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3 PRIMARY ELEMENTS

3.1 GENERAL

3.1.1 Scope

1 This Part includes specifications for Primary Elements, their design, manufacture, installation and commissioning.

2 Related Sections and Parts

This Section

Part 1, General

Part 2, General Telemetry/SCADA

3.1.2 References Standards

1 The following standards are referred to in this Part:

BS 907.....Dial gauges for linear measurement

BS 1042Flow Measurement

BS 1780Bourdon tube pressure and vacuum gauges

BS 1904Industrial platinum resistance thermometer sensors

BS 2765Dimensions for temperature detecting equipment and their pockets

BS 3680Open channel Flow and Level Measurement

EN 50014 to EN 50020 Protection

EN 60529Ingress Protection

EN ISO 6817Flow measurement for conductive liquids

BS 6739Instrumentation in process control systems Installation, Design and Practice

IEC 60839Alarm and warning systems

ISO 5167Measurement of fluid flow by means of pressure differential devices

EC 61000-4Electromagnetic compatibility for Industrial Process measurement & Control Equipment.

IEC 60654Operating conditions for Industrial Process Measurement and Control Equipment.

Part 1: Climatic Conditions

Part 3: Mechanical influences

Part 4: Corrosive and erosive influences

IEC 60584Thermocouples

Part 1: Reference tables (584/1)

Part 2: Tolerances (584/1)

IEC 60751Industrial Platinum resistance thermometer sensors

IEC 60529Classification of degrees of protection provided by enclosures (IP code)

3.1.3 Submittals

- 1 Submittals shall be in accordance with Part 1 of this Section.
- 2 Manufacturer's literature, illustrations, specifications and engineering data including dimensions, weight, instrument set point and range, ambient temperature and humidity rating, process pressure rating, enclosure specifications, installation and wiring diagrams shall be included.
- 3 The submittal shall be subject to approval by the Engineer. The ICA Subcontractor shall submit the final documentation based on the Engineer's comments. The Engineer's comments/approval shall be issued to the Contractor within 21 calendar days of the submittal.

3.1.4 Quality Standards

- 1 Manufacturer. In addition to requirements of Part 1 of this Section, instrumentation and controls equipment furnished shall be manufactured by a Company regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design. The manufacturer shall be approved and designated in the Project Specification.
- 2 Maintainability. All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major dismantling. Internal field adjustments, where permitted or required herein, shall be easily accessible upon removal of a panel or cover.
- 3 Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or specified in the Project Specification.

3.1.5 Warranty

- 1 The equipment manufacturer shall warrant his product to be free from defects in workmanship for a period of 400 days from the date of satisfactory completion of performance test.
- 2 Warranties and guarantees by the suppliers of various components in lieu of single-source responsibility by the equipment manufacturer will not be accepted. The Contractor shall be solely responsible for the warranty. In the event a component fails to perform as specified or is proven defective in service during the warranty period, excluding items normally expended during operation, the equipment manufacturer shall provide the replacement Part without cost to Employer. The Contractor shall be responsible for the supply for all such spares under warranty.
- 3 The Contractor shall furnish the Employer with manufacturer's guarantee and warranty certificates for all equipment, duly registered with the manufacturer.

3.2 PRODUCTS

3.2.1 Electromagnetic Flow Meters

- 1 General. Electromagnetic flow meters shall use electromagnetic induction to produce a dc voltage proportional to the liquid flow velocity. The flow meter shall be certified intrinsically safe and suitable for hazardous area Zone 1, gas group IIA to EN 50014, where specified in the Project Specification. Flowmeter shall be pressure tested and calibrated by the manufacturer and certified. Overall accuracy shall be better than ± 0.5 % of the range throughout the operating range. Repeatability shall be within ± 0.2 %.
- 2 Sensor. Sensor shall have NP16 flanged process connections. Metering tube, flanges and earthing rings shall be of stainless steel 304 to BS 970. Electrodes shall be of stainless steel 316 to BS 970. The sensor lining shall be of Teflon or equivalent material suitable for the application, unless otherwise specified in the Project Specification. The sensor enclosure shall be protected to IP68. Screened and armoured cable between the sensor and the transmitter shall be fitted and potted by the manufacturer. The preamplifier input impedance of the sensor shall be a minimum of 10^5 megaohms to minimise errors due to sensor coating. Ultrasonic electrode cleaning equipment with all accessories for automatic or manual operations, shall be provided when specified in the Project Specification.
- 3 Transmitter. Transmitter shall be remotely installed from the sensor. Transmitter power supply shall be 240 V a.c , 50Hz, unless otherwise specified in the Project Specification. Transmitter shall be microprocessor based with programmable range and engineering units. Outputs shall be isolated 4-20 mA d.c. and pulse with adjustable span. Programmable in-built alarm relays shall be provided for empty pipe, low and reverse flows. Transmitter shall have an inbuilt digital display for flow rate, totalizer value and alarms. Transmitter enclosure shall be protected to IP65. Calibration and programming kit shall be provided

