	B16.34	Valves Flanged, Threaded and Welding End
EN	European Standards	
	10204	Inspection Documents for Metallic Products.
IBR	Indian Boiler Regulations	
ISA	International Society of Automation	
	S75.08.01	Face-to-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (Classes 125, 150, 250, 300, and 600)
	S75.19.01	Hydrostatic Testing of Control Valves

1.1.2 In the event of any conflict between this standard specification, job specification/data sheets, statutory regulations, related standards and codes, the following order of priority shall govern:

a) Statutory Regulations
b) Data Sheets
c) Standard Specification
d) Codes and Standards

1.1.3 In addition to compliance to the purchaser's specification in totality, vendor's extent of responsibility includes the following:

a) Purchaser's data sheets specify material for the body and trim of self actuated control valves. Alternate superior material of construction shall also be acceptable provided vendor assumes full responsibility for selected material for their compatibility with the specified fluid and its operating conditions.

b) Sizing and selection of self actuated control valves suitable for the indicated fluid flow rate over the indicated turndown and viscosity with the stated accuracy, including noise and suitable treatment to limit noise within appropriate limits.

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c) Self actuated control valve / regulator with suitable capacity and rangeability for the process conditions indicated.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached along with the material requisition.

1.2.2 Vendor's quotation shall include the following;

a) Detailed specification sheet for each item which shall provide the information regarding type, size, material of construction of body / trim / diaphragm, capacity at indicated set value etc. The material specification and units of measurement for various items in vendor specification sheets shall be to the same standards as those indicated in purchaser's data sheet.

b) Proven references for each offered model in line with clause 1.2.3 of this specification whenever specifically indicated in the purchaser's specifications.

c) Deviation on technical requirements shall not be generally entertained. In case vendor has some valid technical reason for not complying with the specific requirements due to superior alternatives and materials, tag wise deviation list must be provided along with the technical justification.

d) Catalogues giving detailed technical specifications, model decoding details and other information for each type of self actuated control valves / regulators covered in the bid.

e) One set of soft parts/O-rings for each self actuated control valve / regulator along with each item.

f) Two years operational spares for each self actuated control valve / regulator and its accessories, which shall include plug, o-ring set, packing set, diaphragm etc, as a minimum.

1.2.3 All items, as offered, shall be field proven and should have completed operation for a period of minimum 6 months on the bid due date in the similar application with process conditions similar to those as specified in the purchaser's data sheet. Items with proto-type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 All documentation submitted by the vendor including their quotations, catalogues, drawings, installation, operation and maintenance manuals etc. shall be in English language only.

1.3 Drawings and Data

1.3.1 Detailed drawings, data, catalogues and manuals required from the vendor are indicated by the purchaser in vendor data requirement sheets attached with the requisition.

1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc submitted by the vendor after placement of purchase order, shall include the following, as a minimum:

a) Certified drawing for each self actuated control valve / regulator which shall provide;
   i. End connection details.
   ii. Face-to-face dimensions in mm.
   iii. Height of the completely assembled self actuated control valve / regulator
   iv. Weight of complete assembly in kilograms.
   v. Internal construction details with parts list.

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vi. Material of construction.

b) Installation procedures for self-actuated control valves / regulators and its accessories.

c) Calibration and maintenance procedures including replacement of its internal parts wherever applicable.

2.0 DESIGN AND CONSTRUCTION

2.1 General

2.1.1 The type of self actuated control valve / regulator shall be as specified in the purchaser's data sheet, in general. However, when direct actuated self actuated control valve / regulators are specified, pilot operated valves are also acceptable.

2.1.2 For tank blanketing applications, the offered valve design shall be pilot type only with external sensing specifically suitable for the said application. The valve shall allow large flow turndown at the specified outlet pressure.

2.1.3 All pressure containing parts of the valve shall be able to withstand shut-off pressure and maximum operating temperature specified in the purchaserøs data sheet. Self actuated control valves / regulators for downstream regulation shall be provided with integral relief valves, wherever necessary.

2.1.4 All the wetted parts shall be suitable for the fluid and process conditions specified in the purchaserøs data sheets.

2.1.5 All self actuated control valves / regulators in oxygen and chlorine service shall be thoroughly degreased using reagents like trichloro-ethylene or equivalent non-toxic reagent. End connections shall be blinded / plugged after this degreasing process in order to avoid entrance of grease or oil particles.

2.1.6 All valve casting with rating 600# and above shall undergo radiography.

2.2 Body

2.2.1 Unless otherwise specified in the data sheet, self actuated control valves / regulators shall have flanged end connection integral to the valve body.Wherever different type of flange has been provided such as SORF, where flange will be welded to the body, radiography and post weld heat treatment shall be performed.

2.2.2 The valve/regulator body rating shall be equal to or better than the flange rating specified in the data sheet.

2.2.3 The valve/ regulator shall be suitable for installation in horizontal as well as vertical lines.

2.2.4 Flow direction shall be clearly stamped or cast on the valve/ regulator body to ensure correct installation.

2.2.5 End Connection

2.2.5.1 Unless otherwise specified, the end connection details shall be as below:

a) Threaded end connections shall be to NPT as per ASME B1.20.1.
b) Flanged end connection shall be as per ASME B 16.5.
c) Flange face finish shall be as per ASME B16.5. The face finish as specified in data sheets shall have serrations as follows:

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125 AARH : 125 to 250 microinch AARH
63 AARH : 32 to 63 microinch AARH

d) Ring type joint flanges shall have octagonal grooves as per ASME B16.20.

2.2.5.2 Face-to-face dimensions of self actuated control valve/ regulators with flanged globe body design shall be in accordance with ISA 75.08.01. The allowable error in dimensions shall be ±2 mm.

2.2.5.3 Bottom drains shall be plugged or blind flanged. Wherever plug is used, threads shall correspond to ASME B1.20.1.

2.3 Trim

2.3.1 The term 'trim' covers those parts of a body assembly (excluding the body, diaphragm and bottom flange), which are exposed to and in contact with the line medium, consisting of but not limited to the seat ring, plug stem, plug, plug guide and guide bushing.

2.3.2 Trim in general shall be Flow-To-Open (FTO), unless otherwise specified in datasheet.

2.3.3 **Guiding**

2.3.3.1 The self actuated control valve / regulator guiding shall be as per manufacturer standard.

2.3.3.2 Guide bushing shall be of sufficiently hard material to resist side thrust on the plug.

2.3.4 **Material of Construction**

2.3.4.1 Unless specified otherwise, the trim material for all offered self actuated control valves / regulators shall be 316 Stainless Steel.

2.3.4.2 Wherever stelliting of trim has been specified in purchaser's data sheets it stands for stelliting of the complete plug and seat joint, orifice and plug contour unless specified otherwise.

2.3.4.3 Vendor shall use suitable material pairs, proper surface finish, hardness and clearances, for all internal parts wherever possibilities of galling exist.

2.3.4.4 Wherever diaphragm material is specified as SS316, austentic grade stainless steel is also acceptable. However elastomers shall not be offered for such cases. Reinforced nitrile as diaphragm material can be offered in nitrogen and instrument air services unless specified otherwise in purchaser's data sheets.

2.3.4.5 Asbestos material shall not be used for gaskets or gland packing.

2.4 Actuator and Actuating Mechanism

2.4.1 Actuator for self actuated control valves / regulators shall be spring opposed diaphragm type, in general. Piston and cylinder type of actuator shall also be acceptable if it meets all other requirements specified in the purchaser's data sheets.

2.4.2 The line pressure sensing for the self actuated control valve / regulator shall be internal, in general. Where, external sensing line is necessary, the sense line size shall be ½", as a minimum.

2.4.3 Actuator casing and diaphragm shall be suitable to withstand 1.1 times shut-off pressure indicated in the data sheet except for blanketing applications, the actuator casing and diaphragm shall be suitable for the tank design pressure, as specified in the datasheet.

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2.4.4 Loading spring range shall be selected based on the set pressure while ensuring high accuracy of regulation and minimum droop characteristics. Spring adjustment mechanism shall be external and shall be provided with locking arrangement like seal cap to avoid inadvertent set point adjustment.

2.4.5 All the wetted parts including actuating mechanism, pilot etc shall be suitable for the fluid being handled. Vendor shall clearly come out with alternate material if the materials as indicated herein are not compatible with the specified process fluid.

a) Actuator casing material shall be same as self actuated control valve / regulator body material as a minimum.

b) The pilot internals shall be 316 Stainless Steel or superior material.

c) The actuator diaphragm material shall be 316 Stainless Steel or superior material for the hydrocarbon applications. Other materials shall be acceptable when specifically indicated in purchaser's data sheet.

d) All non-wetted springs shall be corrosion resistant nickel plated. Wetted springs, if any, shall be of 316 Stainless Steel, as a minimum.

