DEP SPECIFICATION

INSTRUMENTS FOR MEASUREMENT AND CONTROL

DEP 32.31.00.32-Gen.

February 2011

(DEP Circular 73/11 has been incorporated)

(DEP Circular 46/12 has been incorporated)

(Amendment A03 has been incorporated – February 2013)

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DESIGN AND ENGINEERING PRACTICE

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PREFACE

DEP (Design and Engineering Practice) publications reflect the views, at the time of publication, of Shell Global Solutions International B.V. (Shell GSI) and, in some cases, of other Shell Companies.

These views are based on the experience acquired during involvement with the design, construction, operation and maintenance of processing units and facilities. Where deemed appropriate DEPs are based on, or reference international, regional, national and industry standards.

The objective is to set the recommended standard for good design and engineering practice to be applied by Shell companies in oil and gas production, oil refining, gas handling, gasification, chemical processing, or any other such facility, and thereby to help achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to Shell companies for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual Operating Units to adapt the information set forth in DEPs to their own environment and requirements.

When Contractors or Manufacturers/Suppliers use DEPs, they shall be solely responsible for such use, including the quality of their work and the attainment of the required design and engineering standards. In particular, for those requirements not specifically covered, the Principal will typically expect them to follow those design and engineering practices that will achieve at least the same level of integrity as reflected in the DEPs. If in doubt, the Contractor or Manufacturer/Supplier shall, without detracting from his own responsibility, consult the Principal.

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1. INTRODUCTION

1.1 SCOPE

The scope of this DEP includes instruments used for measurement and control both in downstream sites (e.g. refineries, chemical plants, gas plants) and facilities of exploration and production. This DEP does not cover Quality Measuring Instruments (QMIs), also known as Analyzers.

The purpose of this DEP is to provide clear requirements for the selection and specification of instruments.

The intended audience of this document are Shell staff, contractors, system integrators and manufacturers of instruments and instrument systems.

This DEP is a revision of an earlier publication of the same number dated July 1999; see (1.5) regarding the main changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

NOTE: Directive 2004/22/EU on Measuring Instruments has impact in the EU countries on the following applications:

- Custody transfer flow meters
- Tank gauges if used for custody transfer
- Stack exhaust QMI if required for environmental monitoring
- Weigh bridges
- Lab instruments if used for product quality release
- On-line analysers if used for product quality release

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

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The word **shall** indicate a requirement.

The word **should** indicate a recommendation.

1.3.2 Specific Definitions

Term	Definition
Analyser systems integrator	A company that has the expertise to engineer, design, construct, test and commission complete analyser systems and provide other related services such as software support, on-site installation, maintenance and prefabricated analyser house installation where needed.
Adjustable Range	The measurement region. It is expressed by stating the LRV and URV.
Adjustable Span	The difference between the URV and LRV.
Instrumented Protective Function	A function comprising one or more sensors, a Logic Solver and one or more Final Elements whose purpose is to prevent or mitigate hazardous situations and that have SIL 1, SIL 2, SIL 3 or SIL 4.
Instrument Range	The region in which the instrument is designed to operate. It is a physical capability of the device. The region limits are expressed by stating the LRL and URL
Instrumented Protective System	The electromechanical, electronic and/or programmable electronic Logic Solver component of the Instrumented Protective Function, complete with input and output equipment.
LRL	Lower Range Limit; the lowest quantity that a device is designed to measure.
LRV	Lower Range Value; the lowest quantity that a device is adjusted to measure.
Modbus-RTU	An industrial networking system that uses serial master-slave communication links. Modbus is the most common protocol in the Process Control Domain (PCD) to interface between systems. Almost all (legacy) systems are provided with Modbus interface cards. NOTE: MODBUS-RTU is a generic phrase and the Contractor shall be specific when quoting this communication system.
Piping class	An assembly of piping components, suitable for a defined service and design limits, in a piping system. The piping classes are contained in DEP 31.38.01.12-Gen. (primarily for DS-Manufacturing applications) and DEP 31.38.01.15-Gen. (primarily for EP applications)
Price (of an item)	The amount paid to the supplier of the item in question.
Project specification	A technical contract document forming part of the agreement between the Principal and the Contractor. It contains all basic information on the project and all instructions and specifications as are required to enable the Contractor to prepare detailed design and engineering work. It furthermore contains all procedures and requirements for the execution of the work and services to be performed by the Contractor for the realisation of the project.
Span	Defined by IEC 60050-300.
Range	Defined by IEC 60050-300.
Reliability	The ability of an instrument or system to perform a specified function under stated conditions for a stated period of time.

