

Sample Transport and Sample Conditioning Systems for Process Stream Analyzers

(This practice is appropriate for attachment to Inquiry or Purchase Document)

IP 15-8-2

Page 1 of 14

Rev. 2

June 1999

Changes shown by ↕

SCOPE

- I 1.1 This practice covers the design, installation, and inspection of sample transport systems and sample conditioning systems for process stream analyzers.
- I 1.2 **An asterisk (*)** indicates that a decision is required by the Owner's Engineer or that additional information is furnished by the Owner's Engineer.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I 2.1 **Table 1** lists the practices and standards which shall be used with the practice.
- I ↕ * 2.2 **Table 2** lists the practices, codes, standards, and publication which shall be used with the practice **as specified** by the Owner's Engineer.

TABLE 1

PRACTICES	
IP 18-10-1 Additional Requirements for Materials	IP 20-1-1 Inspection of Equipment and Materials
STANDARDS	
ANSI / ISA Standard ISA S5.1 Instrumentation Symbols and Identification	ASME Standards B31.3 Process Piping Y32.11 Graphical Symbols for Process Flow Diagrams

TABLE 2

PRACTICES	
IP 3-2-7 Manual Sampling Systems IP 3-6-1 Piping for Instruments IP 3-18-1 Piping Fabrication Shop or Field IP 4-3-3 Shelters for Process Analyzers IP 14-1-1 External Insulation	IP 15-8-1 Process Stream Analyzers IP 16-9-1 Low Voltage A-C Motors Up to 200 HP (150 kW) IP 18-10-1 Additional Requirements for Materials IP 19-7-1 Protection of Stainless Steel During Fabrication, Shipping, Storage, and Field Construction
CODES, STANDARDS, AND PUBLICATIONS	
API Standards TP 555 Process Analyzers 5L Line Pipe ASTM Standards A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless A 106 Seamless Carbon Steel Pipe for High-Temperature Service A 269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service A 312 Seamless and Welded Austenitic Stainless Steel Pipe	ASME Code Section VIII Pressure Vessels, Division 1 ASME Standard B1.20.1 Pipe Threads, General Purpose (Inch) EEMUA Publication 138 Design and Installation of On-Line Analyzer Systems IEC 111S Expression of Performance of Sample Handling Systems for Process Stream Analyzers Exxon Chemical Company Process Analyzer Requirements Handbook- 97 CENG 2141

DEFINITIONS

- I 3.1 **Sample tap** is defined as a connection point used for taking a sample from a process stream.
- I 3.2 **Sample transport system** (fast loop) is defined as a piping system used to transport the sample from the sample tap to the sample conditioning system and where applicable, return the sample to the process.
- I 3.3 **Sample conditioning system** is defined as a combination of modules installed directly upstream of an analyzer inlet used to prepare process samples for analysis. Examples of modules which are used commonly in sample conditioning systems include filters, vaporizers, reducing regulators, separators, scrubbers, and temperature controllers.
- I 3.4 **Analyzer validation / calibration system** is defined as all the facilities required for introducing a standard reference sample into the analyzer for the purpose of validation or calibration and for taking a representative sample of the sample flowing through the analyzer for analysis in a laboratory.



Documents

Document Sharing Hub

THIS INFORMATION FOR AUTHORIZED COMPANY USE ONLY

EXXON RESEARCH AND ENGINEERING COMPANY — FLORHAM PARK, N.J.

IP 15-8-2	Sample Transport and Sample Conditioning Systems for Process Stream Analyzers (This practice is appropriate for attachment to Inquiry or Purchase Document)	
Page 2 of 14		
Rev. 2 June 1999		

DOCUMENTATION

PROPOSAL INFORMATION

- O 4.1 **Bidder's proposal information shall include:**
- a. Total equipment list, including description of each item, function, size, capacity and utility requirements. Where the vendor has a **standard sample conditioning system**, it shall be **quoted separately** as an option.
 - b. Materials of construction.
 - c. Schematic flow diagram.