2.5 Sizing

2.5.1 Self actuated control valve / regulators shall be sized considering following guidelines:

a) Valve flow capacities in terms of C_V may be calculated using standard ISA sizing formula or vendor standard sizing formula.

b) Unless specified otherwise, the self actuated control valve / regulator droop shall be less than 10% over set point.

c) The flow capacity of the offered valve shall be verified against published flow capacities of the offered model of valve at the specified inlet and outlet pressure conditions.

d) Body size and end connection of Self actuated pressure regulator shall not be greater than the line size of the valve.

e) If the pressure reduction and upstream / downstream pressure control is not possible through a single valve then multiple valve assembly to meet process conditions shall be supplied.

2.5.2 Noise level for the offered valve / regulator shall be limited to 85dB as measured at a distance of one meter from the valve / regulator.

2.6 Finish

The body shall be painted as below:

Carbon steel body	:	Light grey
Alloy steel body	:	Canary yellow
Stainless steel body	:	Natural

The actuator shall be painted as below:

Direct action (open on air failure) valves	:	Green
Reverse acting (close on air failure) valve	:	Yellow
Actuator for shutdown valves	:	Red

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3.0 NAMEPLATE

Each valve / regulator shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following details:

a) Valve tag number as per purchaser's data sheets.
b) Manufacturer's serial number, type of valve and model number.
c) Manufacturer's name/trade mark
d) Body and port sizes in inches.
e) Stem travel in millimeters.
f) Type of regulation upstream / downstream

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing at vendor's works as per Inspection Test Plan. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 Self actuated control valve / regulator and its accessories shall be supplied pre-assembled.

5.2 All threaded and flanged openings shall be suitably covered to prevent entry of foreign materials.

5.3 Self actuated control valve / regulator with external lubricator shall be lubricated prior to shipment.

5.4 All self actuated control valves / regulators in oxygen and chlorine service shall be separately packed along with a certificate indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE' as applicable.

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गैस संसूचक प्रणाली के लिए मानक विनिर्देशन

STANDARD SPECIFICATION FOR GAS DETECTION SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	15.03.23	Revised and Reissued as Standard Specification	DKY/JJ	SMK	MN	SM
4	26.02.18	Revised and Reissued as Standard Specification	SP	AR	RG	RN
3	22.03.12	Revised and Reissued as Standard Specification	AR	RG	RP/JMS	DM
2	09.03.07	Revised and Reissued as Standard Specification	AR	TGM	HCJ	VC
1	01.04.98	Revised and Reissued as Standard Specification	RK	BRS	RB	AS

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Abbreviations:

DCS	Distributed Control System
GA	General Arrangement
GPS	Global Positioning System
HART	Highway Addressable Remote Transducer
HVAC	Heating Ventilation & Air Conditioning
LEL	Lower Explosive Limits
LOS	Line of Sight
MOS	Metal Oxide Semiconductor
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
NPT	National Pipe Thread
PFD	Probability of Failure on Demand
PLC	Programmable Logic Controller
SIL	Safety Integrity Level

Instrumentation Standards Committee

Convener : Mr. Mainak Nandi

Members :
Mr. Arupjyoti Saikia
Mr. Sachin Garg
Mr. Jerry Johnson
Mr. Mayank Kaushik
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Ms. K.Pratheepa
Mr. R.K Gupta (Projects)

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1.0 GENERAL

1.1 Scope

1.1.1 This standard specification, together with the data sheets describes the requirements for the design, manufacture, nameplate making, inspection, testing and shipping of the complete gas detection system.

1.1.2 The related standards referred to herein and mentioned below shall be of the latest editions prior to the date of purchaser's enquiry:

API	American Petroleum Institute	
	RP-55	Recommended Practice for Oil and Gas Producing & Gas Processing Plant Operations Involving Hydrogen Sulphide.
	RP-552	Transmission Systems
EN	European Standard	
	10204	Inspection Documents for Metallic Products
	61779-1	Electrical Apparatus for the Detection and Measurement of Combustible Gases - General Requirements and Test Methods.
	61779-4	Electrical apparatus for the detection and measurement of flammable gases. Performance requirements for group II apparatus indicating a volume fraction up to 100% lower explosive limit.
IS/IEC	Indian Standards/International Electro Technical Commission	
IS/IEC 60079-0	Equipment - General requirements	
IS/IEC 60079-1	Equipment protection by flameproof enclosures "d"	
IS/IEC 60079-10-1	Classification of areas - Explosive gas atmospheres	
IS/IEC 60079-10-2	Classification of areas - Explosive dust atmospheres	
IS/IEC 60079-11	Equipment protection by intrinsic safety "i"	
IS/IEC 60079-25	Intrinsically safe electrical systems	
IS/IEC 60079-29-1	Gas detectors- Performance requirements of detectors for flammable gases	
IS/IEC 60079-29-2	Gas detectors- Selection, installation, use and maintenance of detectors for flammable gases and oxygen	
IS/IEC 60079-29-4	Gas detectors- Performance requirements of open path detectors for flammable gases	
IEC 60331	Testing of Fire Resisting Cables	
IEC 60332	Tests on bunched wires and cables.	
IEC 60617	Graphical Symbols for Diagrams	
IS/IEC 60529	Degree of protection provided by Enclosures (IP code).	
IEC 61000-4	Electromagnetic compatibility (EMC) –Part 4: Testing and measurement techniques	
IEC 61131	Programmable Logic controllers	
IEC 61508	Functional Safety of electrical/electronic/programmable electronic safety related systems	
IEC 61511	Functional Safety – Safety Instrumented Systems for the Process Industry Sector.	

1.1.3 In the event of any conflict between this standard specification, job specification/datasheets, statutory regulations, related standards and codes the following order of priority shall govern:

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a) Statutory Regulations

b) Job Specifications / Data Sheets

c) Standard Specifications

d) Codes and Standards

1.1.4 In addition to compliance to purchaser's specifications in totality, vendors' extent of responsibility shall include the following:

a) Purchaser's data sheets indicate the maximum distance between the sensor and the receiver instrument. Vendor shall be responsible to ensure that the offered sensor is suitable for the specified distance requirements. Cable size requirement shall be indicated by vendor in their offer.

b) Selection of proper hardware along with model nos and software to meet functional requirements specified in the material requisition.

c) Engineering of complete system, when specified, including that of addressable gas detector systems, data logger, monitoring system etc.

1.2 Bids

1.2.1 Vendor's quotation shall be strictly as per the bidding instructions to the vendor attached with the material requisition.

1.2.2 Vendor's quotation shall include the following;

a) Compliance to the specifications.

b) Wherever Gas Detectors are specified,

i) A detailed specification sheet for each item, which shall provide information regarding type of detector, portable detectors, portable calibrator, aspirator, hooter, beacon, pushbuttons etc., as applicable. The material specifications and the units of measurement for various parts in vendor's specification sheet shall be to the same standards as those indicated in purchaser's data sheets. Selection of correct Model number to meet the specifications shall be vendor's responsibility and vendor shall replace with the correct model if at any stage, the selected model is found deficient in meeting the specifications.

ii) Proven reference for each offered model number in line with clause 1.2.3 of this specification.

iii) Availability calculation along with MTBF data used for each component with basis.

iv) Deviation on technical requirements shall not be entertained. In case vendor has some valid technical reason to deviate from the specified requirements, they must include a list of components tag number wise, summing up all the deviations, if any, from the purchaser's data sheets along with the technical reasons for these deviations.

v) Catalogues giving detailed technical specifications, model decoding details and other related information for each type of gas detector and gas detection system covered in the bid.

vi) Cable size calculation, Power Consumption and Minimum voltage level for proper operation of the gas detectors for each type/model of detectors offered.

vii) Minimum shelf life of the gas detector's sensor.