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Term	Definition
Total cost of ownership (TCoO)	The total cost of owning an asset over its entire life, from conception of the need through to ultimate disposal. The TCoO is made up of the following cost elements: specification, price, purchasing, introduction/ installation, execution/operation, heat tracing, and termination/ disposal. A method for calculating the TCoO is given in DEP 32.31.09.31-Gen.
Tolerance class	An identification code of measuring instruments that meets certain requirements that are intended to keep errors within specified limits.
Variety control	The process of selecting an optimum number of different types and vendors, of products, processes or services to meet prevailing needs.
Very toxic (substances)	Substances that are very hazardous for the environment or human health, as specified in DEP 01.00.01.30-Gen.

1.3.3 Abbreviations

Term	Definition
AMS	Asset Management System
BPCS	Basic Process Control System
DCS	Distributed control system
EMC	Electromagnetic compatibility
HART	Highway addressable remote transducer
IPF	Instrumented protective function
IPS	Instrumented protective system
PEFS	Process engineering flow scheme
PLC	Programmable logic controller
RTU	Remote terminal unit
SCADA	Supervisory control and data acquisition
TCoO	Total cost of ownership

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (12).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated July 1999. The following are the main, non-editorial changes.

Section	Change
2.3	Updated IEC reference.
2.1	Moved range/span definitions to Informative document.
2.4	Added limits to transmitter range for Dp flow transmitters used for IPFs.
2.5.1	Updated signal transmission types to include Fieldbus, and to discourage the use of pneumatics.
2.6.1	Updated the external standard reference.
2.6.2	Corrected the IEC reference.

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Section	Change
2.7.2	Provided alternative method to attach nameplates.
2.11	Added information from NAMUR standard.
2.13	Updated external standard.
3.4	Updated external standard reference NACE.

Amendment A03

3.4, item b)	The sentence of the NOTE deleted and replaced with requirements for HF service
4.1	Attempted to select the best flow transmitter for the job rather than defaulting to a vortex meter.
4.2.2	Changed several "preferred" into "shalls".
4.7	Modified the adjusted span limitation versus accuracy requirements to reflect the higher accuracy of Dp transmitters as compared to the past.
4.7	Included a statement to adapt to using thicker gaskets such as spiral wound gaskets.
5.6	Added statement to include guided wave level transmitters.
7	Provided a rule of thumb concerning the length of pipe required to adequately mix streams.
7	Added E-type couples to the list.

1.6 COMMENTS ON THIS DEP

Amendment A03

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the “Give feedback” link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://sww.shell.com/standards. Select “Submit DEP Feedback”, fill in the online form and submit.
DEP Standard Form (Other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com.

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

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1.7 DUAL UNITS

Amended per
Circular 73/11
Dual units have been incorporated throughout this DEP.

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

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2. GENERAL REQUIREMENTS

2.1 SELECTION OF INSTRUMENTS

The selection of an instrument for a specific application is an iterative process, carried out as a joint effort of process and instrument engineers, with input where necessary from materials engineers, rotating equipment engineers and heat transfer engineers. The selection process shall be documented for future reference.

The selection process shall involve the following steps as applicable:

a) Define the intended use of the instrument e.g. monitoring at local and remote location, control, and pay meter.

b) Identify all operating modes, such as normal operation at minimum, normal and maximum flow; alternative operating modes; start-up; commissioning and emergency operation; expected future known conditions.

c) Determine the operating envelope (e.g. start-up, shutdown, off specification, maximum, minimum, normal, potential future operating modes) by collecting all relevant process data for each operating mode, including:

- Fluid data such as fluid name and phase(s), physical properties (e.g., density, viscosity, pour point), special fluid aspects such as corrosiveness, erosiveness, flashing, cavitating, toxicity and presence of solids or contaminants, mix phase, special risks such as foaming, decomposition, fouling, plugging, depositing, solidification and chemical reaction.
- Operating data such as flow rate, pressure, temperature, density and viscosity for each set of physical properties.
- Application aspects, such as continuous/batch operation, pulsating flow, uni-directional or bi-directional flow, backflow risk, mechanical integrity, vibration and hydraulic noise.

NOTE: Some sites use mass flow units and others use volume flow units. This choice shall be reflected throughout the selection process.

d) Collect data regarding the operating environment of the instrument. This shall include the following aspects:

- Accessibility and physical location in relation to process equipment and piping.
- Mechanical integrity (e.g. vibration, radiation from hot process equipment, earthquake, wash-down area, vicinity to corrosive atmosphere such as cooling water towers, chlorides, seawater etc)
- Electrical safety and EMC requirements.
- Health and safety and environmental requirements
- Weather related exposure (winterization, intense sunlight, tropical, etc)
- Requirements of the plant organisation regarding maintenance, data collection and retrieval, self-diagnostic, AMS, and documenting features, expertise and training, stock keeping etc.
- Requirements imposed by local or regional legislation: Instruments, instrument systems and components for installation in certain European countries shall conform with the applicable EU (European Union) directives and shall be supplied with the required CE (European Community) certification and markings in accordance with legislation in the European Union. In other areas, equivalent local regulations and certification requirements may apply.

e) Select the adjusted range (2.3) and accuracy (2.7) to suit the application requirements.

f) Select measurement options and define additional data required for the particular measurement principle.