INSTRUCTION MANUALS

- R,M * 4.2 **Instruction manuals** shall be supplied by the vendor for each sample transport and conditioning system. **The number of copies and delivery schedule** shall be specified by the Owner's Engineer. These manuals shall cover all components, and shall include the following:
- a. Interconnecting diagram indicating all connections and shielding requirements. Markings for wire color coding or numbering, and for terminal identification, shall be identical to those actually on the systems.
 - b. A schematic flow diagram and assembly drawing for all systems supplied.
 - c. A bill of materials for all systems showing manufacturer's catalog numbers of all major components.
 - d. Specifications and drawings for all major components such as vessels, regulators, filters, pumps, flow indicators.
 - e. Detailed installation instructions.
 - f. Complete parts list.
 - g. Recommended spare parts list for start-up and 2 years' operation.
 - h. Trouble-shooting procedure.
 - i. A copy of the factory inspection data including pressure tests and materials certificates.

SOFTWARE

- R,M 4.3 Where available, **all drawings shall additionally be provided in software / CAD format**. The vendor shall specify the software package used.
- R,M * 4.4 If applicable, **the original diskettes containing software required to operate or interact** with the system shall be provided by the vendor. The number of copies and the delivery schedule shall be specified by the Owner's Engineer.

MATERIALS

PIPING AND TUBING

- S * 5.1 **Material shall be either stainless steel pipe Type 316 or 304, carbon steel pipe or stainless steel tubing** Type 316 or 304, unless a special material is required for the process or utility fluids handled.
- S 5.2 **Tubing fittings.** Compression fittings **ferrules** shall have a **hardness** greater than the connective tubing.
- S 5.3 **Low melting alloys**, except aluminum in cryogenic service, shall not be used in lines handling hydrocarbon or other flammable substances.
- S 5.4 **Copper or copper bearing alloys** shall not be used in **ammonia service**.
- S 5.5 **If non-metallic materials** are used for hydrocarbon lines, they shall be routed and suitably supported in metallic tubing or pressurizable conduit.
- S 5.6 **Carbon steel shall not be used for pipe subject to shock chilling** where the fluid temperature is below -50°F (-45°C).

ANALYZER SYSTEM PUMPS

- S 5.7 **Steel casings** are required for any pumps located **within process unit areas**, handling a stream containing any flammable or toxic materials.

SAMPLE TAP / SAMPLE RETURN CONNECTIONS

- O,R ♦ *6.1 Unless a special take off design is required, a **sample take-off probe** shall be supplied at each analyzer sample tap for **process line sizes 2 in. and above**. A typical probe design is detailed in [Figure 1](#), the Owner's Engineer shall approve the final design. In all cases, probes shall conform to local process line and small bore piping regulations. Sample taps and associated valves not located at grade shall be accessible from a permanent platform, portable platform (e.g., cherry picker) or ladder. Retractable probes or probes where sample conditioning components are located must have permanent platform access.
- O,R 6.2 **For process line sizes less than 2 in.**, a tee shall be installed in a vertical piping run for the sample tap. If a vertical run is not available, the tee shall be oriented so the sample is drawn from the top of the process line.
- O 6.3 **Sample taps shall be located at least 12 pipe diameters** from the junction of two streams to ensure proper mixing. Sample taps shall be at least 12 pipe diameters downstream of a pressure reducer where two phase flow can exist.
- O,R 6.4 **Sample taps shall be made at the top or side of process lines**. For liquid lines, the sample tap shall be designed to avoid collection of gases or vapor in the fast loop.
- R,M 6.5 **All sample taps and return connections shall** have a permanently fastened corrosion resistant label to identify service including Tag Number, e.g., ADO Distillation Analyzer A2ADT001 Sample Take-Off Point.
- R,M 6.6 **A process piping specification block valve (3/4 in. minimum size) and check valve** shall be installed in the sample return line at the sample return to connection to the main process line.
- O 6.7 **Sample probe volume shall be minimized** when sample vaporizers are used at the sample tap.