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viii) Vendor shall indicate calibration frequency (Time period after which recalibration of gas detectors is required) along with offer. Vendor to indicate drift in the calibration of offered detectors

ix) Calculation for quantity of calibration gas required for calibration of detector.

c) Wherever Gas Detection System is specified, in addition to the details specified in 1.2.2b), It shall also include detailed specification sheet for each item, which shall provide information regarding monitor, data logger, gas detection panel, monitoring console with MMI, gas detection system with PLC etc as applicable.

d) A copy of approval for gas detectors for installations in electrically hazardous area, wherever specified, from local Statutory authority as applicable such as Petroleum and Explosives Safety Organization (PESO), Nagpur India:

i) Test certificate from recognized test house like Central Institute of Mining and Fuel Research (CIMFR) / Electronics Regional Testing Laboratory (ERTL) etc. for the specified hazardous protection class, in the data sheet, as per relevant Standard for all Indian manufactured equipments.

ii) Certificate of conformity from agencies like Laboratorie Central Des Industries Electriques (LCIE), British Approval Service for Electrical Equipment in Flammable Atmospheres (Baseefa), Factory Mutual (FM), Physikalisch-Technische Bundesanstalt (PTB), Canadian Standards Association (CSA), Underwriters Laboratories (UL) etc. for compliance to ATEX directives or certificate of conformity from IECEx or other equivalent recognized standards for all equipments manufactured outside India.

1.2.3 All items as offered shall be field proven and should have completed operation for a period of minimum 6 months on the bid due date in the similar application with the process conditions similar to those as specified in the purchaser's data sheet. Items with proto type design or items not meeting provenness criteria specified above shall not be offered.

1.2.4 Whenever specified, vendor must furnish tested values of failure rates, probability of failure on demand (PFD) and test intervals for the safety integrity level (SIL) analysis from third party certification agency.

1.2.5 All documentation submitted by the vendor including their quotation, catalogues, drawings, installation manual, operation and maintenance manuals etc shall be in English language only.

1.2.6 Vendor shall also quote for the following:

a) Two year's operation spares for gas detection system and its accessories covered in the bid, which shall include the detectors, transmitters, monitors, electronic modules, power supply modules etc. of each type, as a minimum.

b) Any special tools needed for maintenance work on the gas detection system including gas detectors and its accessories. Vendor must confirm in their offer if no special tools are needed for maintenance of offered gas detection system.

c) Aspirator assembly wherever specified in the data sheet.

d) Quantity of calibration gas required for calibration of detector. Volume of calibration gas cylinder and no. of calibration gas cylinders shall be based on the requirements specified in 2.2.3.

1.3 Drawings and Data

1.3.1 Detailed drawings, data and catalogues required from the vendor are indicated by the purchaser in vendor data requirement sheets.

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1.3.2 Final documentation consisting of design data, installation manual, operation and maintenance manual etc. submitted by the vendor after placement of purchase order, shall include the following, as a minimum:

Wherever Gas Detectors are specified,

a) Specification sheets for gas detectors along with model nos as applicable.

b) Maximum and minimum supply voltage required for the detector to function within the stated performance characteristics and power consumption.

c) Power supply distribution drawing and Wiring diagram.

d) Calibration gas sample details along with correlation factors, as applicable.

e) Copy of test certificate including type test certificates.

f) Copy of test certificate for all the tests indicated in clause 4.0 of this specification.

g) Installation procedure for gas detectors and its accessories.

h) Calibration and maintenance procedure for complete gas detectors including replacement of parts, as applicable and recommended calibration frequency.

Wherever Gas Detection System is specified, In addition to the requirements specified in 1.3.2, following shall be included.

a) Specification sheets for gas detection system.

b) Certified drawings of complete gas detection system including each detector, monitor, panel etc. as applicable, which shall provide:

i) Dimensional details in mm.

ii) Material of construction.

iii) GA drawing for Panel / Cabinet, man-machine interface.

iv) Channel base details

v) Panel / Cabinet weight (with or without packing)

c) Wiring diagram of Panel / Cabinet.

d) Purchaser's interface details including details of serial interface.

e) Complete application program as configured, wherever applicable.

f) Number of user's licenses as per job requirements, wherever applicable.

g) Installation procedure for gas detection system including detectors and its accessories.

h) Calibration and maintenance procedure for complete gas detection system including replacement of parts, as applicable and recommended calibration frequency.

2.0 DESIGN AND CONSTRUCTION

2.1 Gas Detectors

2.1.1 All gas detectors shall be suitable for outdoor installation certified for use in electrically hazardous area. The detectors shall be weather proof to IP65 in accordance with IS/IEC60529, as a minimum and certified flameproof (EExd) or certified intrinsically safe (EEx i) in accordance with IS/IEC 60079 for the area classification specified in purchaser's data sheet.

2.1.2 All gas detectors shall be provided with dust guard and splashguard.

2.1.3 All gas detectors shall be provided with terminal box for terminating incoming cabling. Flying leads shall not be acceptable. The cable entry in the terminal box shall be ¾" NPTF.

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2.1.4 Gas detectors shall have an integral transmitter, which shall provide 4-20mA outputs with HART (latest version) Gas Detectors with HART protocol shall be capable of implementing commands from universal Hand Held HART Communicator. RS485 MODBUS (RTU) etc. shall be offered when Smart detectors or Addressable detectors are specified in the purchaser's data sheets.

2.1.5 All detectors shall be supplied with local LED/ LCD digital display, which shall indicate currently detected gas concentration.

2.1.6 Mounting accessories like mounting bracket (Stainless Steel) required for the installation of gas detectors for 2" pipe mounting shall be supplied by the vendor. For open path (line of sight) detectors, 4" pipe mounting accessories shall be supplied by vendor. For the detectors to be mounted on HVAC ducts, suitable mounting accessories like backup flange (SS316) of size & rating 6"x150# along with gasket, nut & bolts, mounting plate, along with calibration valve etc. shall be supplied by vendor.

2.1.7 For 'EExd' detectors, intrinsically safe port shall be provided for connecting the Hand Held Communicator.

2.1.8 Flammable Gas Detectors (Hydrocarbon)

2.1.8.1 Flammable Hydrocarbon gas sensors shall be Non-Selective Infra-Red (IR) type. "Dual beam" with heated optics or other suitable arrangements to overcome environmental effects of fogging/fouling shall be provided.

2.1.8.2 Flammable gas detector including terminal box shall have Stainless Steel body / casing.

2.1.8.3 Detectors installed in pressurized lines e.g. HVAC duct etc., shall be provided with in-situ calibration facility (facility to calibrate the gas detectors externally without removing from the duct).

2.1.8.4 IR detector lamp shall be replaceable type. Detector shall be compensated for lamp intensity variation due to dust, humidity, sun-light, wear & tear etc.

2.1.8.5 Aspirator shall be supplied wherever specified in the data sheet.

2.1.8.6 Range

a) The range of the Flammable gas detectors shall be as follows:

Point detector: 0-100% LEL

Open-path detector: 0-5 LEL meters

(LEL meter is equal to %LEL/100 x length of gas cloud obstructing the beam path).

The gas detectors shall have an over range protection in case of sudden exposure to large quantity of Hydrocarbon gases.

2.1.8.7 Detector failure/sensor failure alarms shall be provided and hardwired contact shall also be provided for the same. In addition, the infrared detector shall provide diagnostic alarms for dirty or misaligned optics and blocked beam.

2.1.8.8 Performance requirements:

The flammable gas detectors shall meet the following performance requirements:

Repeatability: ±2% of full scale

Response time (T90): Less than 30 seconds with splash guard and dust guard.

2.1.8.9 The minimum life expectancy of flammable gas detectors shall be five (5) years.

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2.1.8.10 Once calibrated using a standard gas, Hydrocarbon gas detectors shall be capable of sensing any Hydrocarbon gas by applying a suitable correction factor and without the need of recalibration again with the measurement gas specified in the requisition.

2.1.9 Flammable gas detectors (Hydrogen)

2.1.9.1 Flammable gas sensor for hydrogen shall be poison resistant catalytic diffusion type and shall be specific for hydrogen gas only.

2.1.9.2 Catalytic type detector shall incorporate a plug-in type sensor and metallic flame arrestor.

2.1.9.3 The flammable gas detector shall meet all requirements specified in clause 2.1.8.2, 2.1.8.3, 2.1.8.6, 2.1.8.8.

2.1.10 Toxic gas detectors (Hydrogen Sulphide)

2.1.10.1 The toxic gas sensor for Hydrogen Sulphide shall be either Electrochemical type or Solid-state Semiconductor type, as specified in job specifications.

2.1.10.2 The Electrochemical cell requiring replenishment of electrolyte shall not be offered.

2.1.10.3 The field life of electrochemical type of sensor shall be 2 years as a minimum. The cell shall be able to be replaced in-situ.

2.1.10.4 The semiconductor type sensor shall be the thin film MOS type. Life expectancy shall be a minimum of five years. Zero and span adjustment shall be automatic.

2.1.10.5 Toxic gas detector and its terminal box shall preferably have Stainless Steel body. Alternately vendor's standard proven material of construction (metallic) shall also be acceptable.