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g) Select the type of signal transmission such as mA, HART, Foundation Fieldbus etc.

h) Select suitable instrument makes and types for each measurement option. The types of instruments already installed at the site shall be taken into consideration, for the sake of variety control.

i) Products shall be technically qualified to the satisfaction of the Principal and shall be sourced from Manufacturers acceptable to the Principal.

NOTE: For this purpose Shell Companies may use the list of Technically Acceptable Manufacturers And Products maintained by Shell.

j) Evaluate the pros and cons of each measurement option and select the optimum solution, considering the following aspects:

- Coverage of and performance under the process conditions, listed above.
- Compliance with the aspects listed above.
- The total cost of ownership (TCoO) over a period of 10 years. (A method for calculating the TCoO is given in DEP 32.31.09.31-Gen.)
- Additional hardware required for proper operation, such as calibration facilities or disposal systems.
- Specific maintenance aspects such as accessibility requirements, calibration aspects, self-diagnostic features, purging/flushing/disposal aspects.
- Availability of spare parts, long term software and hardware support and vendor support

The relevant sections of this document cover specific aspects for the selection of instruments per process variable.

Specific fields of application are covered by the following DEP publications:

Instrumentation in equipment packages	DEP 32.31.09.31-Gen.
On-line process analysers Analyser housing	DEP 32.31.50.10-Gen. DEP 32.31.50.13-Gen.
Instrumentation of fire, gas and smoke detection systems	DEP 32.30.20.11-Gen.

2.2 UNITS OF MEASUREMENT

The ranges and scales of instruments shall be in SI units unless otherwise specified by the Principal, see DEP 00.00.20.10-Gen.

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2.3 SELECTION OF RANGES

The accuracy (2.7) and adjusted range of an instrument shall be selected to cover the operating window (2.1), which includes applicable abnormal operation and alternative operating modes.

NOTE: For certain applications it might not be possible to combine all normal and abnormal operating conditions in one measurement at the required accuracy. In such cases, a case-by-case analysis will disclose whether additional instruments are required or the accuracy requirements and/or operating window may be relaxed. It might be acceptable to present measured values during some of the abnormal operating cases at a lower accuracy or it might be justifiable for the measurement not to produce a sensible signal under some of the abnormal process conditions during start-up, commissioning, regeneration, emergency conditions and the like.

Unless otherwise approved by the principal, IPF transmitters shall have the same instrument range, adjusted range and accuracy as corresponding process control transmitters in order to facilitate measurement comparison. For details, exceptions and trip setting limitations see DEP 32.80.10.10-Gen.

NOTE: The exception to this requirement is where the BPCS instrument is being used for Custody transfer (Tolerance Class A). In this case, it is acceptable for the IPF instrument to meet Tolerance Class B.

Another exception is where the actual trip point cannot be reliably measured with an instrument with the same range as the BPCS. As an example, the specific gravity varies significantly and thus a Dp or displacer level measurement of the physical level will vary significantly. In this case, the span should be narrowed or a different measurement technology used.

Where feasible, the LRV shall be selected so that the displayed result represents the zero or sub-zero value of the process variable (e.g. 0 kPa (ga) [0 psig] to 1000 kPa (ga) [150 psig], –100 kPa (ga) [-15 psig] to +300 kPa (ga) [+45 psig], 0°C [32°F] to 500°C [932°F], –50°C [-58°F] to +50°C [122°F] etc.). Elevated zeros (100 kg/hr [220 lb/hr] to 300 kg/hr [660 lb/hr], 100°C [212°F]to 200°C [392°F]) shall be avoided.

NOTE: If an instrument is communicating digitally and the DCS displays reading outside the instrument range, this requirement can be relaxed to optimize operator information and/or controllability. As example, there is a desire to read and control tray temperature between 300°C (575°F) and 400°C (750°F). If the DCS will display 0°C (32°F)to 300°C (575°F) (e.g. during start-up) then ranging the transmitter from 300°C (575°F) to 400°C (750°F) is acceptable.

2.4 SIGNAL TRANSMISSION AND POWER SUPPLY

2.4.1 Electric signal transmission

Foundation™ Fieldbus communication technology is the standard for connecting the field devices with the DCS. Foundation™ Fieldbus shall be used on major projects and major expansions. Foundation™ Fieldbus design and configuration requirements are covered by DEP 32.30.20.13-Gen.

4-20mA with `HART' protocol shall be used for IPF devices. Refer to DEP 32.80.10.30-Gen. for additional signal requirements.

For existing plants where it is not practical or justifiable to use Foundation™ Fieldbus due to the installed base, the signal type currently utilized at the location shall be used.

Wireless communication may be used where it meets the global guidelines and is approved by the Principal.