SAMPLE TRANSPORT SYSTEMS

- O *7.1 **The sample transport system** shall be designed to **minimize holdup**. Unless specified otherwise, sixty seconds is the maximum allowable transit time.
- O,R 7.2 **Liquid sample transport systems**. The sample circulating loop shown in [Figure 2](#) shall be used as a minimum basic design to transport liquid samples from a process line to the sample conditioning system.
- O,R ♦ *7.3 If not otherwise specified, the **source of differential pressure to drive the transport system** shall be in the following order of preference:
- Across a process pump.
 - From one process line to another process line at a lower pressure, that are not connected by only a control valve or are part of a pressure control system.
 - A fast loop circulating pump.
 - Use of a sample recovery system.
- Final selection shall be reviewed with the Owner's Engineer. **Sample transport system fast loops shall not be taken across process control valves, as differential pressure can be variable**; this avoids affecting operation of the control valve loop and avoids variations in fast loop flow caused by control valve operation.
- O ♦ *7.4 **When a pump is required in a liquid sample transport system**, it shall be located to insure at least 150% of the required pump NPSH under lowest process stream pressure conditions. A pulsation damper shall be included in the system for positive displacement pumps if pulsating flow will affect the correct operation of the analyzer.
- O,R ♦ 7.5 **Sample transport systems** shall use as a minimum basic design [Figure 2, 3, 4 or 5](#), selected as follows:
- [Figure 2](#) shall be used for liquid samples and vapor samples that cannot be vented.
 - [Figure 3](#) shall be used for vapors in all other cases, wherever possible.
 - [Figure 4](#) shall be used for vapors containing condensable gases.
 - [Figure 5](#) shall be used when it is not possible to have less than 60 seconds transit time using [Figure 3](#).
- [Figures 2, 3, 4 and 5](#) show minimum basic design for operability. They do not indicate all required components, e.g., relief valves, double blocks, vents, heat tracing, insulation, etc. that may have to be included for the specific application and for protection of downstream equipment.

SAMPLE CONDITIONING SYSTEMS

- S *8.1 **For a toxic or flammable sample line or utility supply line to an enclosed analyzer shelter** (e.g., hydrogen carrier gas for chromatographs), a **restrictor or automatic cut-off shall be provided outside the analyzer shelter**. The restrictor capacity shall be less than 2 times normal flow rate. The cut-off shall function on sudden increase of flow rate (such as would be caused by a line break).

IP 15-8-2		Sample Transport and Sample Conditioning Systems for Process Stream Analyzers (This practice is appropriate for attachment to Inquiry or Purchase Document)	EXXON INTERNATIONAL PRACTICE
Page 4 of 14			
Rev. 2	June 1999		

- O * 8.2 **Sample transit time**, from entry to sample conditioning system until entry to analyzer shall be **minimized**. It must be less than 30 seconds, if possible. **Unless specified otherwise, the sample transit time** from the sample tap to the analyzer shall not exceed 90 seconds.
- M 8.3 **All modules shall be mounted** so that they may be removed and serviced without disturbing the remainder of the system.
- M 8.4 **All interconnecting wires** shall be either **color coded or numbered**.
- M 8.5 **All terminal blocks shall be clearly identified**, and all individual terminals shall be clearly marked.
- O,R 8.6 **Flow, pressure and where needed temperature measuring devices** shall be installed in the conditioning system for each analyzer. **A coalescing filter with a flowmeter in the drain leg** will be provided in the sample conditioning system for each hydrocarbon liquid phase analyzer.
- R,M 8.7 **The sample transport and conditioning system components** shall be mounted in a sample system cabinet located outside the shelter for analyzers inside enclosed shelters handling toxic and flammable materials.
- O,M 8.8 **A block valve and a final sample flowmeter or pressure indicator** shall be mounted inside the shelter close to the analyzer.
- M 8.9 **A primary block valve for isolating the sample** must be installed outside the local cabinet / panel when sample system components are mounted inside local cabinets / panels.
- O,M * 8.10 **Unless specified otherwise, provision shall be made for flushing the sample conditioning system and analyzer** with nitrogen or instrument air prior to disassembly for maintenance. Systems containing hydrocarbons must use nitrogen. The flushing connection shall be immediately upstream of the fast loop filter. **The primary connection to the sample line** shall be via a three way valve with a second double block and vent three way valve to isolate the nitrogen / instrument air. If process pressure is higher than utility pressure, **a check valve and removable flexible hose connection** shall be provided.
- S 8.11 **Relief valves shall be provided** downstream of pressure reducing valves where required to protect the analyzer and downstream conditioning system components.

