

DEP SPECIFICATION

ON-LINE PROCESS ANALYSERS

DEP 32.31.50.10-Gen.

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DESIGN AND ENGINEERING PRACTICE



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TABLE OF CONTENTS

1.	INTRODUCTION	4
1.1	SCOPE.....	4
1.2	DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS	4
1.3	DEFINITIONS	4
1.4	CROSS-REFERENCES	6
1.5	SUMMARY OF MAIN CHANGES.....	6
1.6	COMMENTS ON THIS DEP	6
1.7	DUAL UNITS.....	7
2.	GENERAL ANALYSER SYSTEM DESIGN REQUIREMENTS.....	8
2.1	SAFETY	8
2.2	ROLES AND RESPONSIBILITIES	8
2.3	APPLICATION ENGINEERING	8
2.4	MATERIALS.....	9
2.5	ELECTRICAL	9
2.6	PRESSURE DESIGN	10
2.7	ACCESSIBILITY	10
2.8	RESPONSE TIME	10
2.9	PHASE AND COMPOSITION CONTROL.....	11
2.10	OXYGEN SERVICES	12
2.11	WET H ₂ S/SOUR SERVICES.....	12
2.12	TAGGING.....	12
3.	ANALYSERS	13
3.1	SELECTION.....	13
3.2	LOCATION.....	13
3.3	OUTPUTS.....	13
3.4	SPECIFICATION	14
3.5	DOCUMENTATION	15
4.	VALIDATION/CALIBRATION SYSTEMS.....	16
4.1	GENERAL	16
4.2	ANALYSER PERFORMANCE MONITORING	16
5.	SAMPLE SYSTEMS.....	17
5.1	GENERAL	17
5.2	SAMPLE TAKE OFF AND RETURN	20
5.3	SAMPLE TRANSPORT	21
5.4	FIRE SHUT-OFF VALVES.....	23
5.5	SAMPLE (PRE) CONDITIONING	23
5.6	SAMPLE RECOVERY AND DISPOSAL	24
6	DOCUMENTATION	26
7	INSPECTION AND TESTING.....	26
7.1	GENERAL	26
7.2	ORIGINAL EQUIPMENT MANUFACTURERS (OEM) TESTS	26
7.3	FACTORY ACCEPTANCE TESTS (FAT)	26
7.4	SITE ACCEPTANCE TESTS (SAT)	27
8.	REFERENCES	28

APPENDICES

APPENDIX A	ROLES AND RESPONSIBILITIES	30
APPENDIX B	DOCUMENTATION.....	34
APPENDIX C	INSPECTION AND TESTING	38

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.

NOTE: The previous revision of this DEP (January 2010) incorporated the following former DEPs, which are now withdrawn: DEP 32.31.50.11-Gen. and DEP 32.31.50.12-Gen.

Analyser houses are covered by DEP 32.31.50.13-Gen.

This is a revision of the DEP of the same number dated January 2010; 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.

1.3.2 Specific definitions

Term	Definition
Analyser Application Engineering	The activity of detailing the scope of the analytical measurement and its application.
Analyser Data Sheet	Compilation of technical details as a direct result of analyser application engineering.
Fast Loop	Refers to a 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.
IP	Ingress Protection
LNG	Liquefied Natural Gas
PEFS	Process Engineering Flow Scheme.
Piping Class	An 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	The piping used for transport of fluids (other than sample lines).
Sample	A 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	The tube or pipe used for transporting the sample.
Sample Pre-Conditioning System	Consists of 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	A 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	A 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.
Sample Take-Off Connection	A 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	The 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	The system that includes the sample probe and downstream components up to the connection with the sample transport system.
Sample Transport System	A 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.

Term	Definition
Sample System	The complete system that includes the sample take-off, sample transport and sample conditioning systems.
Secondary Loop	A 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	Refers to a sample transport system that returns the waste sample to a utility system.

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 (8).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2010. The following are the main, non-editorial changes.

Old Section	New Section	Change
	1.7	Dual Units paragraph added
	2.1.1	Insulation of surfaces with temperatures that exceed 50 °C (122 °F) is changed to surfaces with temperatures 60 °C (140 °F).
	2.3	Maximum sample line length added.
	2.6	For pressure relief valve sizing calculation according API 520 Part I added.
	3.1	Principal approval required for installation of probes in Exd boxes
	4.1	Restriction added to use nitrogen as driving force on validation vessels for liquid samples.
	4.2	SAIL requirement replaced by analyser performance monitoring requirement.
	5.4.2	Requirement for plastic tubing to connect Fire Shut-off valves deleted.
	5.6.2	Added that recovery systems should be suitable to handle the products disposed in terms of toxicity, corrosivity and physical properties.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using the DEP Feedback Form by:

- Entering comments directly in the DEP Feedback System on the Technical Standards Portal <http://swww.shell.com/standards> (mandatory for users with access to Shell Wide Web);
- Clicking on the DEP Feedback Form button on the DEPs DVD-ROM main page (for users without access to Shell Wide Web);
- Requesting a copy of the DEP Feedback Form from the Administrator at standards@shell.com (for users without access to Shell Wide Web).

