

GENERAL SPECIFICATION

INSTRUMENTATION

GS EP INS 101

Instrumentation Design

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1. Scope

This specification defines the minimum requirements for the design, engineering and selection of instruments for onshore and offshore oil and gas installations.

The document should be read in conjunction with [GS EP INS 106](#).

2. Reference documents

The equipment shall satisfy the requirements and regulations of the country of installation and specific standards referred to in this specification.

Where national regulations exist, their provisions and those of the standards and codes to which they refer shall apply, supplementing or amending the provisions of this document.

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
API RP 551	Process Measurement
ASME B16.36	Orifice Flanges
ASME PTC 19.3TW	Thermowells
PD 5500	Specification for unfired fusion welded pressure vessels
Directive 2014/34/EU	Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
EN 837-1	Pressure gauges - Part 1: Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing
FCI 70-2	Control Valve Seat Leakage
IEC 60079-14	Explosive atmospheres - Part 14: Electrical installations design, selection and erection
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60584-1	Thermocouples - Part 1: EMF specifications and tolerances
IEC 60751	Industrial platinum resistance thermometers and platinum temperature sensors
IEC 61000-5	Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines
IEC 62591	Industrial networks - Wireless communication network and communication profiles - WirelessHART

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Reference	Title
IEC 62734	Industrial networks - Wireless communication network and communication profiles – ISA-100.11a
IECEX	International Electrotechnical Commission System for Certification to Standards relating to Equipment for use in Explosive Atmospheres (IECEX System)
ISA-100.11a	Wireless systems for industrial automation: Process control and related applications
ISA-5.1	Instrumentation Symbols and Identification
ISO 4406	Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles
ISO 5167 (All Parts)	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full – All Parts
ISO 5168	Measurement of fluid flow - Procedures for the evaluation of uncertainties

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Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 351	External protection of structures and equipment by painting. Floating structures
GS EP COR 354	External protection of onshore structures and equipment by painting
GS EP COR 771	Thermal insulation (hot and dual service)
GS EP DEV 001	Asset Objects Tagging
GS EP ECP 103	Process design criteria
GS EP ELE 032	Design of Earthing and Bonding Systems and Lightning Protection for Onshore Installations
GS EP ELE 079	Electrical Apparatus for Potentially Explosive Gas Atmospheres
GS EP HVA 212	Fire Damper(s)
GS EP INS 000	Contractor Document Requirements

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Reference	Title
GS EP INS 102	Instrumentation Identification
GS EP INS 103	Instrument Database Management
GS EP INS 104	Generation and Distribution of Instrument Air and Instrument Gas
GS EP INS 106	Instrumentation Installation
GS EP INS 109	Instrument cabinets
GS EP INS 110	Instrumentation for package units
GS EP INS 111	Design and supply of liquid custody transfer metering units
GS EP INS 112	Design and supply of gas custody transfer metering units
GS EP INS 115	Instrument Earthing
GS EP INS 116	Instrument Cables
GS EP INS 118	Instrument Troubleshooting Loop Diagrams (TSLDs)
GS EP INS 120	Control valves
GS EP INS 121	Choke valves
GS EP INS 125	Safety Relief Valves and Rupture Discs
GS EP INS 134	Design and supply of integrated control and safety system
GS EP INS 137	On/Off Valve Control Panels and Actuators
GS EP INS 138	Electric Actuators for On/Off Valves
GS EP INS 140	Instrumentation for monitoring packages
GS EP INS 141	Analysers
GS EP INS 143	Fire and Gas Detectors and Associated Detection Systems
GS EP INS 146	Generation and Distribution of Hydraulic Energy
GS EP INS 900	Instrument Hook-up diagrams
GS EP PVV 102	Piping Hook-up Standards
GS EP PVV 202	Standard drawings for accessories and equipment of vessels
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS EP PVV 212	Design and fabrication of pressure vessels according to PD 5500
GS EP SAF 261	Emergency Shutdown and Emergency Depressurisation (ESD & EDP)

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Reference	Title
GS EP SAF 312	Fire and Gas detection
GS EP TEC 007	Obsolescence and Lifetime Cycle Management

3. Terminology and Definitions

There are five types of statements in this specification, the “shall”, “should”, “may”, “can” and “must” statements. They are to be understood as follows:

Shall	Is to be understood as mandatory. Deviating from a “shall” statement requires derogation approved by Company.
Should	Is to be understood as strongly recommended to comply with the requirements of the specification. Alternatives shall provide a similar level of protection and this shall be documented.
May	Is to be understood as permission.
Can	Is to be understood as a physical possibility.
Must	Expresses a regulatory obligation.
Company	TOTAL E&P or any TOTAL E&P subsidiary.
Contractor	Any Party that has signed a Contract with Company for the Engineering, Procurement, Construction, and Installation in part(s) or in full of a project.
Vendor	The package Vendor sub-contracted by the Contractor or by Company.
Supplier	The Party that manufactures or supplies equipment, either individually or as a Packaged unit for the project.