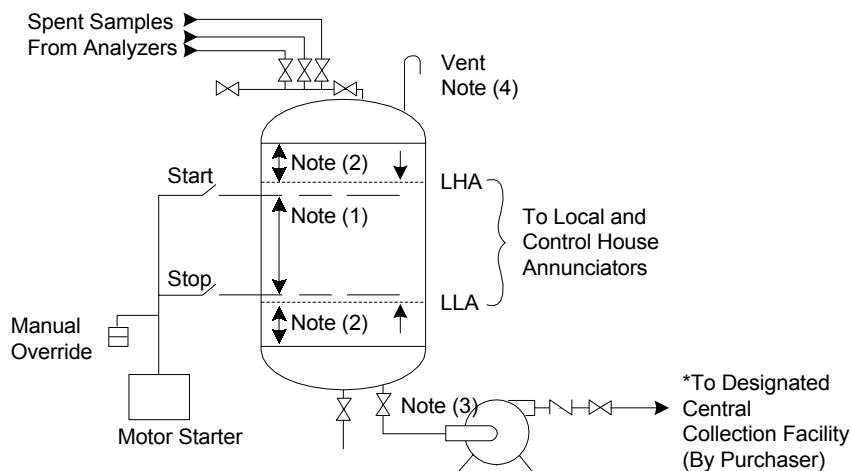
VALIDATION / CALIBRATION FACILITIES

- R,M * 9.1 Unless specified otherwise, **all analyzers shall be provided with a permanent means of validation / calibration by a standard reference sample**. The standard reference sample shall be permanently stored in an appropriate container(s) as an integral part of the sample conditioning system unless it is not possible to obtain a stable standard reference sample.
- O 9.2 **The validation / calibration sample shall be switched into the analyzer sample conditioning system** downstream of all conditioning system components except for the final control valve / flowmeter and final guard filler. **The validation / calibration sample shall be switched** using three-way ball valves in a double block and drain / vent arrangement.
- O,M * 9.3 **The design of the validation / calibration facilities shall be as types A-E detailed below** depending on application, unless specified otherwise. The size of the gas cylinders for Type A and the sample containers / drums for Types B, C and D shall be selected to give approximately three months normal operating service with weekly validations / calibrations.
- O,M 9.4 **TYPE A shall be used for analyzers where the process sample is in the vapor phase**. The validation samples shall be certified gas mixtures in pressurized gas cylinders. **The cylinders shall be purchased with a certificate of analysis**. Both zero and span gas mixtures shall be provided where required. **See Figure 6.**
- O,M ♦ 9.5 **TYPE B shall be used for chromatographs and other analyzers where the process sample is in a volatile liquid phase** (whether liquid or vapor injection is used for the chromatograph). Process sample will be used for the validation sample unless specified otherwise. This will be held in a variable volume piston type container. All wetted parts shall be stainless steel for hydrocarbon samples. Facilities shall be provided for filling the container from the fast loop via double block valves and a filter (or filter / coalescer if coalescers are used in the conditioning system). The motive force for driving the sample through the analyzer will be by pressurizing the other side of the piston with nitrogen or instrument air. **The pressure must be sufficient to ensure all components stay in the liquid phase**. Connections shall be provided for taking a sample from the container for analysis in the laboratory via flexible tubing and tight shut-off quick disconnect fittings into a sample bomb. Where the liquid sample is being vaporized before a chromatograph injection, a separate vaporizer shall be provided for the validation / calibration sample. **See Figure 7.**