For the last two options, the completed DEP Feedback Form can be attached to an email and submitted to the Administrator at standards@shell.com. Only feedback that is entered into the Feedback Form will be considered.

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.

2. GENERAL ANALYSER SYSTEM DESIGN REQUIREMENTS

2.1 SAFETY

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

2.1.1 Personnel protection

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

2.2 ROLES AND RESPONSIBILITIES

(Appendix A) provides a Roles and Responsibilities matrix that identifies the organization responsible for each of the tasks that shall be completed on a project to obtain a fully functional analyser system. The completed form also ensures that appropriate technical input and project technical assurance roles are in place prior to the beginning of detailed engineering. The Roles and Responsibilities Form as per (Appendix A, A.5) shall be completed and approved by the Principal prior to the start of a project.

The Contractor shall provide the organization chart and the resume(s) of the assigned analyzer engineer(s) in relation to the size of the project for the Principal's approval.

2.3 APPLICATION ENGINEERING

Analyser application engineering shall be conducted before decisions are taken on matters covered in this DEP. The outcome of the analyser application engineering shall be documented in the analyser narratives and data sheets. Analyser narratives and data sheets shall be subject to approval by the Principal.

Preliminary design of analyser systems requires review of the analyser datasheet, determination of the preferred location of each analyser (e.g., shelter or field mount) and sample take-off points and return points (e.g., process, flare, sump). This iterative process requires consideration of the following:

- a) the type of analyser and acceptable analyser inlet requirements (e.g., pressure, temperature, flow);
- b) the process temperature and pressure and sample characteristics (e.g., phase, viscosity);
- c) 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),
- d) available differential pressure between the sample and return points (i.e., need for sample pumps),
- e) analysers utilized in control loops and other critical applications shall be single stream applications. This ensures reliability and meets control loop target availability.
- f) maximum sample transport lag times as specified on the analyser data sheet; and,
- g) potential analyser and analyser shelter locations.

The Contractor shall prepare during the preliminary design phase a plot plan showing potential analyser, analyser shelter and sample take-off and return locations and approximate sample transport times. 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

The normal and upset process conditions and the nature of the fluid shall be taken into consideration when selecting materials including elastomeric seals to ensure that materials are suitable (e.g., corrosion resistant, appropriate pressure and temperature rating) for the intended service. 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 (2.9).

The sample probe, the primary isolation valve (i.e., root valve) at the sample take off point and return/disposal point (e.g., flare header) and sample transport tubing and piping shall meet the requirements of DEP 31.38.01.11-Gen. and the appropriate piping class.

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

Both the process conditions and the nature of the fluid shall be taken into consideration when selecting materials.

Unless specified otherwise, AISI 316 stainless steel should be used for all wetted parts of the sampling system. For sample transport tubing, Alloy 825 steel seamless tubing shall be used, unless specified otherwise. Compression type fittings shall be dual ferrule stainless steel.

In cases where AISI 316 and/or Alloy 825 are not suitable (e.g., systems containing water with chlorides, hydrogen fluoride (HF) alkylation service and services where strong reducing acids such as pure hydrochloric and sulphuric acid are used), advice from the responsible materials and corrosion engineer shall be sought.

Sample systems for products in which traces of reactive compounds are to be measured, e.g., traces of hydrogen chloride, hydrogen sulphide, mercury, etc., shall be treated to minimise interaction between the sample and the tube. Sample lines on process streams with reactive components require insulation and heat tracing to prevent adsorption and desorption of gases from the pores of the tubing.

With the exception of seals (e.g., o-rings, gaskets), the use of non-metallic materials requires the Principal's approval.

Glass components or parts shall not be used for flammable and toxic/noxious fluids; any usage of glass components will require Principal approval.

Thermal insulation shall have a guaranteed maximum chloride content of 10 mg/kg and be sealed against water ingress in order to prevent chloride stress corrosion and influence of UV radiation due to direct or indirect sunlight.

2.5 ELECTRICAL

DEP 33.64.10.10-Gen. shall apply.

All equipment installed shall meet the defined area electrical classification of the location for which it is to be installed.