The configuration, range, settings, etc shall be documented in the DCS, AMS, instrument specification, instrument datasheets or electronic configuration files for specialty instruments.

Modbus-RTU communication protocol over serial or Ethernet links is an acceptable communication between DCS and other digital sub-systems, including analyser systems, PLC's. OPC is an alternative method for providing this data connectivity. The Principal shall approve the communication protocol.

Instrumentation such as for machine monitoring, fire and gas detection, tank gauging, sub-systems for motor operated valves, etc. may have other signal transmission requirements according to Manufacturers' standards. The criticality of the serial link shall determine the

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requirement for redundancy. The Principal shall approve communication protocol and redundancy used by these third party vendors.

2.4.2 Pneumatic signal transmission

Pneumatic signal transmission is discouraged and shall only be applied with the approval of the Principal. Where it is used, the transmission signal shall be 20-100 kPa (ga) [3 psig to 15 psig].

Use of process gas to power pneumatic instruments or control valves shall require approval of the Principal. Since DEPs assume the use of instrument air, material selection for components such as filters, regulators may not be compatible with process gas, and shall be verified if process gas is used. Additionally, some regulators vent to the atmosphere which clearly would not be allowed if the regulator was using process gas.

2.4.3 Power supply

The criticality of the application shall determine whether or not an instrument shall be powered from an uninterruptible power supply source at 24 VDC or 115/230 VAC. The normal operation of AC powered instruments shall not be adversely affected by voltage dips caused by load transfer operations of UPS systems. The criticality of instruments and the design for power backup shall be approved by the Principal.

In conformity with IEC 61000-4-11 a voltage dip is defined as a sudden voltage depression followed by a recovery after a short period of time. In industrial plants, a voltage dip may be characterised as a voltage depression with duration of one second or less for any residual voltage or for a longer duration with a residual voltage greater than 70%. Refer also to DEP 33.64.10.12-Gen.

2.5 ELECTRICAL SAFETY IN EXPLOSIVE ATMOSPHERES

2.5.1 General

In order to prevent electrical apparatus, including electronic process instrumentation, from becoming a source of ignition in potentially explosive atmospheres, protective measures shall be taken, based on the hazardous area classification of the particular area in which the electrical apparatus is being installed. Refer to DEP 33.64.10.10-Gen and DEP 80.00.10.13-Gen (North America application).

2.5.2 Selection of type of protection

The selection of type of protection shall be in accordance with IEC 60079-14 or the applicable local country standards (Local rules may overrule IEC 60079-14). In North America, DEP 33.64.10.10-Gen (for North American Application) shall be used.

The following is the order of preference for the selection of type of protection taking into consideration of ease of implementation and maintenance:

Zone 0 areas	Ex 'ia' only - Intrinsic safety - IEC 60079-11
Zone 1 areas	Ex ‘e’ – Increased safety - IEC 60079-7, Ex ‘d’ – Flameproof enclosure - IEC 60079-1, Ex 'ia' ,or Ex 'ib' – Intrinsic safety - IEC 60079-11,
Zone 2 areas	Ex ‘n” – Type of protection – IEC 60079-15

For Zone 2 areas, consult IEC 60079-14, especially section 5. Apart from protection types according to IEC standards, some freedom is allowed with regard to the selection of protection types according to recognised non-IEC standards or national standards or codes of practice The order of preference is Ex ‘n’, Ex ‘e’, Ex ‘d’, Ex ‘ia’ or Ex ‘ib, Ex “p” (Pressurized Enclosure), ‘other’. The selection of type of protection for Zone 1 and 2 shall be subject to TCoO evaluation, taking into consideration local legislation, site practices, etc.

NOTE: For Zones 1 and 2, protection type Ex ‘m’ (encapsulation) in accordance with IEC 60079-18 may be used, e.g. for solenoid operators.

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2.5.3 Safety documentation

Safety documentation for the selected type of protection for the installed electrical apparatus shall be available as follows:

Zone 0 areas	Certificates shall be available.
Zone 1 areas	Certificates shall be available.
Zone 2 areas	If the selected type of protection is according to an IEC standard, certificates shall be available. If the selected type of protection is not based on an IEC standard, follow the requirements of IEC 60079-14, especially clauses 5.2.3 and 5.2.4, and the requirements of the applied standard or code of practice.

NOTE: In the context above, 'available' shall mean that the Manufacturer shall make the certificates freely available to the end-user, either as a piece of paper that is shipped with the equipment or as for instance a web-downloadable document. It does not mean that copies of the certificates need to be purchased with each equipment item.

The Contractor shall:

- investigate whether local requirements overrule the requirements and recommendations defined in this section and propose alternatives for approval by the Principal;
- arrange for the required safety certification and documentation as defined above;
- provide calculations for longest signal run and highest capacity/inductance loop where IS barriers are used.
- The contractor shall provide a certificate of conformity. In its absence necessary calculations shall be submitted (e.g. Power dissipation calculation for enclosures.)