3.2.2 In - Line Ultrasonic Flow Meters

- 1 General. Ultrasonic Doppler type flow meter with nonintrusive sensor permanently bonded to the pipeline. Overall accuracy shall be within ± 2 % of the range with a repeatability of ± 0.2 %
- 2 Transducer. Dual transducers shall be permanently bonded or clamped on to the pipe line to ensure that locked air pockets are eliminated.
- 3 Transmitter. Transmitter shall be remotely installed from sensor. 240 V a.c. 50 Hz power supply, unless otherwise specified in the Project Specification. Wall mounted with in-built flow rate and total display. Enclosure protected to IP65. Automatic gain adjustments to suit pipe line material shall be available. Alarm contacts configurable for diagnostic or low flow alarm shall be provided. Operating velocity range shall be user selectable. Output shall be isolated 4-20 mA d. and facility for connecting industrial standard fieldbus

3.2.3 Thermal Flow meters

- 1 Constant temperature thermal mass flowmeters shall be used suitable for the application. The sensor shall provide 4-20 mA output proportional to actual flow and have alarm outputs for detecting high, low, sensor malfunction conditions. Overall accuracy shall be better than ± 0.5 % of the operating range and repeatability shall be within ± 0.2 %.

3.2.4 Rotameters

- 1 Rotameters shall have borosilicate glass metering tube, stainless steel 316 float and wetted Parts to BS 970, scale shall have black markings on white background with a nominal length of 250 mm. Graduation units shall be as specified in the Project Specification. Flanged process connection. 2 % accuracy and 10:1 rangeability. Glass tube shall be easily removable for cleaning.

3.2.5 Venturi Flumes

- 1 Rectangular flumes used for open channel flow measurement to BS 3680 Part 4c, shall be moulded in a single GRP piece with 5 mm thick walls, reinforcing ribs and internal removable blocking to prevent distortion during shipment. Provide staff gauge, 50 mm width by full depth with 1 mm increments recessed into flume. The flume shall be self supporting and be provided with an adequate number of lugs integral to the structure to enable the flume to be cast into a reinforced concrete channel without additional internal or external supports.
- 2 U-throated flumes to BS 3680 Part 4C, shall be used for measurement of flows in sewers and other conduits running partly full.

3.2.6 Flow Switches

- 1 General. Flow switches shall sense an adjustable preset flow rate of fluid in a pipe and operate a SPDT switch to actuate alarms or control circuits. The switch shall be rated for 5 ampere load at 110 V a.c., 50 Hz or 1 Ampere at 30 V d.c.
- 2 Vane type flow switches shall be housed in a watertight case, unless explosion proof is specified in the Project Specification, with electrical conduit connection. Switches for mounting in 40 mm pipe or larger shall be fitted for BSP thread mounting directly in the pipe. Smaller sizes shall be supplied mounted on a pipe fitting with female BSP threads. The switch assembly shall be isolated from the flow by a diaphragm or suitable seal. The actuator vane and other wetted parts shall be stainless steel, monel, brass or other corrosion resistant material suitable for the fluid in the pipe. These flow switches are suitable for gases or clear liquid applications only and shall not be used for raw sewage applications.
- 3 Thermal type flow switches shall be housed in an explosion proof or watertight case as specified in the schedule with NPT electrical conduit connection and shall be either of the probe type of insertion in the pipe or shall incorporate a pipe spool for installation in the line, end fittings as shown on the Drawings. They shall operate by means of sensing the differential cooling of heated sensor elements caused by flow and no flow condition, and shall be all solid state. The switches shall be available for pressure up to 14 MPa and shall be capable of sensing velocities as low as 3 cm/s. Wetted parts shall be stainless steel to BS 970 or other materials suitable for the application.
- 4 Operating Conditions. The flow switch shall be sized and adjusted for the pipe, fluid and flow rate or velocity shown in the Flow Switch Schedule. Repeatability of sensing shall be within 10 percent for any setting, and differential shall be less than 4.0 percent within the flow range specified. Set point shall be within 10 percent of flow rate of velocity specified. Care should be taken while installing, to avoid locations with turbulent flow conditions.

