

DEP SPECIFICATION

ON-LINE PROCESS ANALYSERS

DEP 32.31.50.10-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the selection, specification and installation of on-line process stream analysers, systems for sample take-off and transport of the sample, the sample conditioning systems and the disposal of sample fluids.

Analyser houses are covered by DEP 32.31.50.13-Gen.

This is a revision of the DEP of the same number dated February 2015; see (1.5) regarding the 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 authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in refineries, upgraders, chemical plants, gas plants, exploration and production facilities and supply/distribution installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall 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.

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.

NOTE: In this DEP, the word **Vendor** shall be understood to mean Supplier.

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.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
analyser application engineering	Activity that details the scope of the analytical measurement and its application.
analyser data sheet	Compilation of technical details as a direct result of analyser application engineering.
BPCS	Basic Process Control System
DCS	Distributed Control System. Also referred to as BPCS (Basic Process Control System)
fast loop	Sample transport system that takes a sample from the process at one point and returns the withdrawn sample back to the process at another point.
GC	gas chromatograph
IP	ingress protection
LNG	Liquefied Natural Gas
PEFS	Process Engineering Flow Scheme
piping class	Assembly of piping components, suitable for a defined service and design limits, in a piping system. Piping classes for refining and chemicals are contained in DEP 31.38.01.12-Gen.; piping classes for exploration and production are contained in DEP 31.38.01.15-Gen.
process line	Piping used for transport of fluids (other than sample lines).
sample	Representative portion of the product or process stream having all relevant properties of the product or the process stream itself.
sample conditioning system (SCS)	One or more devices that properly prepare a portion of the sample from the sample transport system for testing by the process analyser to meet the requirements of the analyser.
sample line	Tube or pipe used for transporting the sample.
sample pre-conditioning system	One or more devices that condition the sample (pressure, temperature, flow, change of state) so that it is suitable to be transported to the sample conditioning system. The sample pre-conditioning system forms part of the sample take-off system.
sample probe	Device (usually in the form of a special tube) that is inserted into a defined point in the bulk of the process stream to extract a small portion as a sample.
sample recovery system	System that collects waste sample and/or by-products from the analyser system for the purpose to either return them to an assigned point of disposal or to a suitable point in the process.

Term	Definition
sample take-off connection	Piping connection for the extraction of the sample from the process line and through which a sample probe may be inserted into the process.
sample take-off point	Exact location from where the sample is extracted in the process, i.e., the location of either the tip of the sample probe or the pipe wall connection from where the sample fluid leaves the process piping.
sample take-off system	System that includes the sample probe and downstream components up to the connection with the sample transport system.
sample transport system	System used to transport a sample from the sample take-off, either to the sample conditioning system (and from there to the analyser) or directly to the analyser, and to return the waste sample, if any is collected, from the sample conditioning system, either to a suitable point in the process or to a suitable utility system.
sample system	Complete system that includes the sample take-off, sample transport and sample conditioning systems.
secondary loop	Circulating loop, part of the sample transport system, which is fitted to reduce the lag time caused by components such as filters, coalescers, etc., and/or to reduce the quantity of a sample entering the analyser shelter. The secondary loop is part of the sample conditioning system.
single line sample transport	Sample transport system that returns the waste sample to a utility system.
STEL	Short Term Exposure Limit
Total Cost of Ownership	Price of an asset plus the costs of operation.

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a full revision of the DEP of the same number dated February 2015. The following are the main, non-editorial changes.

Section/Clause	Change
All	Restructured and clarified requirements, enforced use of shall/should/may for normative statements.

1.6 COMMENTS ON THIS DEP

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://swwww.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.

1.7 DUAL UNITS

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.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL ANALYSER SYSTEM DESIGN REQUIREMENTS

2.1 SAFETY

2.1.1 General

1. Analyser systems should be designed, installed and operated in such a manner that they minimize hazards to personnel, plant and environment.
2. Local safety rules and regulations shall be taken into consideration during design of the Analyser systems, in addition to what is stated in this DEP.

2.1.2 Personnel protection

1. All surfaces that exceed 60 °C (140 °F) shall be insulated or shielded for personnel protection.

2.2 ROLES AND RESPONSIBILITIES

1. The Roles and Responsibilities form in Appendix A shall be completed to assist in obtaining a fully functional analyser system.
 - a. The form shall be approved by the Principal prior to the start of a project.
2. The Contractor shall provide an organization chart and resume(s) of the analyser engineer(s) assigned to the project for the Principal's approval.