3.1 Abbreviations

The following terms and abbreviations are used in this document.

CCR	Central Control Room
ESD	Emergency Shut Down (SIS)
FAT	Factory Acceptance Test
FGS	Fire and Gas System (SIS)
GS	Company’s General Specification
HIPS	High Integrity Protection System
ICSS	Integrated Control and Safety System
I/O	Input / Output
IS	Intrinsically Safe
ISO	International Standard Organisation
ITR	Instrument Technical Room

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PSS	Process Safety System (SIS)
SIS	Safety Instrumented System
UCP	Unit Control Panel
USS	Ultimate Safety System (SIS)

4. General Instrumentation Principles

Instruments are provided to ensure the safe operations of the plant. They shall be designed to be safe, simple and robust, ensuring segregation and independence between monitoring/control functions and safety functions.

4.1 Instrument Definition

The term "Instrument(s)" includes all devices that are used directly or indirectly to measure or control a variable. This includes primary element (sensors), transmitters, final control elements, computing devices, annunciators, switches and push-buttons, related to process, utilities, safety and fire & gas functions.

4.1.1 Safety Instruments

This term is used for any instrument involved in a Safety Instrumented Function or trip function (i.e. partial or complete stop of a machine or process equipment) following a parameter being outside the normal operating range (e.g. lube oil low pressure meaning a machine is no longer lubricated).

Safety instruments are normally connected to a safety control device such as PSS, ESD, FGS, USS, HIPS, safety UCP, safety panel.

4.2 Environmental Conditions

Instruments and instrument equipment shall be suitably designed for permanent operation under the prevailing environmental conditions of the installation location or as specified by project particular Design Conditions.

Environmental conditions comprise climatic exposure, vibrations, temperature conditions, humidity, potential gaseous ambience from produced fluids (e.g. H₂S), salt laden and corrosive atmosphere.

It should be noted that the environmental conditions at the fabrication yard may be different to those of the final site location. Therefore, the fabrication yard storage and installation conditions shall also be taken into account.

4.3 Instrument Architecture

4.3.1 Standard Architecture

The standard instrument loop architecture consists of field instruments connected to junction boxes, which are in turn connected to marshalling cabinets by means of multi-cables. Signals are then routed to the appropriate instrument control or safety system.

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In general, marshalling cabinets and system cabinets are installed indoors in technical rooms when junction boxes are installed in the field and outdoors.

4.3.2 External Remote I/O Architecture

Alternative instrument loop architecture is with the use of external remote I/O's. This alternative consists of instruments connected individually, or via junction boxes, to remote I/O units located externally within the field. The remote I/O is then connected via a network to appropriate controller of the system located in the technical room.

Remote I/O's installed outside technical rooms shall be certified for use in Zone 1 hazardous area and, when used for safety functions, shall meet the SIL requirements.

Remote I/O's are considered as "smart junction boxes". They consist of I/O modules, power supplies, communication bus interfaces and field terminals enclosed in boxes or cubicles according to the number of sensors or actuators they have to cope with.

Maintenance facilities shall include:

- Replacement of I/O or power supply modules under power
- Diagnostic data available at the ICSS or UCP maintenance/operator stations in the same way as for standard I/O's
- Parameters of smart transmitters available in technical rooms.

Refer to [GS EP INS 109](#), [GS EP INS 134](#), [GS EP INS 110](#) and [GS EP INS 140](#) for detailed requirements of remote I/O's.

Company written approval is required prior to use of such system.

4.4 Building Network Interconnections

Copper network links shall not be used to interconnect control, monitoring and safety systems when located in different buildings and when part of the network is installed outdoor, whatever their nature: part of the ICSS or UCP's for controlling and monitoring packages.

These interconnections shall be fibre optic as a base case. Radio link may be considered according to the telecommunications network availability.

Such links shall be redundant and shall run on different cable routings.

4.5 Signal Segregation

Instrumentation signals and cables shall be segregated according to their type and the control or safety system they belong to, as follows:

- Signals within cables shall be segregated following their nature and magnitude:
 - Analogue input & output and on/off input signals
 - Low level signals (e.g. RTD, thermocouple)
 - Frequency signals
 - I.S. signals
 - Instrument power supplies

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- On/off output signals
- System cable (e.g. network cable).
- Cables shall be segregated according to their function:
 - Control and Monitoring
 - Process Safety
 - Emergency Shut-Down
 - Fire and Gas.