3.2.7 Ultrasonic Level Measurement

- 1 General. Unless otherwise specified in the Project Specification, the system shall comprise of a separate transducer and a transmitter. Overall accuracy shall be better than $\pm 1\%$ of the span with a repeatability of $\pm 0.5\%$. Ultra-sonic level measurement is to be accomplished by the use of non-contact, echo-time measuring equipment operating at ultra-sonic frequency. The equipment is to transmit pulses, which are reflected back to the sensor from the surface of the liquid whose level is being measured. Provide equipment with automatic temperature compensation and suitable for operation in the designated application under the specified climatic conditions. The wiring connections between the sensor and transmitter shall be carried out by a manufacturer's supplied original cable
- 2 Transducer. The enclosure shall be protected to IP68. Automatic compensation for changes in ambient temperature shall be in-built. The transducer shall be certified for hazardous area use if necessitated by the installed conditions, unless otherwise specified in the Project Specification. The transducer shall be supplied complete with all required mounting accessories.
- 3 Transmitter. Surface or panel mounted transmitter with 240 V a.c. 50 Hz power supply. Microprocessor based transmitter with programmable range and alarms. Transmitter shall be complete with in-built indication for level or for flow, if used for open channel flow measurement. 4 Nos. in-built relay contacts, shall be provided for process and diagnostic alarms. Transmitter shall be provided with an in-built keypad or a hand held programming unit of programming the instrument. Output shall be isolated 4-20 mA d.c and facility for connecting industrial standard fieldbus.

3.2.8 Hydrostatic Level Transmitter

- 1 Hydrostatic head type level transmitters shall be used for tank level measurement at atmospheric pressure. Flush diaphragm type capacitance sensor suspended inside the tank. Sensor shall be certified intrinsically safe and protected to IP68. Sensor material shall be stainless steel 316 to BS 970. Two wire transmitter with 4-20 mA d.c. output $\pm 0.5\%$ accuracy and built-in display. Flanged process connection on top of the tank.

3.2.9 Level Sensing System - Air Reaction Type

- 1 General. The level sensing system shall be designed to operate on the back pressure caused by the level of the liquid above the open end of a pipe through which air is being discharged. The device shall be capable of sensing a rising or a falling liquid level and shall translate this rise or fall into a proportional analogue signal. Device shall be two-wire loop powered 4-20 mA dc output and facility for connecting industrial standard fieldbus with an accuracy of $\pm 0.5\%$ of span. All equipment such as required to meet the operational requirements set forth herein shall be included and connected to obtain a complete functional system as specified herein.
- 2 Air Supply. The system shall operate from the auxiliary air sources specified below. To facilitate control, the system shall include a strainer, shutoff valve, pressure regulator with gage, flow control valve and flow metering rotameter with differential pressure regulator. A 4-way purging valve or equivalent shall permit purging of the bubbler tube while isolating the pressure sensing line.

- 3 Piping Connections. A "tee" with a removable plug for cleaning purposes shall be provided to connect the air tubing to the bubbler tubing in the wet well. The plug shall be readily accessible for cleaning.. The wet well sensing tube shall be 12 mm diameter stainless steel to BS 970 grade 316 S12 and extend to 150 mm below the low alarm level or as otherwise shown on the Drawings and be supported on not more than 1200 mm centres using stainless steel clamps on the wet well wall to avoid movement due to turbulence. Static pressure connection to the 4-way purging valve shall be 8 mm polyethylene tubing, enclosed in steel conduit or equivalent protection. The pressure output signal shall be sensed by indicator dials, pressure switches, electronic or pneumatic transmitters as specified in the Project Specification.
- 4 Auxiliary Air Supply. The system shall incorporate and operate from internally mounted dual oil-less heavy duty air compressors, each capable of providing the required air flow. The compressors shall operate in a duty-standby mode. Failure of the duty compressor shall generate an alarm and start the standby compressor. Facility shall be provided to drain out condensate from the system.