- O,M ▶ 9.6 **TYPE C shall be used for light volatile liquid samples** where process sample is used for the validation sample and the required volume is too large for **TYPE B** facilities. The sample shall be held in a stainless steel sample drum for hydrocarbon samples with an internal bladder to prevent loss of light ends. Facilities shall be provided for filling the drum from the fast loop via double block valves and a filter (or filter / coalescer if coalescers are used in the conditioning system). The motive force for driving the sample through the analyzer shall be by pressurizing the other side of the bladder with nitrogen or instrument air. Connections shall be provided for taking a sample from the drum for analysis in the laboratory via flexible tubing and tight shut-off quick disconnect fittings into a sample bomb. **See Figure 8.**
- O,M ▶ 9.7 **TYPE D shall be used where non-volatile liquid process sample, a pure component or non-process reference sample** is being used for the validation sample. The sample will be held in a fixed volume drum. A stainless steel sample drum shall be used for hydrocarbon samples. Where process sample is used for validation sample, facilities shall be provided for filling the drum from the fast loop via double block valves and a filter (or filter / coalescer if coalescers are used in the conditioning system). Manual filling facilities shall be provided where a pure component or non-process reference sample is being used. The sample in the drum shall be low pressure (5 mm W.G.) nitrogen blanketed. The motive force for driving the sample through the analyzer will be by a sample pump which will also recirculate the sample to the drum via a back pressure control valve. Capacity of pump must be at least 5 times analyzer sample flow rate. Connections shall be provided for taking a sample from the drum for analysis in the laboratory via flexible tubing and tight shut-off quick disconnect fittings into a sample bomb. **See Figure 9.**
- O,M 9.8 **TYPE E. Where it is not possible to obtain a stable standard reference sample**, a suitable connection via a three-way ball valve shall be provided at the inlet to the analyzer to allow the connection of a portable sample cylinder, sample bomb or permeation tube calibrator, etc., for validation / calibration of the analyzer.
- O,M 9.9 **Cyclic analyzers, e.g., chromatographs, using liquid phase validation samples** shall have a ball valve located close to the analyzer to block sample flow during the validation analysis cycle to minimize use of validation sample.
- M,S ▶ *9.10 **Unless otherwise specified, facilities for taking laboratory / maintenance samples shall be included in each sample transport system fast loop in accordance with IP 3-2-7.** The take-off connections shall be via isolation valves and flexible stainless steel tubing with tight shut-off quick disconnect fittings installed across the fast loop flow control valve. A support shall be provided for the bomb while taking samples. **If the sample temperature is greater than 55°C**, a cooler shall be provided to cool the sample to 55°C before the inlet of the sample bomb. A temperature indicator shall be provided on the outlet of all sample coolers.

SAMPLE DISPOSAL SYSTEM

- E * 10.1 **Spent hydrocarbon or toxic samples from analyzers and sample systems shall**, wherever possible, be returned directly to process or for vapor samples to a low pressure flare recovery system.
- E 10.2 **A sample disposal system**, such as in the following illustration, shall be provided to return spent hydrocarbon or toxic liquid samples to process when it is not possible to return the sample directly.



Notes:

- (1) Vessel holdup 30 minutes, min.
- (2) Vessel holdup 5 minutes, min.
- (3) Minimum pump design capacity, 200% of sample in-flow rate.
- (4) Vent discharge location is subject to the restrictions of par. 11.8.

150802fA


Documents

Document Sharing Hub