Dedicated study shall be carried out to determine what type of segregation to implement (junction boxes, marshalling cabinets, I/O boards, etc.) when considering redundant instruments attached to the same equipment or instruments attached to redundant equipment in taking into consideration equipment criticality.

For cable routing design, refer to the requirements of [GS EP INS 106](#).

4.6 Instrument Standardisation

Instrument standardisation requirements shall be addressed during Basic Engineering taking into consideration the project contractual strategy (i.e. different EPC Contractors).

Instrument standardisation will be considered for the whole plant, including packaged units, i.e. same technology, supplier and model for the same use.

Instruments shall only be from approved vendors.

4.7 Instrument Identification

All instruments shall be individually identified.

Instrument identification shall be in accordance with [GS EP DEV 001](#) and [GS EP INS 102](#), based on international rules and practices and in particular [ISA-5.1](#).

5. General Instrument Characteristics

All instruments shall be in accordance with the following common characteristics.

5.1 Independence of Safety and Control Functions

Safety and control/monitoring functions shall be performed by independent and autonomous instruments and/or devices each with their independent process connection. Consequently, alarm and trip thresholds shall not be derived from same instrument.

In case of dual transmitters (one for Safety, one for Control) for the same process measurement, they shall have same range and span and the process connections shall be fully independent but close enough to allow comparison of measurements. Particularly in level measurements, the nozzles shall be on same level.

Switches shall not be used for process and safety threshold functions. Such functions shall be based on analogue signals.

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5.2 Signal Transmission protocol

5.2.1 Standard Instruments

All sensors/transmitters and controlled final receivers shall be 4-20 mA, 24 VDC, with HART protocol whenever available.

HART safety-related instruments shall be equipped with hardware write protection (i.e. switch or jumper) inside the transmitter.

The use of sensors where the HART function itself may be enabled / disabled on site is not permitted.

Fire and Gas detectors shall be based on 4-20 mA standard. If HART is provided, HART configuration shall be fixed at factory. Therefore at site it will only be possible to read the measurement, configuration parameters and diagnostic information. Access to configuration for modifications shall be forbidden. Use of discrete sensors will be studied on a case-by-case basis.

In residential buildings (living quarters, site offices, accommodation, etc.) use of addressable fire detectors may be considered.

The requirements for addressable fire detectors, or addressable fire and gas detectors when accepted by [GS EP SAF 312](#), are defined in [GS EP INS 143](#).

5.2.2 Fieldbus Instruments

Use of fieldbus for instruments is not recommended.

However, its use may be studied on a case-by-case basis and shall be subject to Company written approval.

Fieldbus protocols shall be according to recognized international standards (i.e. Foundation Fieldbus, Profibus PA).

5.2.3 Wireless Instruments

The use of wireless instruments shall not be permitted for control and safety functions (PCS, PSS, ESD, FGS, HIPS, USS and UCP), time critical applications and any other critical safety applications.

Wireless instruments may only be considered for:

- Non essential and non critical monitoring applications
- Non real time services
- Applications which do not require fast response time
- Applications which may withstand unavailability.

Before decision to consider such technology, the use of wireless instruments shall be subject to a case-by-case study at pre-project and basic engineering level. This study shall include interoperability, interchangeability, cyber-security, reliability, availability/sustainability issues and a risk analysis. For more details about this study, refer to [GS EP INS 140](#).

This wireless instruments study dossier shall be subject to Company written approval.

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Performances and availability of wireless instrumentation networks shall not be compromised by any other concurrent wireless networks or EM interferences.

Wireless data communication protocol will be as per recognized international standards.

Wireless Instruments connected to a monitoring system compatible with the standards [IEC 62734](#), [ISA-100.11a](#) or [IEC 62591](#) should be used as they offer greater interoperability with the equipment of up and coming generations.

Should any wireless technology be installed on a plant, then the overall design, scope of work and supply shall follow the rules for P4 packages (monitoring system) and be compliant with the requirements of [GS EP INS 110](#) and mainly [GS EP INS 140](#).

5.3 Process Connections

All process connections for instruments shall comply with [GS EP PVV 102](#) and [GS EP INS 900](#).

Each instrument shall have its own individual process tapping(s), not shared with any other instrument, in order to allow individual isolation of the instrument and to avoid any common mode failure.

Instruments will be installed with vent and drain facilities as necessary. For hazardous, toxic and/or polluting fluids, the vent/drain of instruments shall be piped to the vent/drain networks.

5.4 Electrical Connections

All electrical connections shall be in metric threaded in accordance with applicable ISO standards.

Electrical connection to instruments shall be ISO M20 x 1.5. For JB, connection size will depend of cable size.