3.2.10 Capacitance Level Transmitter

- 1 General. Radio frequency type level sensors shall sense the varying capacitance admittance of a sensing probe as function of the level of submersion. Varying capacitance is converted to a 4-20 mA d.c current signal or volt free contact output as indicated in the Project Specification.
- 2 Specific Requirements. The type of process medium, temperature range, pressure other than atmospheric, measurement range, indicators, switches, etc. shall be as specified in the Project Specification. Unless otherwise specified the accuracy shall be $\pm 1\%$ of full scale. The electronics for the sensor shall incorporate circuitry which shall act to cancel error caused by coating build-up on the probe.
- 3 Construction. The radio frequency level sensor shall consist of a probe and a solid state electronic unit housed in an IP66 case for surface or panel mounting. Probes shall be designated for mounting through a threaded flange adapter unless otherwise shown on the Drawings. The probe mounting parts shall be stainless steel 316 to BS 970 and the probe shall be in accordance with the manufacturer's recommendation for the application specified. Rigid probes shall be Teflon coated. Local indicators shall be mounted on the electronics housing and shall indicate in the engineering units specified in the Project Specification. The output shall be isolated 4-20 mA d.c. unless otherwise required by the Project Specification.
- 4 Power. The level sensing system shall either be a two wire transmitter loop powered by the receiver or operate from 110 V /240 Va.c., 50 Hz power supply.

3.2.11 Multiple Level Measurement Systems

- 1 General. Multiple level detection systems shall be used for pump control or multiple level alarm applications. Each system shall comprise of one or more electrode assemblies and a controller.
- 2 Electrodes. Conductivity type electrode assemblies shall have a weatherproof enclosure to IP56. Electrodes shall be of 316S12 material to BS 970 Part 1. Process connection shall be BSP threaded or flanged to BS 4504. The electrode assembly shall have a glazed ceramic insulator cemented to the metal housing. The measuring electrodes shall be Teflon insulated except at the tip.

- 3 Controller: Controller power supply shall be 110 V a.c. 50 Hz. Provide double pole changeover contact for the output relays. Controller shall have LED indication for relay status. Zener barriers shall be provided for intrinsically safe installations when the electrode assembly is located in hazardous areas. Multiple level detection signals shall be used by the Controller for control of up to 4 pumps or level alarm. The number of control modules in each controller shall depend on the number of level signals and control contacts required.

3.2.12 Tilting Float Level Switches

- 1 General. Tilting float level switches shall use the tilting movement of a float, whose specific weight is less than that of the process liquid, to actuate switches as the level changes. The switch(es) shall be integrally mounted in the float and connected to a control box by an appropriate, waterproof electric cable. A movable weight shall be mounted on the cable to allow adjustment of the setpoint(s). Sufficient cable length shall be provided to facilitate termination in a control or electrical room unless otherwise stated in the Project Specification. The float shall be polyethylene, stainless steel or other approved material.
- 2 Specific Requirements. The desired switching action Pump-up ("pump-down", or alarm), level set-points, cable length and optional features shall be as specified in the schedule. Contractor may utilise either a series of floats or a single float to provide the specified switching action. The "pump-up" type shall close a contact at a low level and open it at a high level. The "pump-down" type shall provide the opposite action.
- 3 The switch shall be rated for 5 A, 110 V 50 Hz or 1 A, 24 V d.c. inductive load.

3.2.13 Level Switches - Conductivity Probe

- 1 General. Level sensing switches of the conductivity probe type shall use the electric conductivity property of the sensed fluid to close an electric circuit between two or more sensing probes or between probe and an electrically conductive tank shell. The level switches shall consist of a probe assembly and an electronic sensing unit.
- 2 Sensing Unit. The solid state sensing unit shall operate from a power source of 110/240 V a.c., 50 Hz, but shall not apply more than 10 V to probes and the current shall be limited to one milliamperes maximum. The unit shall be housed in an IP66 enclosure, unless explosion proof is specified in the Schedule, and shall be for pipe stand or surface mounting. The unit shall be suitable for direct or inverse operation (i.e. output contacts) operate on liquid contact or non-contact. The output shall have two SPDT switches, rated at 5 A resistive load at 110 V a.c., with provision for latching or non-latching operation, by appropriate connection of the output contacts, to provide for "pump-up", "pump down" or alarm type operation.
- 3 Probes. The probes shall be either of the rod or flexible wire type when not specified the Contractor shall select the type most suitable for the application and submit the choice for approval. Solid rods shall generally be used only where the installation requires less than 2 m in length. Both rod and flexible wire types shall be insulated except at the sensing end. Either type shall be suspended from a holder which provides liquid tight connections, and when installed in a pressure vessel they shall be pressure tight to at least twice the system operating pressure. Exposed probe ends shall be type 316 stainless steel to BS 970 and holder shall be cadmium plated cast iron, unless otherwise stated in the Project Specification. The number of probes per holder shall be as specified in the Project Specification. The holder mount type (i.e. pipe threaded, flanged or conduit style) shall be selected to suit the installation unless otherwise specified in the Project Specification.