2.1.10.6 Range

a) Unless otherwise specified in purchaser's data sheet, the range of the toxic gas detectors for Hydrogen Sulphide shall be 0-20ppm

2.1.10.7 Performance Requirements

a) The toxic gas detector for Hydrogen Sulphide shall meet the following performance requirements:

Repeatability: ±2 ppm

Response time (T90): Less than 60 seconds with splashguard and dust guard.

2.1.11 Toxic gas detectors (Chlorine, Sulphur Dioxide, Ammonia, others) and Oxygen gas detector

2.1.11.1 The gas detectors for Chlorine, Sulphur Dioxide, Ammonia, Oxygen and other Toxic gases shall be of electrochemical cell type.

2.1.11.2 The detectors shall meet all the requirements specified in clauses 2.1.10.2, 2.1.10.3, 2.1.10.4 and 2.1.10.5 of this specification.

2.1.11.3 Range

Unless otherwise specified in the purchaser's data sheets, the range of toxic gas detectors shall be as follows:

Chlorine detectors, Sulphur Dioxide, Ammonia: 0-10ppm

Oxygen detector: 0-25% v/v

Other detectors: As per purchaser's data sheet

2.1.11.4 Performance Requirements

The offered toxic gas detectors shall meet the following performance requirements:

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Repeatability: ±2 % of full scale

Response time (T90): Less than 60 seconds with splashguard and dust guard.

The performance of the sensor shall not be affected by the presence of other gases like Methane or Hydrogen.

2.1.12 Toxic gas detectors (Volatile Organic Compound (VOC)/Benzene)

2.1.12.1 The toxic gas detectors for VOC/Benzene shall be of photo ionization detection type (PID).

2.1.12.2 The field life of PID type of sensor shall be 2 years as a minimum. The cell shall be able to be replaced in-situ.

2.1.12.3 Toxic gas detector and its terminal box shall preferably have Stainless Steel body. Alternately vendor's standard proven material of construction (metallic) shall also be acceptable.

2.1.12.4 Range

Unless otherwise specified in purchaser's data sheet, the range of toxic gas detector for VOC/Benzene shall be 0-25 ppm.

2.1.12.5 Performance Requirements

The offered toxic gas detectors shall meet the following performance requirements:

Repeatability: ±2 % of full scale

Response time (T90): Less than 60 seconds with splashguard and dust guard.

2.1.13 Addressable gas detectors

2.1.13.1 Addressable detectors, when specified, shall be similar in mechanical construction, range and performance requirements of detectors specified in clauses 2.1.1 to 2.1.10 as applicable. These detectors, in addition, shall provide two-way communications with the gas detection system.

2.1.13.2 Addressable gas detectors shall be connected over a system communication bus with each detector having a unique address code, which shall be programmed on each device. The detector address shall be programmable from the gas detection system.

2.1.13.3 The communication protocol for data transfer between detector and host shall be deterministic. The protocol shall ensure reliable data transfer and verify the data integrity using parity data bit error checking subroutines for address code and check sum routine for the data transmission.

2.1.13.4 All addressable devices shall have capability of being disabled or enabled individually.

2.1.13.5 It shall be possible to replace failed detector on-line with a similar device without any specific tools and without data interruption.

2.1.13.6 The addressable system digital communication network shall be continuously monitored for detection and isolation of network communication failure and shall also provide an alternative path in case of a single failure of a gas detector in the network.

2.2 Portable Calibrator

2.2.1 Portable purge calibrators (one each required for different type of gas detectors as specified above) each consisting of a volume bottle containing a known gas/air mixture, a pressure regulator, a flexible hose, adapter cap (to fit the sensing head) and carrying case shall be supplied to enable calibration of the sensors in the field without dismantling them.

2.2.2 Calibration range for all sensors will be 0-100% LEL for Hydrocarbon, 0-20 ppm for Hydrogen Sulfide, 0-100% LEL for Hydrogen, 0-10 ppm for Toxic Gas (Chlorine, Sulphur

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dioxide, Ammonia), 0-25% v/v for Oxygen, 0-25 ppm for VOC/ Benzene and as per job specifications for other toxic gases.

2.2.3 Vendor to furnish quantity of calibration gas required for calibration of detector. Volume of each calibration gas cylinder and no. of calibration gas cylinders shall be based on the requirements specified below:

a) Sufficient quantity of calibration gas cylinders shall be supplied to enable calibration of all sensing heads at least thrice considering minimum 3 minutes for each detector. Vendor to ensure that the composition and stability of the calibration gas provided in the gas cylinders shall be suitable for minimum six months periods.

b) In case vendor's standard product requires higher calibration time, vendor to indicate the same and calculate the gas quantity accordingly.

Gas cylinders, self-regulating valves, pressure gauges, hose, interconnecting tubing, fittings etc. shall be supplied by the vendor. The delivery of gas cylinders shall be staggered in such way that the composition and stability of gas do not deteriorate. Date of supply shall be intimated to the bidder and shall be prior to commissioning.

2.2.4 All detectors shall be supplied pre-calibrated at vendor's works either with the gas to be detected or by applying cross sensitivity factors.

2.2.5 HC Detectors shall be calibrated for gas for which they are least sensitive. Vendor shall indicate the gas with which the gas detectors shall be calibrated.

2.2.6 Gas detector sensors shall be capable of non-intrusive calibration.

2.2.7 Vendor to furnish calibration procedure for the detectors along with make/model no. with catalogue/technical details of calibration kit.

2.3 Portable Gas Detectors

2.3.1 The portable gas detectors shall be supplied for Hydrocarbon, Hydrogen, H_2S, Chlorine, Sulphur Dioxide, Ammonia, Oxygen, VOC/Benzene and other toxic gases specified in the requisition, complete with its controller and audio-visual alarm. The portable gas detectors shall be suitable (preferably intrinsically safe) for use in hazardous area specified. These units shall be supplied with rechargeable batteries and 240 V, 50 Hz AC battery chargers. Sufficient number of battery charger/number of points per charge shall be provided based on quantity of such portable units. These units shall be supplied complete with its accessories like carrying case, maintenance kit, calibration kit etc.

2.4 Beacon and Hooter

2.4.1 Beacon and Hooter shall be supplied by the vendor as per the requirements specified in the purchaser's data sheets

2.4.2 Unless otherwise specified, the Beacons and Hooter shall meet the following functional requirements:

a) The Beacon colour shall be 'ORANGE' for flammable gas detection while 'BLUE' for Toxic gas detection.

b) Beacon light shall follow the following sequence:

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Sequence step	Detector Alarm State	Push buttons status	Hooter with Hi Tone	Hooter with Hi Hi Tone	Beacon
1.	Normal		OFF	OFF	OFF
2.	HI		ON	OFF	ON
3.	HH		ON	ON	ON
4.	HI / HH	Acknowledge button pressed	OFF	OFF	ON
5.	Normal	Reset button pressed	OFF	OFF	OFF

Reset shall be activated only after acknowledge and leakage stop.

2.4.3 The beacon shall be of stroboscopic type and shall be of sufficient intensity to provide visibility and clear contrast during full daylight.

2.4.4 The hooter shall be electronic type and shall have sound intensity of 100dBA, as a minimum. Different tones shall be provided for Flammable gas and Toxic gas releases.

2.4.5 Both Beacon and hooter units shall operate at 110V AC / 110 V DC / 24 V DC as specified in the data sheet and shall be certified explosion proof (flame proof) when installed in hazardous area.

2.4.6 Hooter/ Beacon shall be flameproof and shall be supplied with test / Acknowledge / reset push-buttons which shall be rated for 110V AC, 0.5 A / 110V DC, 0.5 A/ 24V DC, 2 A as per the requirement specified in the data sheets.

2.5 Gas Detection System

2.5.1 General

2.5.1.1 Purchaser's requisition shall specify the functional requirements of gas detection system. Vendor shall size their system as per the specified requirements and shall be responsible to consider all hardware and software necessary to meet these requirements based on the offered system.

2.5.1.2 Gas detection system shall be a stand-alone microprocessor based system fully compatible with the type of sensors specified in the data sheet.

2.5.1.3 The system shall be designed to avoid common cause of any failure. Redundancy shall be provided for all common mode failure modules/ components/ subsystems, unless otherwise specified in the purchaser's specifications.

2.5.1.4 The system shall be designed considering normally energized with normally closed concept to make it fail-safe. Monitored inputs/outputs shall be provided whenever the purchaser's data sheets specify normally de-energized/normally open system.