2.3 APPLICATION ENGINEERING

1. Analyser application engineering shall be conducted before decisions are taken on the requirements/recommendations covered in this DEP.
 - a. The outcome of the engineering should be documented in the analyser narratives and data sheets.
 - b. Analyser narratives and data sheets shall be subject to approval by the Principal.

Design of analyser systems is an iterative process that requires consideration of the following:

- *the type of analyser and acceptable analyser inlet requirements (e.g., pressure, temperature, flow, corrosivity, toxicity);*
 - *the process temperature and pressure and sample characteristics (e.g., phase, viscosity);*
 - *the potential for change in phase or composition of the sample during sample pre-conditioning and transport (i.e., the characteristics of the sample fluid in relation to changes in pressure and temperature);*
 - *available differential pressure between the sample and return points (i.e., need for sample pumps);*
 - *maximum sample transport lag times as specified on the analyser data sheet;*
 - *potential analyser and analyser shelter locations;*
 - *the lower detection limit required by measurement and the expected accuracy at that low level of measurement.*
2. Analysers utilized in control loops and other critical applications shall be single stream applications;

This ensures reliability and meets control loop target availability.
 3. The Contractor shall prepare, during the preliminary design phase, a plot plan showing potential locations of the following:
 - a. analysers;
 - b. analyser shelters;
 - c. sample take-off and return points, and
 - d. approximate sample transport times.
 4. No analyser shall be mounted more than 150 m (490 ft) from the sample take off point without approval from the Principal.

2.4 MATERIALS

2.4.1 General

1. Selection of analyser materials (including elastomeric seals) shall take following into consideration:
 - a. normal and upset process conditions, and
 - b. the nature of the analysed fluid.

This is to ensure that the materials are suitable (e.g., corrosion resistant, appropriate pressure and temperature rating) for the intended service.

2. Changes in sample composition due to absorption, adsorption or reactivity with sample transport wetted materials shall be considered for all samples particularly where the component of interest is present at low ppm concentrations:
 - a. Refer (2.9) for details.
3. Refer DEP 31.38.01.11-Gen for the appropriate piping class of:
 - a. the sample probe;
 - b. the primary isolation valve (i.e., root valve) at the sample take off point and return/disposal point (e.g., flare header);
 - c. sample transport tubing and piping.
4. Piping, tubing, components and equipment (e.g., booster pumps) installed between the sample root valve and return root valve shall be selected and installed to meet the design conditions for that portion of the sample transport system.

2.4.2 Selection

1. AISI 316 stainless steel should be used for all wetted parts of the sample conditioning system unless specified otherwise.
2. Alloy 825 steel seamless tubing shall be used for sample transport tubing, unless specified otherwise.
3. Project shall seek Principal's approval for the material selection for cases where both AISI 316 and Alloy 825 are not suitable.

This is for example a. systems containing water with chlorides, b. Hydrogen fluoride (HF) alkylation service c. services where strong reducing acids such as pure hydrochloric and sulphuric acid are used.

4. Compression type fittings shall be stainless steel.
5. Sample systems for products in which traces of reactive compounds are to be measured, (e.g., traces of hydrogen chloride, hydrogen sulphide, mercury), low ppm moisture, shall be sulfinert treated.

This is to minimise interaction between the sample and the tube.

6. Sample lines on process streams with reactive components shall be insulation and heat tracing to prevent adsorption and desorption of gases from the pores of the tubing.
7. With the exception of materials for seals (e.g., o-rings, gaskets), the use of metallic materials shall be subject to Principal's approval.
8. Use of glass components shall be subject to Principal's approval.
9. Thermal insulation shall have a guaranteed maximum chloride content of less than 10 mg/kg and be sealed against water ingress.

This is in order to prevent chloride stress corrosion and influence of UV radiation due to direct or indirect sunlight.

2.5 ELECTRICAL

1. Refer DEP 33.64.10.10-Gen for design of analyser electrical facilities.
2. Refer DEP 33.64.20.10-Gen for design of analyser electrical facilities in North America.
3. All electrical equipment shall be appropriate for the hazardous area classification of the location in which it is to be installed.
4. All electrical components, or assemblies consisting of electrical components, shall have approval from a nationally recognized testing laboratory (e.g., CSA, ULC, ATEX) for the specified electrical hazardous area classification.
5. Each powered equipment shall have the following:
 - a. A dedicated switch adjacent to the device that powers it.
 - b. The powering device will have a tag identifying the component that it powers with the exceptions of loop-powered transmitters (e.g., gas detectors, flow switches, level switches).