3.2.14 Electronic Pressure Transmitters

- 1 General. Unless otherwise specified in the Project Specification, the instrument shall be a two-wire loop powered transmitter with a 4-20 mA dc output, with an accuracy of $\pm 0.25\%$ of span. The wetted parts shall be stainless steel Grade 316S31 to BS 970 and the enclosure protected to IP67. Complete with flush diaphragm or remote seal sensing system. To achieve optimum accuracy, transducers shall be selected to have a range as close as possible to the anticipated operating range. A datum point shall be provided adjacent to the transducer installation. An engraved plate shall define any offsets resulting from its elevation relative to the tapping point (zero level) and also define the range of the transducer. All elevation measurement shall be in metres, with the equivalent bar offset shown. Sensors shall be positioned in a location accessible for safe maintenance. Where separate transducers and transmitters are used, the transmitter where possible, shall be positioned locally to the transducer to facilitate calibration. Site operatives shall be provided with a remote readout at a convenient point.
- 2 Construction. The transmitter enclosure shall be IP65 unless explosion proof is specified in Project Specification. Enclosure and wetted surface material shall be stainless steel to BS 970 or as indicated in the Project Specification.

3.2.15 Electronic Differential Pressure Transmitters

- 1 General. Electronic differential transmitters shall convert a differential pressure measurement to a loop powered 4 to 20 mA d.c. output signal. Range shall be as indicated in the Project Specifications and span shall be field adjustable over at least a 10 to 1 range. Elevation or suppression facility shall be provided. Overload protection shall be at least +3.5 MPa. Accuracy shall be ± 0.5 percent of full scale span or better. Integral adjustable damping shall be provided. An indicating meter shall be provided. Zero and span adjustments shall be provided.
- 2 Construction. The transmitter enclosure shall be IP65 unless explosion proof is specified in project specification.. The process connection shall be 12 mm NPT. Enclosure and wetted surface material shall be stainless steel to BS 970. Vent drain plug shall be provided on meter body. A 3-valve manifold shall be provided such that the transmitter can be removed without disturbing piping connections.

3.2.16 Pressure Gauges

- 1 Gauges shall have bourdon tube sensor with 270 degrees pointer travel. Dials shall have black markings on white background. Dial size shall be 100 mm unless otherwise specified. Wetted Parts and case shall be 316 stainless steel to BS 970. Accuracy shall be $\pm 1\%$. 1/2 inch NPT process connection unless otherwise specified. Pressure range and units shall be as specified in the Project Specification.
- 2 Isolation diaphragm shall be stainless steel 316 to BS 970 with silicone fill, pulsation dampeners or vibration snubbers shall be provided where specified in the Project Specification.

3.2.17 Vacuum Gauges

- 1 Gauges shall have bourdon tube sensor with 270 degrees pointer travel. Dials shall have black marking on white background. Dial size shall be 100 mm unless otherwise specified. Wetted Parts and case shall be stainless steel 316 to BS 970. Accuracy shall be ± 1 %. 1/2 inch NPT process connection unless otherwise specified. 0-760 mm HgA range unless otherwise specified in the Project Specification. Cases shall be black phenolic.

3.2.18 Pressure Switches

- 1 Pressure switches shall have a diaphragm type sensor with a switching differential adjustable within 25 % of the range. Contact shall be micro switch SPDT rated 110 V a.c. 5A, 30 V d.c. 2A. Accuracy shall be ± 1 % of span. Stainless steel enclosure certified explosion proof where specified in the Project Specification.