In North America, electrical instrumentation shall be certified by a Nationally Recognized Testing Laboratory (NRTL) such as Factory Mutual (FM), Canadian Standards Association (CSA, US), or Underwriters Laboratories (UL), and shall have a label attesting that the equipment is approved for installation in the electrical area classification, including general-purpose area, stated in the specification. A copy of the approval documentation shall be made available to the purchaser on request. The Vendor shall state in the quotation if NRTL approval documentation is not available and shall also state the method used to verify that the equipment is suitable for the area classification stated in the specification. For equipment that is not approved by any NRTL the issue of acceptability shall be referred to the Principal for resolution.

NRTL-certified intrinsically safe instrumentation and simple apparatus may be used with approved I.S. barriers if this is the only means available to meet area classification requirements.

2.6 INSTRUMENT NAME PLATES AND WARNING PLATES

2.6.1 General

All instruments, junction boxes, cabinets, panels and ancillary equipment shall be provided with nameplates indicating the tag number only or the tag number and the service. Tag numbers shall be aligned with the instrumentation database and instrument specification sheets. For details, see standard drawing S 37.601.

In addition to the above, the text on nameplates for manual selector switches shall repeat the switch position markings and shall describe what each switch position represents. Similarly, the text on nameplates for push buttons shall describe what action is taken when the push button is activated. Red nameplates shall have white lettering. White nameplates shall have black letters

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The Principal will advise the language or languages to be used on nameplates at the Principal's site. Licenser or local requirements may dictate special nameplate and/or language requirements, in particular for safety related instruments and instrument systems.

For nameplate requirements associated with impulse lines, see DEP 32.37.10.11-Gen.

2.6.2 Field-mounted nameplates

All plant-mounted instruments, e.g. inline instruments, transmitters, local indicators, converters, control valves, limit switches, solenoid valves etc., and junction boxes shall be provided with nameplates. The nameplate shall be properly secured to the instrument support. The name plate shall not be attached to a bracket fitted on the process connection. The preferred method is by means of stainless steel screws; the use of alternative methods such as adhesives or stainless steel wire (1.0 mm or 18 ga minimum single wire), or multi-strand wire is subject to the approval by the Principal. No holes shall be tapped into instruments for fixing nameplates, as this will affect the integrity and warranty of the instrument.

The material of the nameplate shall be laminated plastic or stamped stainless steel plate, as specified by the Principal. Plastic base tags shall not be used in +40°C (104°F) environments.

Unless otherwise specified by the Principal, IPF sensors of SIL 1 and higher shall have a red nameplate with white lettering.

For control valves, additional identification requirements apply – see DEP 32.36.01.17-Gen.

For valves and instruments in gaseous oxygen service, additional marking and identification requirements apply as per DEP 31.10.11.31-Gen.

NOTE: Any medium containing more than 21 % oxygen by volume or a system with air at a pressure above 5000 kPa (ga) (725 psig) is to be considered oxygen service.

Thermocouples used for furnace coil balancing services require special markings as specified in (7.4).

2.6.3 Nameplates for indoor use

All panel-mounted instruments shall be provided with nameplates in accordance with the Manufacturer's standard.

Cabinets and distribution frames shall be provided with nameplates, carrying at least the tag number and description. The material of the nameplates shall be laminated plastic and the colour shall be as specified by the Principal.

Labels and marking methods used inside instrumentation cabinets shall be to Manufacturers' standards provided they are secure and permanent.

2.6.4 Titles on nameplates

Where abbreviations are necessary, these shall be standardised and consistent for all titles as specified in the Project Specification or the Principal's site standards.

2.7 MEASUREMENT ACCURACY

The required accuracy of a measurement depends on the duty and service and shall be defined by parties responsible for process control. The tolerance classes and accuracy figures listed below are a minimum and shall be confirmed with the Principal.

NOTE: Design class can impact the Tolerance class selection. As an example, Design class 3 may only require Tolerance Class D as a default.

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Process variable	Tolerance Class A	Tolerance Class B	Tolerance Class C	Tolerance Class D
Application	– Custody transfer. – Critical reactor (ratio) feed control.	– Enhanced monitoring and control. – Internal accounting.	– Regular monitoring and control.	– Coarse monitoring and control.
Flow (see note below)	– Liquid: better than 0.25 % of reading. – Gas/steam: better than 0.5 % of reading.	– Liquid: better than 2 % of reading. – Gas/steam: better than 3 % of reading.	Better than 6 % of reading.	Better than 10 % of reading.
Level (see note below)	Better than 2 mm (.079 in) (absolute).	Better than 10 mm (.394 in) (absolute).	Better than 5 % of adjusted span.	Better than 10 % of adjusted span.
Pressure	To be assessed on a case-by-case basis to site specific requirements.	Better than 0.25 % of adjusted span.	Better than 1 % of adjusted span.	-
Temperature	– TC type E/K/J: tolerance class 1 as per IEC 60584-2. – TC type T/B: tolerance class 2 as per IEC 60584-2. – RTD: see (7.4) – Others: To be assessed on a case-by-case basis to suit specific requirements.	-	– TC type E/K/J: tolerance class 2 as per IEC 60584-2. – TC type T/B: tolerance class 3 as per IEC 60584-2. – RTD: see (7.4) – Others: Better than 1 % of adjusted span.	-

The accuracy figures include linearity, hysteresis, repeatability, static pressure and temperature effects on the instrument.