2.5.1.5 System Reliability and Availability:

The system shall be designed to avoid unrevealed failures ensuring maximum reliability, safety and integrity. The system design availability shall meet the requirement of 99.7%, as a minimum where system availability shall be defined as follows:

$$\% \text{ System Availability} = \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} \times 100$$

Vendor shall consider the following points while calculating the system availability:

a) MTBF values for detectors and corresponding system components i.e. detector, input and output module, power supply module, display unit, alarm annunciator etc.

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b) Items like data logger, serial outputs to purchaser's systems, hooters and beacons shall not be considered for availability calculation.

c) MTTR value of 4 hours shall be considered uniformly for all items.

2.5.1.6 Redundancy shall be provided such that single revealed or unrevealed failure shall not affect the performance of the system.

2.5.1.7 All contacts provided by the vendor for purchaser's use from the system shall be potential free and shall be rated for 110V DC 0.5A / 240V AC 5.0A / 2 A, 24 V DC as specified in the data sheets.

2.5.1.8 Bypass Philosophy

Whenever the system is specified with a dedicated panel, vendor shall provide by-pass switches with by-pass indication lamp on the panel for the output contacts from the system which are used in shutdown system. The by-pass contacts shall be logged in the data logger.

2.5.1.9 Whenever the gas detection system is specified with man-machine interface, vendor shall provide the following:

a) By-pass switches with lamps in the system cabinet.

b) Separate graphic display for by-pass contacts with a red flashing group alarm, which shall appear on each screen on the top or bottom message area of each display screen area.

c) Historical logging of all by-passed contacts for a period of minimum one month.

d) Password protection for bypassing any contact from the man machine interface screen along with an audit trail.

2.5.1.10 Whenever the gas detection system is interfaced serially with the purchaser's Control System, all by-pass status shall also form part of serial signal transfer to Control System.

2.5.1.11 Interface with purchaser's Control System

Gas detection system shall be interfaced with purchaser's control system e.g. Distributed Control System, Shut down system etc. Following outputs shall be provided for interface:

a) A redundant serial MODBUS (RTU) output with RS485 physical interface for complete data transfer and display in purchaser's Distributed Control System. The data shall include tag wise concentration, high & high high alarms, diagnostic, status alarms and bypass status etc.

b) Potential free contacts for shutdown system as per purchaser's specification.

c) Potential free contacts for High-High group alarms for connection to purchaser's Distributed Control System.

2.5.1.12 Power Supply

The Gas detection system shall operate at 110V, 50Hz. AC / 240 V, 50 Hz AC power supply. The system performance shall be within specified requirements for a voltage variation of ±10% and frequency variation of ±3 Hz of the specified value. In addition system shall be unaffected by a power fluctuation / power dip up to one cycle i.e. 20 millisecond. This power supply shall be made available to the vendor at one point i.e. in control panel or system cabinet, as applicable. Further distribution of this power supply for the equipments being supplied by vendor shall be in vendor's scope. The detailed power supply distribution requirements shall be as follows:

a) Distribution of power supply within the Control Panel/ Cabinet shall be by vendor.

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b) For the equipments installed outside the Control Panel / Cabinet i.e. monitors, printers, gas detector etc., vendor shall provide outlet feeders of suitable size in the Panel/ Cabinet.

c) The system shall be capable of accepting two power feeders either from the same source or from two different power sources. The distribution of power supply to other system consumers shall be through dedicated switch-fuse unit. Circuit breakers can also be used in place of switch-fuse unit.

d) The system power supplies shall be dual redundant each of which shall be sized for 150% of the total load of the power supply under the worst loaded condition. Redundant power supplies shall be supplied power from the different power feeders.

e) Power supply units shall be replaceable on-line without switching-off the power. The system shall remain operational uninterruptedly under single power supply unit failure and during failed power supply unit replacement.

2.5.1.13 The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-61000-4.

2.5.2 Gas Monitors/Controllers

2.5.2.1 Type

The gas monitors/controllers shall be microprocessor based and shall have panel or standard rack mounted modular plug-in type construction.

2.5.2.2 No. of channels per gas monitor/controller

Each gas detector shall either have dedicated single channel module or 1:1 redundant multi-channel module to maintain single loop integrity.

2.5.2.3 Monitor/Controller facia

When specified with indicating type of monitor/controller, it shall meet the following requirements:

a) Monitor/controller shall have either dedicated monitor/controller for each detector or a common indicator selectable for a maximum of 16 detectors. In either of the case, the requirements specified in clause 2.5.2.3 (b) of this specification shall be complied.

b) Following indications shall be available on each monitor/controller for each detector channel:

Power-on light

Alarm high light (default setting at 20% of LEL or 20 ppm)

Alarm high-high light (default setting at 60% of LEL or 50 ppm)

Malfunction light (this shall include short circuit, line-breaking, over-range and earth fault).

c) Latched type of relay contacts shall be provided for each channel for

Alarm high

Alarm high high

Malfunction alarm

d) Each channel shall also have calibration switch to allow sensor calibration without alarm output.

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2.5.3 Data logger

2.5.3.1 When specified in purchaser's specification, data logger shall be supplied complete with a dedicated printer and necessary software to:

a) Store and print out all analog data and alarms.

b) Generate reports like daily alarm report, faulty detector report, on-demand reports etc.

c) Alarm and event printing.

2.5.3.2 Type

Data logger shall be microprocessor based, rack mounted and modular in construction.

2.5.3.3 No. of channels

Data logger shall have a minimum of 256 channels. In case the number of inputs (as per detectors specified in the purchaser's data sheets) exceeds 256 nos., vendor shall offer data logger of suitable higher capacity. Number of inputs to data logger per detector shall be:

a) Analog input corresponding to LEL/ H_2S / Toxic Gas level.

b) High and High-High level.

c) Gas monitor / controller fault alarm.

However, the number of inputs per Input module shall not exceed 16.

2.5.3.4 Scan time

Data logger shall scan various inputs, analog as well as contacts, as per following rate:

100 mSec. for alarm inputs.

500 mSec. for analog inputs.

2.5.3.5 Printer

Laser printer shall be provided to print out alarms, events and reports.

2.5.3.6 Programming Terminal

It shall be possible to perform following functions either from the data logger front facia or from a PC connected to data logger:

a) Configuration and re-configuration

b) Program modifications

c) Add/delete inputs

d) Compilation of reports and generation of new reports.

2.5.3.7 Diagnostic alarms

LED indication on each I/O module.

2.5.3.8 Software features

The data logger shall meet the following software requirements:

a) Data-acquisition and data manipulation.

b) System configuration and configuration modification.

c) Diagnostic software and printout of diagnostic alarms.

d) On-demand reports for high/ high-high/ fault alarms.

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e) Daily reports for high/high-high/fault alarms and Gas concentration levels.

f) Faulty detector report.

g) Printing of alarm and events.

h) Printing of reports

2.5.4 Gas Detection Panel

2.5.4.1 The Gas detection panel when specified shall be designed to house the following instruments/accessories:

a) Monitors/controllers for the gas detectors being supplied

b) Addressable Gas Detection System Monitors / Modules, when specified in Purchaser's specifications.

c) Alarm annunciator

d) Data logger

e) Semigraphic

f) Relays/logic cards for shutdown/protection system.

g) Pushbuttons/Switches as required (including lamp test Pushbuttons)

h) Any other items which are not listed above but essential to make the system operational and to meet requirements specified in purchaser's specification.

Whenever multichannel gas monitor/controller is offered, hydrogen sulfide gas monitors and other toxic gas monitors shall be segregated from hydrocarbon and hydrogen gas monitors.

2.5.4.2 Construction

a) Panels shall have self-supporting free standing cubical construction with back doors made up of sectional steel panels. Two doors shall be provided for each panel, as standard.

b) Each panel section shall have the following dimensional details:

Height	:	2000mm
Width	:	1200mm (maximum)
Depth	:	1000mm (maximum)

Panel shall be rigidly mounted on 100mm high channel base.

c) The panel shall be fabricated using angle iron frame section of minimum 50mm x 50mm x 4.0mm size. The control panel front shall be fabricated preferable from 3.0mm cold rolled carbon steel sheet.

d) Unless otherwise specified the panel shall be straight face type. Desk type panel shall be supplied where specified. Care shall be taken to ensure that the face of the panel is truly flat and smooth.

2.5.4.3 Painting

Panel painting procedure shall include sand blasting, grinding, chemical cleaning, surface finishing by suitable filler and two coats of high grade lacquer with wet sand blasting between coats. Two coats of paint in the panel colour shall be provided for non-glossy high satin finish. Final coat shall be given after assembly at site when specified in the job specifications. Colour of the panels shall be as per job specifications.

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2.5.4.4 Cutouts

Panel cutout sizes, instrument supports and panel reinforcements shall be strictly in accordance with the instrument manufacturer's recommendations. Cutouts shall not be made with flame producing devices.