3.2.19 Limit Switches

- 1 Limit switches shall be provided to sense the limiting positions of equipment, such as valves. The switches shall be non-contact reed type, magnetically coupled to the actuating device. SPDT contacts shall be rated 110 V a.c. 3A. Reed switch shall have a life expectancy of one million operations.

3.2.20 Temperature Sensors

- 1 General. Temperature sensors shall be (RTD) platinum resistance element. RTD sensors shall have a temperature resistance relationship and tolerances for 100 ohm platinum resistance element to BS 1904.
- 2 Construction. Temperature sensors shall be equipped with accessory equipment as specified in the Schedule. In general, accessory equipment shall consist of general purpose, or explosion proof connection heads; pipe extension with union connectors or bushings; wells or protecting tubes and spring-loading assemblies. Well or protecting tube material shall be to BS 2765. Sensors shall be integrally mounted with transmitters to provide a 4-20 mA, loop powered signal, where specified in the Project Specification.

3.2.21 Gas Detection System

- 1 General. Gas detection system shall be rack-mounted. The system shall measure and display gas concentration and shall provide audio and visual alarms when preset limits are exceeded. Relay output for alarms and malfunction indications and analogue signal representing gas concentrations shall be provided. The system shall be configured for fail safe operation. Failure of a sensor shall generate an alarm. The system shall consist of a sensor, control module, and calibration check kit including sensor separation accessories and calibration gas tanks. Sensor and transmitter location shall be as shown on the drawings and schedule. The gas detection system shall operate from 110 V a.c., 50 Hz power.
- 2 Control Module. The control module shall amplify the sensor current signal through a solid-state amplifier for display and alarm functions. The control module shall include a two or three-digit LED display and three discrete alarm levels: Low, high, and malfunction. Output relay contact shall be rated at 2 amp, 110 V a.c. and single pole, double throw. Analogue output signal representing the gas concentration shall be 4-20 mA.
- 3 Oxygen Gas Detector. The oxygen gas detector shall have a 0-25 percent range, full scale. The oxygen sensor shall be housed in an explosion proof enclosure. The sensor shall be the electrochemical fuel cell type and not require the periodic addition of reagents.

- 4 Combustible Gas Detector. The combustible gas detector shall have a 0-100 LEL range, full scale calibrated on methane gas. The combustible gas sensor shall be the catalytic bead type. The sensor must have a demonstrated resistance to degradation by silicones and reduced sulphur gases.
- 5 Hydrogen Sulphide Gas Detector. The hydrogen sulphide gas detector shall have a 1-100 ppm range; full scale. The hydrogen sulphide sensor shall be of the electrochemical type which shall not require periodic addition of reagents.
- 6 Chlorine Gas Detector. The chlorine gas detector shall have a 0-10 ppm range, full scale. The chlorine gas sensor shall detect a minimum concentration of 0.5 ppm by volume and a maximum response time of 30 s for 80 % of range to 10 ppm gas at 20° C. Sensor recovering time shall be 3 minutes for 90 % of range at 10 ppm chlorine.

3.2.22 Guided Wave Radar Level Transmitter

- 1 The probe shall:
 - (a) have single rod with extended flexible wire, minimum probe diameter 6mm and constructed of stainless steel to BS970-1 Grade316S31 (partially replaced by EN 10084);
 - (b) have flange mounted and threaded process connections;
 - (c) be able to work with ambient rating of 150°C at 20 bar, for a dielectric range of 10-100;
 - (d) have ingress protection and hazardous area protection and shall meet the CE requirements on Electromagnetic compatibility
 - (e) be energised in an intrinsically safe way.
- 2 The transmitter shall:
 - (a) have locally remote wall/post mounting with a flexible connection to the probe head;
 - (b) give a 4-20mA output with a resolution of 0.01mA;
 - (c) have a push button keypad and a HART communicator, with menu language English;
 - (d) have ingress protection and hazardous area protection and shall meet the CE requirements on Electromagnetic compatibility.

3.3 INSTALLATION

3.3.1 General

- 1 Installation, testing and commissioning shall be in accordance with Part 1 of this Section.

3.3.2 Testing and Final Acceptance

- 1 All the primary elements shall be calibrated and tested prior to final acceptance, in accordance with Part 1 of this Section.

3.3.3 Spare Parts and Tools

- 1 Spare Parts for all instruments listed in the schedules shall be provided for two (2) years of normal service. Refer to Part 1 of this Section for additional spare parts requirements.

END OF PART