



# Engineering Standard

SAES-Y-501

1 October 2013

Dynamic Sampling of Hydrocarbon  
Liquids for Royalty/Custody Transfers

Document Responsibility: Custody Measurement Standards Committee

## Saudi Aramco DeskTop Standards

### Table of Contents

1	Scope.....	<a href="#">2</a>
2	Conflicts and Deviations.....	<a href="#">2</a>
3	References.....	<a href="#">3</a>
4	Definitions and Abbreviations.....	<a href="#">5</a>
5	General Requirements.....	<a href="#">9</a>
6	Application Requirements.....	<a href="#">12</a>
7	Equipment Requirements.....	<a href="#">13</a>
8	Testing and Inspection.....	<a href="#">17</a>
9	Shipping Requirements.....	<a href="#">17</a>
10	Documentation.....	<a href="#">19</a>

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Page 1 of 19

## 1 Scope

This standard describes the minimum mandatory requirements governing the design, construction and installation of dynamic sampling and associated equipment used to obtain representative samples of liquid hydrocarbons [e.g., crude oil, petroleum products, butane, non-refrigerated propane, natural gas liquids, mixed liquefied petroleum gases (Specification [A-150](#))] where the sample test results will be used for purposes of royalty or custody transfer measurement.

### *Commentary Note:*

*This standard applies irrespective of the method (meters or tank gauging) used to determine the volume.*

This standard does not apply to sampling applications involving refrigerated propane (Specification [A-140](#)) and asphalt. SAPMT shall consult P&CSD/PID/Custody Measurement Unit for sampling requirements involving these hydrocarbons.

This standard does not cover requirements for sampling from tanks

## 2 Conflicts and Deviations

Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

Direct all requests to deviate from this standard in writing to the Company or Buyer Representative, who shall follow internal company procedure [SAEP-302](#) and forward such requests to the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

Direct all requests for interpretation of this standard in writing to the Company or Buyer Representative who shall forward them to the Chairman, Custody Measurement Standards Committee for resolution. The Chairman, Custody Measurement Standards Committee shall be solely responsible for determining whether a proposed installation meets the requirements of this standard.

SAPMT is responsible for ensuring the design and construction contractors provide a fully operational sampling system that meets both the provisions of this standard and the approved project functional specifications. Project execution shall conform to the requirements of [SAEP-21](#) or [SAEP-50](#), as applicable.

### 3 References

Designs shall comply with the latest edition of the references listed below, unless otherwise noted.

Additional codes, practices, standards and bibliographies listed in the individual documents shall also apply.

#### 3.1 Saudi Aramco Documents

##### Saudi Aramco Engineering Procedures

<a href="#"><u>SAEP-21</u></a>	<i>Project Execution Requirements for Saudi Aramco Royalty/Custody Metering Systems</i>
<a href="#"><u>SAEP-50</u></a>	<i>Project Execution Requirements for Third Party Royalty/Custody Metering Systems</i>
<a href="#"><u>SAEP-302</u></a>	<i>Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement</i>

##### Saudi Aramco Engineering Standards

<a href="#"><u>SAES-A-112</u></a>	<i>Meteorological and Seismic Design Data</i>
<a href="#"><u>SAES-B-054</u></a>	<i>Access, Egress, and Materials Handling for Plant Facilities</i>
<a href="#"><u>SAES-B-068</u></a>	<i>Electrical Area Classification</i>
<a href="#"><u>SAES-H-001</u></a>	<i>Selection Requirements for Industrial Coatings</i>
<a href="#"><u>SAES-J-002</u></a>	<i>Regulated Vendors List for Instruments</i>
<a href="#"><u>SAES-J-003</u></a>	<i>Instrumentation Basic Design Criteria</i>
<a href="#"><u>SAES-J-004</u></a>	<i>Instrument Symbols and Identification</i>
<a href="#"><u>SAES-J-005</u></a>	<i>Instrument Drawings and Forms</i>
<a href="#"><u>SAES-J-100</u></a>	<i>Process Flow Metering</i>
<a href="#"><u>SAES-J-600</u></a>	<i>Pressure Relief Devices</i>
<a href="#"><u>SAES-J-700</u></a>	<i>Control Valves</i>
<a href="#"><u>SAES-J-902</u></a>	<i>Electrical Systems for Instrumentation</i>
<a href="#"><u>SAES-L-100</u></a>	<i>Applicable Codes &amp; Standards for Pressure Piping Systems</i>
<a href="#"><u>SAES-L-101</u></a>	<i>Regulated Vendor List for Pipes, Fittings and Gaskets</i>
<a href="#"><u>SAES-L-102</u></a>	<i>Regulated Vendors List for Valves</i>