All electrical components or assemblies consisting of electrical components shall have a nationally recognized testing laboratory approval (e.g., CSA, ULC, ATEX) for the specified electrical area classification and shall be marked accordingly.

Each powered component will have a separate switch adjacent to the device that will have a tag identifying the component it powers. Exceptions to this requirement are loop-powered transmitters (e.g., gas detectors, flow switches, level switches).

2.6 PRESSURE DESIGN

The pressure rating of selected components shall meet the design conditions.

Where practical, sample systems shall utilize equipment and components with pressure ratings which exceed the system design pressure (i.e., inherent safety). This should preclude the requirement for pressure relief systems. When this is not practical, the sample system shall incorporate protection from excessive pressures caused by the failure of components (e.g., pressure regulators, pressure reducing valves) and/or components or equipment (e.g., analysers) with a pressure rating below the supply pressure (e.g., process fluid, carrier gas, instrument air).

Relief valves shall be used in all cases where failure of a component such as a regulator could cause over pressurization of an analyser or sample system.

Relief valves should be vented to the flare system for gas streams and to an appropriate process connection for liquid streams. Venting to atmosphere at a safe location shall be approved by the Principal.

Check valves shall not be used as pressure relief valves.

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. For calculating the pressure relieve valve size, the formula in the current API 520, Part I shall be used. Relief valve sizing shall be approved by the Principal.

Pressure relief valves shall be provided with a stainless steel tag detailing tag number and relief pressure setting.

Pressure ratings and the tolerances for outside diameter and wall thickness of the tubing shall meet the requirements of ISO 4200 for metric sizes, and, when applicable, ASTM A269 for US customary sizes.

2.7 ACCESSIBILITY

Sample systems shall be designed so that their components are readily accessible from grade or permanent platforms.

Sample systems shall be designed so that components can be removed with the minimum of disturbance to the system.

Sample cabinets shall be designed so that access to components that require normal maintenance can be performed without removal of any other component or tubing line.

2.8 RESPONSE TIME

Analyser system lag (i.e., response) time is the sum of the sample transport lag time, the sample conditioning lag time and the analyser response time. Therefore, sample transport systems shall be designed so that the sample transport lag time is appropriate considering the relative contributions of the analyser and sample conditioning system to the total system lag time.

Sample transport systems shall be designed to provide a lag time no greater than that required for effective process control and monitoring or that permitted by regulation, e.g., Continues Emission Monitoring Systems (CEMS). The required lag time shall be defined in the analyser data sheet.

Preliminary transport system design shall be performed using the following default lag times:

- 120 seconds maximum for continuous analysers (e.g., pH, oxygen, CEMS),
- the greater of 120 s or 10 % of cycle time of cyclic analysers (e.g., GCs).

Lag time calculations shall be performed by means of a computer program that has been approved by the Principal. The results of lag time calculations shall be submitted to the Principal for approval.

Sample transport systems shall be designed taking into consideration the analysis cycle time so that an acceptable (minimum) total time-lag is obtained. The transport flow shall not exceed 10 % of the total process flow and should not exceed 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). Sufficient sample transport pressure shall be provided to maintain adequate velocities, where typical flow velocities are approximately 2 m/s to 4 m/s (7 ft/s to 13 ft/s) for liquids and 7 m/s to 15 m/s (23 ft/s to 49 ft/s) for gases.

2.9 PHASE AND COMPOSITION CONTROL

Parameters such as bubble, pour, cloud and freeze points, viscosity and water solubility shall be considered for liquid samples. For gases or vapour samples, parameters such as hydrocarbon and water dew point and tendency to form hydrates, shall be considered.

Phase envelopes shall be prepared and utilized for all gas, vapour, LNG and LPG samples (excluding water and steam).

SCS designs for multi-phase fluids require the approval of the Principal.

Changes in composition during sample conditioning due to absorption, adsorption or reactivity with wetted materials or sample contaminants shall be considered for all samples, particularly where the component of interest is present at low level ppm concentrations (e.g., traces of moisture, hydrogen chloride, hydrogen sulphide, mercury). SCS shall be designed to minimise such effects as follows:

- a) selection of proper materials,
- 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.

For applications with <10 ppmv H₂S content and if H₂S is being measured, an inert coating approved by the Principal shall be used where practical for sample transport tubing and sample (pre)conditioning system components such as tubing, filter housings, sample coolers, valves, calibration gas tubing, etc.

Preliminary sample transport and conditioning system design shall be performed using the greatest of the following default hold temperatures:

- a) For applications where the ambient temperature falls below 0 °C (32 °F), maintain a minimum of 10 °C (50 °F) for any liquid sample containing 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).

Consideration shall be given to avoid sample de-composition or polymerization due to high process temperature at take-off, sample transport and conditioning.