Normal mounting heights of instruments (center lines of instruments to floor) on panel shall confirm to the following, with minor adjustments depending upon instruments selected.

1	Miniature and sub-miniature instruments. (3 rows)	Bottom Row Middle Row Top Row	1100 mm 1350 mm 1600 mm
2	Annunciators		1950 mm
3	Electrical push buttons		700 mm

2.5.4.5 Auxiliary Equipment

All rear of panel equipment (terminal blocks, auxiliary relays, PLC cards etc.) shall be physically located off the exterior walls of the panel by means of suitable mounting brackets/plates welded to the wall prior to finishing the painting. Drilling and tapping on sidewalls of the enclosure for mounting internal equipment is prohibited. The auxiliary equipment shall be located and arranged for easy access for calibration and maintenance. It shall not be necessary to remove any item in order to gain access to check or remove any other item.

All cable runs shall be grouped, routed and secured to provide a neat appearance and prevent interference with the operation and maintenance of auxiliary equipment. Auxiliary relays, if used, shall be plug-in, enclosed type.

2.5.4.6 Electrical Construction

Code Compliance

The installed electrical equipment component parts and associated wiring in the panel shall be in accordance with the practices outlined in the National Electric Code, latest edition, for non-hazardous area.

Panel Wiring

For panel internal wiring, interconnecting wires shall be stranded copper conductor, with 600 volt rated fire retardant insulation. Minimum size shall be 1.0 mm2 except for power wiring which shall be 1.5 mm2. The size and type of wires shall be confirmed by vendor. Each wire shall be distinctly colour coded or tagged at both ends with full ring type labels, colour coding/tagging corresponding to that used on panel schematic drawings. The panel shall be designed for field wiring entry from the bottom. Vendor shall provide removable gland plate for this purpose.

2.5.4.7 Terminals

Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound. Terminal strips shall be spring-loaded, screw locked with all terminals clearly labeled. All terminal blocks shall be mounted on suitable anodised metallic or plastic stand-off. Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used. The metal parts of terminals shall be of high quality (pure electrolytic) copper

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and shall be tin or nickel plated (of thickness up to 15 micron). A minimum of 10% spare shall be provided.

2.5.4.8 Earthing

Each cubical (panel / cabinet / console) shall be provided with earth bus bars of at least 15 x 5 square mm cross-section for the following:

i) Electrical earthing (non-isolated earth) where all metal components like all cabinet panels, doors etc shall be connected.

ii) System earthing (isolated earth) where cable shielding of all cables shall be earthed. System earth bus bar shall be isolated from electrical earth and also from metallic doors, panels etc.

2.5.4.9 Power Supply and Distribution

The main power supply feeder to the panel shall be protected by a suitably sized circuit breaker with manual trip lever. The breaker shall be housed in a suitable surface-mount enclosure. Power distribution to controllers and associated group of auxiliary relay or solid-state logic circuits shall be via fused terminals.

2.5.4.10 Lighting

Internal illumination shall be provided for all panels / cabinets / consoles to ensure proper illumination level of 250 lux for performing maintenance activities.

LED lamps shall be provided in each cabinet / console / panel which shall be activated individually by door operated magnetic switches. The lamps shall activate when door is opened and deactivate when the door is closed. The magnetic switches selected shall have undergone life cycle cyclic test of at least 1000000 operations. A manual over-ride switch shall be provided inside the panel / cabinet / console which shall keep the lamp deactivated even when the door is open.

The cabinet / panel / console lighting shall operate on 240V AC power supply.

2.5.4.11 Alarm Annunciator

i) Alarm annunciator shall be provided at top of panel to display group alarms, shutdown alarms etc. as indicated in job specification. In addition, following system alarms shall be provided:

- Malfunction in hydrocarbon gas detection system.
- Malfunction in hydrogen sulfide gas detection system.
- Malfunction in hydrogen gas detection system.
- Malfunction in any other toxic gas detection system

ii) Alarm annunciator shall be solid state electronic type or microprocessor based provided with single input type logic module and solid-state audio alarm unit. It shall be provided with first out type sequence (ISA F3A) with function test, acknowledge and reset push buttons. The visual display shall be cluster LED type. Each facia window shall be provided with at least two sets of super bright cluster LEDs in parallel to ensure highly reliable visual annunciation of adequate light intensity.

iii) No alarm/shutdown contacts shall be derived from alarm annunciator unit.

2.5.4.12 Spares

i) The panel shall be provided with 5% installed spare (minimum one number) for items like monitors/controllers, relays/logic cards etc.

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ii) Also, 5% usable spare space shall be provided in the panel for installing items like monitors/controllers, relays/logic cards etc. in future. However internal wiring for the same shall be completed in the panel up to the terminals blocks. This shall include all hardware like Rack, Terminals, and Wiring etc. that would be necessary to install these items in future.

iii) Alarm annunciator shall have 10% spare points.

2.5.4.13 Utility Sockets

Each cabinet / panel / console shall have at least one number each of 240V AC and 110V AC (UPS) power socket. The sockets shall be rated for 10A as a minimum.

2.5.4.14 Ventilation

In order to effectively remove dissipated heat from the cabinets / panels / consoles, ventilation fans along with vent louvers backed by wire fly screen shall be provided as required. Ventilation fans shall be provided in all cabinets / panels / consoles where the temperature rise with all doors closed and all internal and external loads energised shall exceed 10°c above the ambient temperature. A temperature element (resistance temperature detector) shall be provided in each cubicle for temperature measurement. Ventilation fans shall be provided in dual configuration, as a minimum.

Each fan shall have a separate dedicated assembly and shall be replaceable on-line without shutting down any equipment / panel / cabinet / console in part or in complete.

Ventilation fan assembly shall operate at 240V AC power supply. Each fan shall have its own dedicated circuit breaker.

Each ventilation fan shall be fitted with a protection type finger guard. Whenever, the numbers of panels / cabinets / consoles are compacted (supplied in mechanical joined conditions), each panel / cabinet / console shall be provided with separate ventilation fan assembly.

The maximum noise level with all fans operating and cubicle doors open shall not exceed 85dBA.

2.5.4.15 Lifting lugs

All control panels and system cabinets shall be provided with removable lifting lugs to permit lifting of panels / cabinets. The panel structure / frame shall be designed to permit panel / cabinet lifting without deformation. The normal working load of the lifting lugs shall be more than 1.5 time the panel / cabinet load. The eye bolts shall be certified for their normal working load.

Panels / cabinets shall also be supplied with plugs which can be fitted after the lifting lugs are removed after their placement.

2.5.4.16 Name Plates

All panels / consoles / cabinets shall have name plates fixed on the front, back and inside with following details:

Front and Back	:	Tag number and description
Inside	:	Manufacturer's name, purchase order number and year of manufacture, part number of manufacture.

2.5.5 Monitoring Console with Man Machine Interface

2.5.5.1 In addition to the Gas Detection panel, Monitoring Console with Man Machine Interface shall be supplied for presentation of complete data related to gas detection, when specified in the purchaser's specifications. The console shall meet the following functional requirements:

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a) Provide all data online for all gas detectors distributed in the unit in a pre-defined or user definable format. The data includes the actual concentration of each detector and the gas detector data in alarm.

b) Provide all maintenance data, which shall include system alarms (hardware and software) and graphic representation of failed module.

c) Provide facility to configure complete system including detectors.

d) Report Generation

d) Data storage and archival

e) Multi-user access with multi-level protection shall be provided for programming, monitoring and maintenance software.

f) Time synchronization

When specified, the system shall be time synchronized with GPS or with host system i.e. DCS. The DCS / GPS shall send time synchronization pulses at predetermined times and shall automatically reset the system clock.

2.5.5.2 Gas Detection Displays

2.5.5.2.1 The system shall have a powerful set of user-friendly displays for gas detection and monitoring. User shall be able to navigate through the displays in a logical manner.

2.5.5.2.2 The displays shall be structured in hierarchical manner, which shall allow operator to select the display of choice with minimum keystrokes.

2.5.5.2.3 For the purpose of easy monitoring, gas detectors shall be arranged in logical groups. Each group shall represent a set of gas detectors related as per the process equipment or process area.

2.5.5.2.4 Software shall facilitate windowing of displays in such a way that any display can be opened-up as a window. In general the system shall allow opening up of upto 4 windows in any display.