5.5 Selection of Ranges

Unless otherwise specified, the instrument ranges should be selected such that the normal value is between 50 and 75 percent of scale, taking into account the specified minimum and maximum process conditions.

Set points thresholds derived from an analogue signal, should be between 10 and 90% of scale.

Special attention should be paid to cases requiring:

- A "narrow span" range
- A range elevation (suppressed zero range)
- A range suppression (elevated zero range).

5.6 Instrument Performance

Figures given for electronic instruments accuracy in the following chapters include the combined linearity, hysteresis and repeatability errors.

For applications where fast response time is required, dampening or filtering may be completely disabled inside electronic instruments. This shall be clearly stated on the instrument data sheets and verified. However, care should be taken to ensure that this will not cause spurious action due to 'spikes'.

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All instruments not treated in fail safe configuration (e.g. Manual Call points (MAC), (Emergency) Shut-Down push-buttons, deluge pull handles/buttons...) shall be line monitored.

5.7 Engineering Units

Unless local rules apply, metric units shall be employed with charts and scales as follows:

Process Variables		Units	Scales
Flow	Liquids	m ³ /D m ³ /hr	Direct reading
	Gases	Nm ³ /hr	Direct reading
Level	General	%	0-100 Linear
	Tank gauge	meter or %	0-100 Linear
Pressure	Above Atmospheric	barg	Direct reading
	Below Atmospheric	bara	Direct reading
	Differential	mbar	Direct reading
Analysis			Direct reading
Temperature	General	°C	Direct reading

5.8 Hazardous Area Protection

All equipment must comply with the requirements of the specific hazardous area where they are installed. Refer to **GS EP ELE 079** for detailed requirements about hazardous areas definitions and protection methods.

ATEX European [Directive 2014/34/EU](#) shall strictly apply in European countries and associated countries (e.g. Norway, Iceland).

ATEX European [Directive 2014/34/EU](#) or [IECEX](#) standards shall apply in other countries.

All field instruments and instrument equipment (i.e. Junction Boxes, Outdoor Control Panels/cabinets etc.) shall be certified for zone 1 as a minimum.

Should this be proved impossible, field instruments and instrument equipment certified for zone 2 may be installed on a case-by-case basis, subject to Company written agreement. They shall be de-energized in case of gas detection.

Particular care should be taken for signals, hardwired and networked, between buildings to ensure full electrical isolation of the building is achieved when required by the Safety Concept.

For category 3 equipment as per ATEX European Directive classification, certification by Manufacturer is not accepted. A "Declaration of conformity" shall be delivered by a Notified Body.

Preferred protection methods are Ex d, Ex e, Ex de, Ex i, Ex m, Ex me according to IEC standards.

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Use of the protection methods Ex p and Ex n should be limited to specific applications and shall be subject to a case-by-case study and Company written approval.

The protection method should be selected by project during Basic Engineering taking into account the context of the overall project (new standalone project, standardisation with other developments or existing facilities, etc.).

The enclosures related certification shall consider all internal components including additional parts for possible extension.

All Instruments shall be installed in accordance with [IEC 60079-14](#) regulations. An IS loop calculation sheet shall be submitted for each installed IS instrument.

Technical rooms are usually pressurized and safe areas consequently.

Concerning the instruments installed outside hazardous areas (e.g. restricted area), the same type of instruments should be selected for standardisation of maintenance and operation, as those installed in hazardous areas, unless their quantity may justify different stock.

Ex components shall be provided with a permanent AISI 316 plate stating the ATEX/IECEx protection method and the relating code and shall be delivered with a conformity certificate issued by a Notified Body.

A unit certificate must be provided by a Notified Body for the complete unit assembly, irrespective of the individually certified components.

All works associated with hazardous area equipment shall be carried out by a competent person as per [IEC 60079-14](#).

Any modification to Ex equipment shall be fully in compliance with the [IEC 60079](#) standards requirements and the equipment's certification.

5.9 Enclosure Protection and Environmental aspects

Depending on the location of instruments or equipment, one of the following enclosure "degree of protection", as described in [IEC 60529](#), shall be selected:

- Indoor: IP21 or higher
- Indoor with water mist: IP54 or higher
- Outdoor: IP65 or IP66 if subject to marine classification.

It should be noted that IP67 or IP68 are not necessarily a higher or more stringent protection than IP65 or IP66, but are specific degrees of protection for immersed equipment. These ratings (IP67 and IP68) should therefore be used only for immersed applications.

An IP test report or certificate shall be provided for all instruments.

Instrument technical rooms will usually have a controlled environment (Temperature, Humidity, Ventilation, Pressurisation).