The accuracy requirements apply under all normal design conditions, including alternative operating modes. If the accuracy figures cannot be met during abnormal process conditions, such as start-up, commissioning, regeneration and emergency operation, the Principal's approval is required; see also (2.3).

The above accuracy requirements for flow and level measurements apply to the accuracy of the 'presented' result of the measurement in the relevant units of measurement. If, for example, a liquid flow measurement of tolerance class B is to be presented in mass flow units, the 'overall' accuracy of the presented mass flow figure shall be better than 2 % of the reading. If in such a case a flow sensor is used that measures a volumetric flow, pressure/temperature and/or density measurements might be required to meet the 2 % 'overall' accuracy requirement on the 'presented' mass flow figure. This requirement extends to soft sensors whereby one or several instruments are used to infer a measured component. The accuracy of the individual instruments must be appropriate to achieve the accuracy of the result.

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2.8 REQUIREMENTS FOR MATERIAL INSPECTION, CERTIFICATION AND MARKING OF INSTRUMENTS AND RELATED COMPONENTS

2.8.1 In-line instruments

In-line instruments are considered to be all instruments and components direct-mounted in or on process and utility lines or equipment and are subjected to the pressures and temperatures of the piping systems or equipment in or on which they are installed.

Typical examples:

Measurement	Types of Instrument
Flow	Turbine and PD meters with their accessories, orifice and restriction orifice plates, venturi, vortex flow meters, cone (inverted venturi), Coriolis mass flow meters, ultrasonic flow meters, magnetic flow meters, thermal mass flow meters, multiphase meters, swirl meters.
Level	Displacer type level instruments, capacitance level instruments, tank gauges, radar gauges, Magnetostrictive level gauges.
Temperature	Thermowell
Quality	Analyser sample probes, water-cut meter,
-	Control valves, including IPF valves, depressuring valves, deluge valves.

For in-line instruments, the traceability and associated material certification for pressure retaining parts (including bolting of pressure retaining parts) shall be in accordance with the requirements of the piping class or equipment in or on which the instruments are installed.

Inspection document shall follow the requirement of local standards or project specifications where applicable.

2.8.2 On-line instruments

On-line instruments are all instruments and components connected to process and utility lines or equipment via small (maximum DN 50 or 2 in) primary isolation valves. They are subjected to the pressures of the piping systems or equipment on which they are installed. Typical examples are impulse line components, transmitters, pressure gauges, monoflange assemblies, analyser sampling systems, etc.

Pressure or differential pressure instruments that require diaphragm seals are not considered to be on-line instruments unless the size of the diaphragm seal makes it necessary to use a line class shut-off valve. Unless otherwise specified by the Principal, no material certification is required for on-line instruments and their connections to process systems, provided that facilities are present to isolate these instruments and connections from the process. As an exception to this rule, material certification is required for the following:

- All impulse line tubing.
- Pressure retaining parts of instruments and impulse line components in ‘Sour’ or ‘Wet H_2S’ service (as defined in DEP 31.38.01.11-Gen.).
- Where required by local regulations.

2.8.3 Off-line instruments

Off-line instruments are considered to be all instruments and components, which are not in direct, contact with any process medium or which are not connected to any process/utility line or equipment.

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Typical examples are thermocouples, resistance elements and bi-metallic thermometers in thermowells, signal converters, local receiving indicators, etc.

Unless otherwise specified by the Principal, no material certification is required for off-line instruments.

2.9 LAMP TEST FACILITIES

All indication lamps shall be provided with test facilities in the vicinity of the lamp, so that one man can execute the test. The test logic shall be located in the BPCS or IPS if available. If there is no BPCS or IPS interface (e.g. a stand alone panel), then a lamp test push button shall be supplied on the panel.

2.10 FAULT DETECTION FOR ANALOGUE TRANSMITTERS

Transmitters shall comply with NAMUR NE-43 recommended values for abnormal signal levels for 4-20 mA type output signals. The BPCS and IPS shall detect a faulty signal when the signal is less than 3.7 mA or above 20.8 when NAMUR NE-43 is used.

2.10.1 Failure mode shedding

Failure mode shedding strategies shall be developed after the makes and models of DCS, IPS, in-line meters and transmitters have been selected. The failure mode shedding strategy may include controller mode switching; output value selection/freezing and process alarm suppression, and sets the rules for failure mode selection of analogue transmitters (upscale or downscale). For IPS, refer to DEP 32.80.10.10 Gen – Sensor Diagnostics and Response.