2.6 PRESSURE DESIGN

1. The pressure rating of selected components shall meet the design conditions.
2. Analyser systems shall utilize equipment and components with pressure ratings which exceed the system design pressure (i.e., inherent safety).
3. The analyser system shall incorporate protection from excessive pressures caused by failed components (e.g., pressure regulators, pressure reducing valves) or equipment (e.g., analysers) with a pressure rating below the system design pressure (e.g., process fluid, carrier gas, instrument air).
4. Relief valves shall be used in all cases where failure of a component, such as a pressure regulator, could cause over-pressurization of an analyser system.
5. Relief valves should be vented to the flare system for gas streams and to an appropriate process connection for liquid streams:
 - a. Venting to atmosphere at a safe location shall be approved by the Principal.
6. Check valves shall not be used as pressure relief valves.
7. Pressure relief valves shall be sized and positioned so that under over-pressure conditions, the protected section does not exceed 110% of the maximum operating pressure:
 - a. Refer to the formula in the current API STD 520 part 1 for calculation of Pressure Relief valve size.
8. Pressure relief valves shall be provided with a stainless steel tag detailing tag number and relief pressure setting.
9. Refer ISO 4200 (metric sizes) and ASTM A269 (US customary units) for pressure ratings and tolerances of tubing wall thickness and outside diameter.
10. All regional pressure equipment shall be adhered to within said specific local regulations.

2.7 ACCESSIBILITY

1. Analyser systems shall be designed so that:
 - a. Their components are readily accessible from grade or permanent platforms.
 - b. Components can be removed with the minimum of disturbance to the system.
 - c. Access to components that require normal maintenance can be performed without removal of any other component or tubing line.

2.8 SAMPLE TRANSPORT LAG TIME

Analyser system lag time is the sum of the sample transport lag time, the sample conditioning lag time and the analyser response time.

1. Sample transport systems shall be designed to provide a lag time no greater than:
 - a. that required for effective process control and monitoring, or
 - b. that permitted by regulation, e.g., Continuous Emission Monitoring Systems (CEMS).
2. The sample transport system lag time shall be specified in the analyser data sheet.
3. Preliminary sample transport system design shall be performed using the following default lag times:
 - a. 120 seconds maximum for continuous analysers (e.g., pH, oxygen, CEMS);
 - b. the greater of 120 seconds or 10% of cycle time for cyclic analysers (e.g., GCs).
4. Lag time calculations shall be performed by means of a computer program that has been approved by the Principal:
 - a. The results of lag time calculations shall be submitted to the Principal for approval.
5. Sample transport systems shall be designed taking into consideration the analysis cycle time so that an acceptable (minimum) total time-lag is obtained.
6. Sample transport flow rate shall not exceed the following:
 - a. 10% of the total process flow, and
 - b. 300 l/h (80 gal/h) for a liquid sample or 300 l/h (10 cu ft/h) for a gaseous sample at base conditions, 101.325 kPa (14.7 psi) and 15 °C (60 °F).
7. Any transport flow rate that exceeds the levels referred in (2.8, item 6) requires approval of the Principal.
8. Sufficient transport pressure shall be provided to maintain adequate sample velocity, where typical flow velocities are approximately:
 - a. 2 m/s to 4 m/s (13 ft/s) for liquids, and
 - b. 15 m/s (49 ft/s) for gases.

2.9 PHASE AND COMPOSITION CONTROL

1. For phase and composition control of liquid samples following parameters shall be considered:
 - a. bubble point;
 - b. pour point;
 - c. cloud point;
 - d. freeze points;
 - e. viscosity;
 - f. water solubility.
2. For phase and composition control of gaseous samples following parameters shall be considered:
 - a. hydrocarbon and water dew point, and
 - b. tendency to form hydrates.
3. Phase envelopes shall be prepared and utilized for all gas, vapour, LNG and LPG samples (excluding water and steam).
4. SCS designs for multi-phase fluids shall require the approval of the Principal.
5. During sample conditioning, all samples shall be considered for change in composition due to following reasons:
 - a. absorption;
 - b. adsorption;
 - c. de-composition;
 - d. reactivity with wetted materials;
 - e. sample contaminants.