2.5.5.2.5 The displays shall be arranged as per following requirements:

2.5.5.2.6 Overview Display

a) The overview display shall summaries the complete plant, arranged in the logical groups. Each group shall preferably be identified by a different colour for clear understanding.

b) Each group area shall have Smart buttons, which shall represent the type of detector. The colour for these smart buttons shall be as follows:

i) Flammable gas detector shall have orange colour and Toxic gas detector shall have blue colour button for clear identification.

ii) The colour of the healthy device / network except detectors shall be green while faulty device / network shall be 'Red' flashing before acknowledgement and steady 'Red' when acknowledged.

2.5.5.2.7 Group Display

Operator can navigate into any group by selecting the smart button. Generally single group display shall display both flammable and toxic gas detectors. In case the density of detectors is large, each flammable and toxic gas detectors may have independent sub groups.

a) The group display shall have process layout of the area as per the plant PFD identifying the location of the detectors with respect to their physical location.

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b) Each detector shall be identified with a Smart button, the colour of which shall be as per clause no. 2.5.5.2.6 of this specification.

2.5.5.2.8 Detailed Display

Operator can open a window by selecting any detector in-group display. The detailed display window shall indicate:

a) Tag number of the selected detector

b) A bar graph showing concentration in the scale of 0-100% of LEL in case of flammable gas detector and actual detector range in case of Toxic detectors.

c) Configuration/program modification

d) Logic generation, if applicable, using ISA or IEC-61131 Complaint Logic Symbology.

e) Defining/redefining user keys

f) Any other programming/program modification facility necessary but not specifically indicated.

2.5.5.2.9 Trend Display

a) Historical trending display shall be provided for all the gas detectors. The trend shall be available for a period of minimum 30 days with an automatic removal facility after the specified time period.

b) The data shall be archived every one minute for each detector. The disc space shall be sized accordingly.

c) Trend display shall either be provided for individual Tag number or for a group of Tag numbers. Each group trend display shall have trend of at least six (6) detectors, each identified with a separate colour.

d) It shall be possible to scroll the display by expanding or compressing the time base.

2.5.5.2.9 Alarm and Event Display

a) All alarms shall be displayed in the sequence of their occurrence. Alarm and Events shall be displayed in following sub-displays.

(i) Gas alarms and Events

(ii) System alarms

b) A minimum of 25 numbers of latest alarms/events shall be available in each current alarm display.

c) Historical alarm display shall be provided, which shall display alarms for a period of minimum 30 days.

d) Alarms and Events in the current alarm display or in historical alarm display shall be clearly identified by colour or by other means.

Following actions shall be considered as events:

(i) alarm acknowledge

(ii) change in set point

(iii) Addition or deletion of a detector from the configuration

(iv) Calibration of detector

(v) Forcing any input i.e. inhibiting or overriding an alarm.

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2.5.5.2.10 Special Graphic Displays

a) In addition to the hierarchal displays, the system shall also provide the following displays:

(i) Multiple Bar Graph Display

Bar graph display of a group of selected Tag numbers to present relative concentration of the gas. The display shall have a typical of twelve (12) bar graphs placed adjacent to each other. The detectors shall be selected from the group display, in general, in the sequence of their relative position in multiple bar graph display.

(ii) Graphic Displays

It shall be possible to configure and display the user specific graphics. The graphic may be a block diagram, a process flow diagram or an equivalent. The colour of lines, equipments etc. shall be selected by the user, however the colour and alarm sequence of the detectors shall be same as per clause 2.5.5.2.6 of this specification.

(iii) Diagnostic Display

The system shall provide a detailed diagnostic display, which shall show:

- Status of each detector-the colour of faulty detector shall be displayed with 'Yellow' colour.
- Status of the network - the network shall include status of network switches/ hubs also.
- Status of each server/PC connected over the network for each type gas detectors.

b) In case of gas detection beyond the high set point or high-high set point, the Smart button shall start flashing. On acknowledgement, these buttons shall turn to steady red status identifying group in alarm in case of high alarm while shall keep flashing in case of high-high alarm.

The button shall assume the normal colour if the detector indicates concentration below high set point.

2.5.5.3 System Engineering/Programming

The system configuration shall be possible either from a separate PC (i.e. engineering console) or from the operator PC, as specified in the purchaser's specification.

In either of these cases, the engineering function shall be protected against unauthorized operation either by password protection or by key lock switch.

Following functions shall be possible in engineering mode:

a) Configuration/assignment of detectors

b) Configuration of network / network devices and servers / PCs

c) Display configuration including graphic / groups / trends etc. formation.

d) Historical trend and alarm configuration

e) Program modification

f) Report generation and assignment

g) Maintenance aids

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h) Set point value as configured for the Tag number

i) The actual concentration and set points shall also be indicated in digital form

2.5.5.4 Data Storage and Archival

a) It shall be possible to store data and retrieve the same when required. System data like Historical data and System configuration data shall be stored in dual discs including dual disc drives.

b) In general, the system shall have facility to retrieve data from the storage disc to archive disc when the storage disc is full. In addition, the system shall also alert the operator whenever the storage disc is 80% full.

2.5.5.5 System Licenses and Software copies

a) All software, system as well as application, shall be supplied fully installed on the equipment.

A master copy on a suitable portable media like DVD shall be provided for purchaser's safe custody.

b) The number of user licenses shall be as specified in purchaser's specification. When no requirement is indicated, vendor shall supply at least six (6) numbers of licenses.

2.5.5.6 Log Reports

a) The system shall facilitate generation of Reports based on the data available. The type and format of each report shall be user definable. Following reports shall be possible.

b) Current alarm report showing detector in alarm (High or High-High), time of occurrence, time of acknowledgement etc.

c) Daily report showing detectors, which are or which have been in alarm during the day. The report shall indicate Tag number, Type of alarm (Hi or Hi-Hi) time of occurrence, time of acknowledgement and time to clear the alarm etc.

d) Weekly Report and Monthly Report

Same as 'Daily Report' except the time period shall be either a week or a month as the case may be.

e) Alarm Inhibiting Report shall indicate the alarms inhibited/overridden/forced along with date & time of enforcement, time of return to logical state etc.

f) In addition to above user shall also be able to generate reports as per their standard operational requirements

g) Reports shall be printed on the log printer or any other multi-function printer as applicable, or as specified in the purchaser's specification.

2.5.5.7 The Monitoring Console shall be Personal Computer (PC) based with 21" size active matrix TFT type LCD display unit with backlit LED (Full HD) and having one operating cum programming keyboard and a laser printer. Unless the vendors have their own proprietary machine, the Personal Computer shall have processor of latest version with following minimum specification:

Hard Disc Capacity	1TB
Clock Speed	2.8 GHz
RAM Size	16 GB
Monitor Size	21" TFT type LCD display unit with backlit LED

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2.5.6 Gas Detection System Programmable Logic Controller (PLC)

2.5.6.1 When specified in the purchaser's specifications, Gas Detection system with Programmable Logic Controller (PLC) shall be supplied along with a Monitoring Console as Man Machine Interface (MMI), Hardwired console with pushbuttons/ switches, as required and a coloured laser printer for printing alarms and reports. The PLC shall receive the following from all gas detectors:

a) (4-20 mA) for gas concentration levels,

b) Serial link RS485 for the diagnostics, programming and calibration information, when specified.

2.5.6.2 The PLC shall perform the following functions:

a) Display the gas concentration levels from each detector in engineering units on the MMI

b) Generate high alarm, high-high alarm as specified under the Gas Monitors/ Controllers section (clause No. 2.5.2 of this specification) and display the same on the MMI.

c) Printing of alarms and events on the printer.

d) Display diagnostic messages from each detector on the MMI and printout of diagnostic alarms.

d) Dynamic graphic displays for each area on the MMI.

e) In addition, the monitoring console shall meet all the requirements specified in clause 2.5.5 of this specification.

f) Calibration/test switches on the hardwired console to allow for sensor calibration without alarm outputs.

g) Provide actuation signal and reset signals to Hooters in the field and Hooter & Beacon in the control room.

h) Provide serial RS485 output with 'MODBUS RTU' protocol for interfacing with purchaser's Distributed Control System (DCS)

i) Provide isolated hardwired contacts to purchaser's Emergency Shutdown System (ESD).

2.5.6.3 All other specification of the PLC shall be as per 'Standard Specification for Programmable Logic Controllers' 6-52-0040.

3.0 NAMEPLATE

3.1 Wherever Gas Detectors are specified,

Local mounted instruments shall have a stainless steel nameplate attached firmly to it at a visible place, furnishing the following information:

a) Tag number as per purchaser's data sheets.
b) Manufacturer's serial number and /or model number
c) Manufacturer's name/trade mark.
d) Body material.
e) Measuring element material.
f) Range of measurement.
g) Area classification in which the equipment can be used, this shall be to the same code as per purchaser's data sheets.