- For each transmitter / system combination, the assessment shall disclose whether the combination has the ability to detect a failed transmitter and/or a line break and/or a short-circuit. Furthermore, the relevant parameter settings for the transmitter and the system shall be defined.
- In specific cases, compliance with NAMUR recommendation NE 43 might be restricted by transmitter loop powering demands or by Zener barrier current limitations.
- If the transmission distance is long, the loop resistance might be so high that a short circuit near the transmitter will not cause the loop current to exceed the 21 mA specified by NAMUR Recommendation NE 43.
- The failure mode/fault signal (e.g., 21 mA) shall not cause the DCS to detect a process alarm condition as the device output passes from its last good value to the fault signal.

2.11 ENVIRONMENTAL PROTECTIONS

All instruments, systems and related components shall comply with the environmental conditions as specified in the Project specification. The effects of the local environment on instrumentation shall be considered, and where required additional environmental protection shall be included (tropical requirements, winterisation, protection from intensive sunlight).

Plant-mounted instruments shall be suitable for operation in industrial, humid, saliferous and corrosive atmospheres and shall be adequately protected according to the electrical area classification.

For outdoor locations, the climatic conditions of location class D2 of IEC 60654-1 apply.

The minimum degree of ingress protection of plant instruments shall be IP 65 as defined in IEC 60529, or, in the North America, NEMA-4X as defined in NEMA 250.

For mechanical influences, classification in accordance with IEC 60654-3 shall apply.

For corrosive influences, classification in accordance with IEC 60654-4 shall apply.

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The corrosive influence class shall comply with the requirements of Class 1 (Industrial clean air) or Class 2 (moderate contamination), as specified by the Principal.

For tropical areas more stringent requirements, such as anti-corrosion coatings or tropicalisation of printed circuit boards, may be applicable and requirements shall be obtained from the Principal.

Special attention shall be paid to potential damage caused by insects and animals.

The purpose of winterization shall be documented as part of the project definition. Potential winterization purposes include: prevent freezing of water, prevent hydrates formation, prevent condensation in gaseous streams, prevent abnormal fluid states interfering with the orderly and safe handling, measurement or monitoring of the process fluids. The design of the winterization shall meet the demands identified in the winterization purpose.

Special attention shall be paid to instruments and ancillary equipment that will be used in marine (e.g. jetty) services and/or installed in coastal or offshore environments. In such cases hermetical sealing of the electronic circuitry is required.

Depending on site conditions, the contacts of switches/relays may require protection against traces of H_2S and SO_2 in the indoor and outdoor atmospheres by gold coating (at least 10 μm (394 μin) or by locating them in hermetically sealed housings.

Lightning surge protection is normally not required inside the process area even if the instrument is mounted at height. However, in offplot tank farms area, provision for surge suppressions shall be made if the location has determined it necessary.

2.12 ELECTROMAGNETIC COMPATIBILITY (EMC)

Unless otherwise specified by the Principal, EMC of instruments, instrument systems and instrument installations shall be in accordance with the latest Shell Global Solutions International policies. The Principal will inform the Contractor on the applicable requirements.

Metal cable glands shall be fitted where instrument signal cables enter the housings of field instruments, with a low impedance earthing connection between the cable armouring/braiding and the instrument housing via the metal gland being ensured by a robust, circumferential (360 degrees) connection. Glands constructed in accordance with EN 50262 types C/D/E or CK/EK provide such an earthing connection. For details, see DEP 32.37.20.10-Gen. The use of plastic cable glands is not allowed for instrument signal cabling.

2.13 HUMAN FACTORS ENGINEERING CONSIDERATIONS FOR FIELD INSTRUMENT DISPLAYS

2.13.1 General

2.13.1.1 Information Content

The content of information displayed to an operator shall allow the operator to perform the intended task but shall be limited to only that necessary to perform specific actions or to make decisions.

2.13.1.2 Format

Information shall be presented to the operator in a directly usable format that shall not require transposing, computing, interpolating or mentally translating to other units.

2.13.1.3 PPE Compatible

Display characteristics (e.g. clarity, legibility) shall allow displays to be viewed while wearing a protective mask or goggles.

2.13.2 Choice of Colours

The following requirements apply to nameplates, labels, instructions and other displays.

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- The choice of colour for characters shall be black characters on a light background rather than light characters on a dark background.
- Where personnel may have difficulty discriminating colours (that is, colour deficient vision), colour coding shall be supplemented by other forms of coding or text.
- Magenta, blue, blue-violet and violet shall be avoided.
- Saturated blue and saturated red contrasts shall be avoided (red-on-blue background and blue-on-red background).