Through the use of fluid static head (i.e., elevation) between sample point and downstream sample transport system components and pressure controlling devices such as pumps, valves and regulators, sample transport systems shall be designed to prevent the flashing of volatile liquid samples. Preliminary sample transport 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/hold temperature (considering normal and upset operating temperatures and maximum ambient temperatures).

2.10 OXYGEN SERVICES

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

All materials for gaseous-oxygen applications shall be carefully designed, constructed, cleaned, inspected, operated and maintained in accordance with the requirements of DEP 31.10.11.31-Gen.

2.11 WET H₂S/SOUR SERVICES

All wetted components installed in sour services shall comply with the requirements of DEP 31.38.01.11-Gen.

Sour services or sour environments are defined as fluids containing water as a liquid and hydrogen sulphide exceeding the limits prescribed in ISO 15156 or NACE MR0103, as applicable. These environments may cause sulphide stress cracking of susceptible materials.

- NOTES:
1. ISO 15156 shall apply to oil and gas production facilities and natural gas sweetening plants. NACE MR0175 is equivalent to ISO 15156.
 2. NACE MR0103 shall apply to other applications (e.g., oil refineries, Upgraders, LNG plants and chemical plants).

If components cannot be obtained in accordance with the above standards, Alloy-C (Hastelloy) or type 17-4 PH stainless steel should be used.

Typical examples are valve head spindles.

The wetted parts of the components shall meet the hardness requirements of ISO 15156 or NACE MR0103, as applicable (see above).

The application of complete components made of Alloy C (Hastelloy) requires the written approval of the Principal.

The threads of screwed components shall be coated with a lubricant/sealing material before installation to prevent corrosion.

2.12 TAGGING

2.12.1 General

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 etc.) in the analyser system shall be identified with engraved nameplates. The nameplates shall be white background with black lettering with safety or warning nametags to be red background with white lettering.

Components such as relief valves, excess flow valves, variable-area flow meters and pressure regulators shall also be provided with nameplates showing their settings.

The nameplate shall be in accordance with the requirements of DEP 32.31.00.32-Gen., but shall be screwed and not glued.

In addition to the above, incoming and outgoing connections at thermal insulation enclosures for sample conditioning systems, shall be provided with nameplates on the outside of the enclosure.

All sample and return connection points will be tagged with stainless steel nametags.

2.12.2 Hazards

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

CAUTION: TOXIC SERVICE

Tagging for caution should comply with regional requirements and conform to MSDS for compounds.

Analyser cabinets that contain samples with toxic material shall have the proper tag installed on the exterior with warning when opening door.

Other hazards such as temperatures above 60 °C (140 °F) or electrical power provided from several sources in a panel or remote pump starts, shall also be identified with nameplates.

3. ANALYSERS

3.1 SELECTION

Analyser selection shall be made on the basis of Total Cost of Ownership taking into account the following:

- a) analyser performance (e.g., accuracy, response time, suitability),
- b) housing requirement (e.g., case, cabinet, shelter),
- c) site installed base impact (e.g., training, spare parts),
- d) for new analyser types, level of site expertise,
- e) consumable costs,
- f) measurements requirements required for process.

Where appropriate, the analyser shall be selected so that the applied Standardized Analysis Test Method (e.g., ASTM or Shell Method Series) on which the on-line analysis is based or correlated, is the same method as is applied by the site laboratory.

Analysers that are intended for environmental/pollution control or Continuous Emission Monitoring System (CEMS) may require approval or have to confirm to the requirements specified by the local environmental/pollution control authority.

Analysers shall be sourced from Manufacturers approved by the Principal.

The use of analyser probes in gas applications installed in Exd boxes shall be approved by the Principal.

3.2 LOCATION

The analyser should be located close to the sample take-off point, if this can be done without adversely affecting the performance or maintainability of the analyser. If performance or maintainability cannot otherwise be assured, the analyser should be located in an analyser shelter. The required environment, e.g., humidity, temperature, area classification, etc., may require the analyser to be located in a shelter. An analyser shelter is preferred where harsh and fluctuating environmental conditions inhibit maintainability and the stability of conditions for analyser performance or when a group of analysers require utilities such as carrier gases, e.g., PGCs.

Analysers shall be grouped as appropriate to minimize the number of shelters required in an operating unit.

See DEP 32.31.50.13-Gen. for additional analyser housing requirements.

3.3 OUTPUTS

Foundation™ Fieldbus communication technology is the standard to connect field devices with the DCS/BPCS. Where practical and appropriate (i.e., available for analysers), it shall be used on major projects and major expansions. For existing plants, where it is not