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3.2 Wherever Gas Detection System is specified, In addition to the details specified in 3.1, Following shall also be noted.

a) Nameplates shall be constructed of black laminated plastic plates with engraved lettering and securely fastened with 316 Stainless Steel screws. One screw hole for each nameplate shall be elongated to provide for expansion and contraction of the nameplate.

b) The nameplates shall be mounted below the controllers, identifying the location of their respective sensors. If a multi-channel controller is used, each sensor shall be tagged on the nameplate using the corresponding point number.

c) Front panel-mounted control switches shall also be tagged. Nameplates shall be located directly below the corresponding switch with the size and lettering proportional to the front panel mounting dimensions of the device.

d) All front panel-mounted instruments shall also be identified with a metal or plastic nameplate attached to the rear of the device and easily visible from the rear of the panel.

e) Tagging for these nameplates shall be identical to that used in the panel front. All rear panel auxiliary equipment shall be similarly identified. The tagging for this equipment shall correspond to that used on the applicable schematic diagrams.

4.0 INSPECTION AND TESTING

Purchaser reserves the right to inspect and witness testing of all the items at the vendor's works in line with the inspection test plan and approved quality documents for gas detection system. All these tests shall be completed by the vendor and test reports shall be submitted to Purchaser for scrutiny.

5.0 SHIPPING

5.1 Wherever Gas Detectors are specified,

a) All threaded and flanged openings shall be suitably protected to prevent entry of foreign material.

b) Instruments shall be supplied individually, in suitable sealed packing.

c) All electronic instruments in oxygen and chlorine service shall be separately packed along with a certificated indicating 'CERTIFIED FOR OXYGEN / CHLORINE SERVICE', as applicable.

d) Loose supplied accessories shall be packed with proper tag numbers of their respective instruments.

5.2 Wherever Gas Detection System is specified, In addition to the details specified in 5.1, following shall also be noted.

a) After initial acceptance of the panel at the vendor's shop by the purchaser, the sensors and all panel components, which the vendor considers liable to be damaged during shipment or storage, shall be packaged for separate shipment. If instruments are removed from the panel, panel and their connections shall be suitably tagged to ensure simple re-installation at the job site. Each instrument shall be sealed in plastic bags containing moisture-absorbing desiccant.

b) Spare parts shall be packaged separately and clearly marked as "Spare Parts".

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LIST OF STANDARD SPECIFICATIONS
STATIC & MACHINERY EQUIPMENT
ANNEXURE-C: ROTATING EQUIPMENT

COOLING TOWER PACKAGE
TENDER No.: C050-1U68-81-45-PB-T-8010

PROJECT : **EPCM SERVICES FOR POLYPROPLENE PROJECT AT NUMALIGARH REFINERY**

UNIT : **RECIRCULATING COOLING WATER SYSTEM**

CLIENT : **M/s NUMALIGARH REFINERY LIMITED(NRL)**

EPCM : **M/s ENGINEERS INDIA LIMITED (EIL)**

JOB NO. : **C050**

Rev. No.	Date	Purpose	Prepared by	Checked by	Approved by
A	02.12.2024	ISSUED WITH TENDER	VS/SG	MG	TK

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LIST OF STANDARDs, STANDARD SPECIFICATIONs & ITPs FOR ROTATING EQUIPMENT

S. No.	Doc. No.	Title Description
1.	6-41-0003	Standard Specification for Centrifugal Pumps (Water Service)
2.	6-41-0002	Standard Specification for Centrifugal Pumps (General Purpose)
3.	6-41-0021	Standard Specification for Positive Displacement Pumps - Controlled Volume
4.	6-41-0301	Standard Specification for Dosing Packages (Skid Mounted)
5.	6-76-0001	Standard Specification for Erection of Equipment & Machinery
6.	6-78-0001	Specification for Quality management system requirements from Bidders
7.	6-78-0002	Specification for Documentation requirement from Contractors
8.	6-78-0003	Specification for Documentation requirement from Suppliers
9.	6-81-0037	Inspection & Test Plan for Pump Centrifugal Horizontal (General Purpose Process)
10.	6-81-0052	Inspection & Test Plan for Pump Reciprocating (Controlled Volume)

Notes:

1) For Piping, Electrical, Instrumentation, Static or other equipment referred in various rotating equipment packages, refer list of specifications, standards & ITP, etc. of respective discipline section in the tender.

2) In case of non-availability of any specific standards/specifications/ITP of particular equipment (or) any additional document applicable/required, same will be given to successful bidder after award of contract, and the same shall be complied by the CONTRACTOR.

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JOB NO :	**C050**
TENDER NO :	**C050-1U68-81-45-PB-T-8010**
PROJECT NAME : CONTRACTOR :	
ACTIVITY/ DELIVERABLE :	**ARCHITECTURE DRAWING**
DOCUMENT TITLE :	
DOCUMENT NO./ REV. :	

SR. NO.	CHECK/ CONTROL POINTS	CONTRACTOR RESPONSE
1	Drawings to be prepared by approved architect/architectural agency.	
2	Drawings shall include details of architect/architecture agency such as title , name, sign and stamp etc.	
3	Drawing is prepared based on requirements of approved GA/Feed drawings ? In case drawings are prepared based on approved GA drawings , Contractor to include the drawing number in the drawing legend.	
4	Attach the Approved GA drawings along with the first submission drawings	
5	Drawing is prepared in compliance with Engineering Design Basis.	
6	List all licensor requirement included in drawings if applicable for the project.	
7	Compliance to OISD-163 in case of Control room /SRR buildings if applicable to the project.	
8	Comment from OWNER to be obtained for important occupancy Plant and Non-Plant buildings such as control room ,SRR, admin building , lab building , gate house , canteen workshop etc etc. Please enclose the comment sheet obtained from client along with resolution.	
9	Drawing shall indicate the space utilization based on the equipment layout, furniture layouts, circulations, exits etc.	
10	Drawing is co-ordinated with related disciplines and comment/observations/input from them are incorporated.	
11	Drawing note shall include the building classification as per NBC.	
12	Drawing note shall include the type of Construction as per per NBC.	
13	Drawing note shall include the height of building calculated as per NBC and its classification as high rise and low rise buildings.	
14	Drawings shall include the critical calculations based on number of occupancy such as; a. Number of exits b. Clear width of exits & aisle c. Travel distance d. number of fire exit staircase e. width of fire exit staircase	

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SR. NO.	CHECK/ CONTROL POINTS	CONTRACTOR RESPONSE
	f. exit doorways g. fire rating of door assembly and walls.	
15	Drawing shall include critical information of fire exit requirement as applicable a. Fire zoning b. Compartmentation c. Emergency escape route d. Emergency exits e. Refuge area	
16	Drawing Note shall include type of active fire suppression system considered for the building.	
17	All rooms in the drawing to be tagged for AC, FC, FF, UD& OD as per tender requirements.	
18	Drawing number is as per approved DCI.	
19	Drawing contains Plans, Elevations, Sections, Schedules of Door-Window, Finishes, Standard Notes, Key Plan etc. as required.	
20	North Line, Orientation is provided and is as per input data/ Plot Plan.	
21	All relevant Level i.e. Finished Floor level (FFL), Finished Road Level (FRL) or Finished Ground Level (FGL) are marked in the plan.	
22	Schedules of Door-Window, Finishes, comply with Job Specifications, approved Design Basis and Tender Specifications.	
23	Field notes for specific instructions/ scope of work defined.	
24	Layout of grids and spacing/ dimensions/ etc. as per input data and compatible with the structural drawings.	
25	All internal and external dimensions marked in the drawing.	
26	All relevant Level i.e. Finished Floor level (FFL), Finished Road Level (FRL) or Finished Ground Level (FGL) are marked in the plan.	
27	All revision and changes to be cloud marked for tracking the changes over previous submission.	
28	All wall openings schedule to be specified in the drawing pertaining to utility and services.	
29	False ceiling drawings of building shall be prepared based on approved electrical layout and HVAC duct layout.	
30	Correct Revision no is marked in drawing title block.	
31	“Holds” are clearly marked in the drawing.	
32	Parts of drawing which is revised is clearly marked by clouding and writing revision nos.	
33	Floor drains to be indicated in the drawings.	
34	Drawing is in standard Format in requisite scale.	

Any other observation/comment (attach additional sheet, if required):

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Date: Name & Signature

Notes:

1. Contractor shall attach this filled in checklist along with document for OWNER/PMC review and approval.

Signature Not Verified

Digitally signed by MD MAZHER ALI
Date: 2026.04.09 17:58:16 IST
Location: eProcure-EPROC

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