2.13.3 Choice of display (graphical representation versus numerical)

Graphical displays include dials, plotters, bar charts, simple indicator lights, and legend lights. These types of displays shall be used when providing information about rates-of-change, trends, or deviations from a given values.

Numerical displays include counters and numbers displayed on a screen. Use numerical displays when quick, precise readings of quantitative values are required. Do not use numerical displays, if perception of a trend, pattern, or variation is important or where value changes occur too slowly or too rapidly to be easily detected.

NOTE: Both analogue and digital displays are used for continuous signals such as 4-20mA, Fieldbus, HART, etc. The above requirement is concern with the form information is displayed to the operator e.g. Analogue or Digital.

2.13.4 Location, visual access and orientation of displays

2.13.4.1 Location

Displays, including sight gauges, shall be located and designed so that they may be read to the degree of accuracy required by personnel in the normal operating or servicing positions without requiring the operator to assume an uncomfortable, awkward, or unsafe position.

2.13.4.2 Visual access

Minimum Viewing Distance – the viewing distance from the operator's eye to the face of the displays, should lie between 0.3 m and 0.7 m (12 in and 28 in). All displays shall be able to be accurately read at these distances.

Primary and Secondary displays – displays used most frequently, those used for obtaining precise readings, and those used in an emergencies shall be placed between 1.2 m and 1.7m (47 in and 67 in). Those displays used for normal operations and those not requiring accurate readings may be located from 0.5 m to 1.2 m (20 in to 47 in).

Visual displays shall be visually accessible from the normal work position without requiring the operator to stand on equipment components, handrails, wire ways or wire way supports, pipes (bare or insulated), or any structure that is not specifically designed and provided for supporting a person's weight.

No display shall require the removal of a cover (for example, sheathing, deck plate) or any other component to be visible, unless the display is noncritical and a clearly marked quick access door is provided. The access door should be of transparent material.

2.13.4.3 Display orientation

Displays such as dial thermometers and pressure gauges that are attached directly to a pipe shall be mounted so they are read upright, or turned no more than 90° from the upright position if the upright orientation cannot be achieved.

2.13.5 Lighting

Ambient lighting levels shall be sufficient to permit visual display viewing under all conditions of operation without the use of a flashlight or other temporary light source.

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3. INSTRUMENTS

3.1 GENERAL

Instruments with continuous analogue signals (e.g. Foundation™ Fieldbus, HART, 4-20 mA) shall be used. Foundation™ Fieldbus is the preferred signal type. Discrete (on/off), direct mounted, field switches (e.g. level and pressure switches) shall not be used unless specified or approved by the Principal.

Unless directed otherwise by the Principal, IPF trip sensors of SIL 1 and higher shall have a red colour and the finish of plant-mounted instruments in oxygen service shall be yellow. The finish of all other plant-mounted instruments may be in the Manufacturer's standard colour (but not red or yellow).

NOTE: The requirement for providing either a red finish for IPF or yellow finish for O2 service to the transmitter can be waived if the site does not have that standard. Instruments in IPF loops shall have red tags.

In-line instruments shall comply with the requirements of the piping class or equipment in or on which the instruments are installed.

Threaded process connections are not allowed for both on-line and in-line instruments, except for pressure gauges and manifold compression fittings.

3.2 INTEGRAL AND RECEIVING INDICATORS

Integral or receiving indicators shall be considered as an alternative to pressure and temperature gauges.

NOTE:
1) An integral indicator is a display which is an integral part of a transmitter and which is often an optional item.
2) A receiving indicator is a separate device that displays the variable measured by a transmitter in engineering units and is usually connected to the signal output of the transmitter.

Where a local indicator is required to support operating personnel, the physical location of the indicator shall be selected so that it can be read from the location of the operator when manipulating that process value. If an integral indicator cannot meet this requirement, a receiving indicator shall be applied.

If there is no local level gauge, the level transmitter shall be provided with an integral indicator

No LED's are allowed for numerical displays on field instruments, only LCD's are acceptable.

Blind transmitters are preferred for all applications where an integral indicator is not required for operational reasons. The use of local indicators shall be minimized to reduce project costs. Additionally, the 4-20 mA local indicator can affect control loop performance by consuming power required by certain microprocessor-based transmitters and resulting in temporary transmitter failure when the process measurement approaches the low end of the span. These can be addressed by the use of loop isolators and external power sources or by configuring the local indicator as a DCS output

Integral and receiving indicators required for operational reasons shall be shown on PEFS and shall present measurement information in engineering units.

NOTE: Some transmitter designs are only available with an integral indicator. Such an indicator is acceptable even if local indication is not a requirement.

3.3 PRESSURE AND TEMPERATURE LIMITS OF PRESSURE-CONTAINING PARTS

For in-line instruments, the upper and lower pressure and temperature limits of the pressure containing parts shall meet the requirements of the piping class.

For in-line instruments associated with equipment where no piping class applies (e.g. vessels/package units), the upper and lower pressure and temperature limits of the

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