This is particularly where the component of interest is present at low level ppm concentrations (e.g., traces of moisture, hydrogen chloride, hydrogen sulphide, mercury).
6. SCS should be designed to minimise effects from issues such as the following:
 - a. material selection;
 - b. minimizing wetted surface area (e.g., shorter lines, smaller tubing);
 - c. reducing sample contact time by increasing flow rates;
 - d. optimization of heat tracing temperature;
 - e. coating of tubing and other components with inert coatings, and
 - f. cleaning of components with solvent or other cleaning agent prior to commissioning.
7. For applications with <10 ppmv H₂S content and if H₂S is being measured, an inert coating approved by the Principal shall be used for sample transport tubing and sample (pre) conditioning system components such as tubing, filter housings, sample coolers, valves, calibration gas tubing, etc.

8. Preliminary sample transport and conditioning system design shall be performed using the highest of the following temperatures:
 - a. 10 °C (50 °F) in applications where the ambient temperature falls below 0 °C (32 °F), and liquid samples contain free or dissolved water (i.e., freeze protection);
 - b. 20 °C (35 °F) above the hydrocarbon or water dew points or hydrate point at the normal operating pressure for any gas or vapour sample;
 - c. 20 °C (35 °F) above the freeze, cloud or pour point of any liquid sample;
 - d. 20 °C (35 °F) above the normal operating temperature where product viscosity is limiting, and
 - e. 20 °C (35 °F) above the normal operating temperature for any fluid with the potential to exhibit a composition change (e.g., separation of free water, adsorption of trace component to be measured);
 - f. 20 °C (35 °F) less than the de-composition or polymerization point.
9. Sample transport and conditioning systems shall be designed to prevent flashing of volatile liquid samples through the use of a fluid static head (i.e., elevation) between the sample point and downstream sample transport system components and pressure controlling devices such as pumps, valves and regulators.
10. A preliminary sample transport and conditioning system design shall be performed to provide an overpressure of the greater of 200 kPag (29 psig) or 20% of the absolute vapour pressure of the sample at the maximum operating temperature (considering normal and upset operating temperatures and maximum ambient temperatures).

2.10 OXYGEN SERVICES

1. A service containing more than 21% oxygen by volume or a system containing air at a pressure above 5000 kPa (ga) (725 psig) shall be considered an oxygen service.
2. Refer DEP 31.10.11.31-Gen for material requirements for oxygen service.

2.11 WET H₂S/SOUR SERVICES

Sour services are defined as services that contain fluids with liquid water and hydrogen sulphide exceeding the limits specified in ISO 15156 or NACE MR0103, as applicable.

Sour service fluids can cause sulphide stress cracking of susceptible materials.

1. Refer NACE MR0175/ ISO 15156 for sour services in oil and gas production facilities and natural gas sweetening plants.
2. Refer NACE MR0103 for sour services in applications, such as oil refineries, upgraders, LNG plants and chemical plants.
3. If sour service components conforming to the above standards cannot be obtained, components made of Alloy-C (Hastelloy) or type 17-4 PH stainless steel should be used.

A typical example is valve head spindles.

4. Use of components made completely of Alloy C (Hastelloy) shall require the written approval of the Principal.
5. Refer DEP 31.38.01.11-Gen for requirements of wetted components installed in sour services.
6. The wetted parts of the components shall meet the hardness requirements of ISO 15156 or NACE MR0103, as applicable (see above).
7. The NPT threads of screwed components shall be coated with a lubricant/sealing material before installation to prevent corrosion.

2.12 TAGGING

2.12.1 General

1. All equipment (e.g., pumps, heaters, cabinets), connections to the sample system and major components (e.g., rotameters, regulators, flow, pressure, level and temperature indicators) in the analyser system shall be identified with engraved nameplates:
 - a. Refer DEP 32.31.00.32-Gen for the requirements for nameplates.
 - b. Components such as relief valves, excess flow valves, variable-area flow meters and pressure regulators shall also be provided with nameplates showing their settings.
 - c. Nameplates shall be suitable for the maximum SCS temperature.
 - d. Nameplates for safety and warning statements shall have a red background and white lettering.
2. Incoming and outgoing connections at thermal insulation enclosures for sample conditioning systems shall be provided with nameplates on the outside of the enclosure.
3. All sample and return connection points shall be tagged.

2.12.2 Hazards

1. The sample conditioning system for toxic and noxious services shall be provided with the following red nameplate bearing the inscription in white:

CAUTION: TOXIC SERVICE

2. Tagging for caution should comply with regional requirements and conform to MSDS for compounds.
3. Analyser cabinets that contain samples with toxic material shall have the proper tag installed on the exterior with warning when opening door.
4. The following other hazards shall also be identified with nameplates:
 - a. temperatures above 60 °C (140 °F);
 - b. electrical power provided from several sources in a panel;
 - c. remote pump starts.