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<a href="#"><u>SAES-L-105</u></a>	<i>Piping Material Specifications</i>
<a href="#"><u>SAES-L-108</u></a>	<i>Selection of Valves</i>
<a href="#"><u>SAES-L-140</u></a>	<i>Thermal Expansion Relief in Piping</i>
<a href="#"><u>SAES-L-150</u></a>	<i>Pressure Testing of Plant Piping and Pipelines</i>
<a href="#"><u>SAES-L-310</u></a>	<i>Design of Plant Piping</i>
<a href="#"><u>SAES-P-101</u></a>	<i>Regulated Vendor List for Electrical Equipment</i>
<a href="#"><u>SAES-P-103</u></a>	<i>Direct Current and UPS Systems</i>
<a href="#"><u>SAES-P-104</u></a>	<i>Wiring Methods and Materials</i>
<a href="#"><u>SAES-P-111</u></a>	<i>Grounding</i>
<a href="#"><u>SAES-Y-100</u></a>	<i>Regulated Vendor List for Custody Measurement Equipment</i>

#### Saudi Aramco Materials System Specifications

<a href="#"><u>04-SAMSS-001</u></a>	<i>Gate Valves</i>
<a href="#"><u>04-SAMSS-041</u></a>	<i>Expanding Plug Valve</i>
<a href="#"><u>04-SAMSS-051</u></a>	<i>Ball Valves, API 6D</i>
<a href="#"><u>34-SAMSS-525</u></a>	<i>Automatic Sampling Systems for Crude Oil &amp; Refined Products</i>
<a href="#"><u>34-SAMSS-711</u></a>	<i>Control Valves - General Services</i>
<a href="#"><u>34-SAMSS-718</u></a>	<i>Electric Motor Operated Valve Actuators</i>
<a href="#"><u>34-SAMSS-831</u></a>	<i>Instrumentation for Packaged Units</i>
<a href="#"><u>34-SAMSS-913</u></a>	<i>Instrumentation and Thermocouple Cable</i>

#### Saudi Aramco Product Specifications

<a href="#"><u>A-140</u></a>	<i>Refrigerated Propane LPG (a)</i>
<a href="#"><u>A-150</u></a>	<i>Liquefied Petroleum Gas (LPG)</i>

### 3.2 Industry Codes and Standards

#### API Manual of Petroleum Measurements Standards (MPMS)

<i>Chapter 8.1</i>	<i>Standard Practice for Manual Sampling of Petroleum and Petroleum Products</i>
<i>Chapter 8.2</i>	<i>Standard Practice for Automatic Sampling of Liquid Petroleum and Petroleum Products</i>

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#### Other Documents

<i>ANSI/NFPA 70</i>	<i>National Electrical Code (NEC)</i>
<i>ASTM D1265</i>	<i>Sampling Liquefied Petroleum (LP) Gases, Manual Method</i>
<i>ASTM D3700</i>	<i>Obtaining LPG Samples Using a Floating Piston Cylinder</i>
<i>EU Directive 89/336/EEC</i>	<i>Electromagnetic Compatibility (EMC)</i>
<i>IEC 61000-4-3</i>	<i>Electromagnetic Compatibility (EMC) - Testing and Measurement Techniques - Radiated, Radio Frequency Electromagnetic Field Immunity Test</i>
<i>IEC 61000-6-2</i>	<i>Electromagnetic Compatibility (EMC) - General Standards - Immunity for Industrial Environments</i>
<i>US CFR 49</i>	<i>United States Code of Federal Regulations, Title 49: Transportation</i>

## 4 Definitions and Abbreviations

### 4.1 Definitions

**Commentary Note:** A sub-paragraph that contains comments that are explanatory or advisory in nature. These comments are not mandatory, except to the extent that they explain mandatory requirements contained in this standard.

**Controller:** A device that governs the operation of the sample extractor.

**Custody Transfer Measurement:** A specialized form of measurement that provides quantity and quality information used for the physical and fiscal documentation of a change in ownership and/or responsibility of commodities. The following measurements are custody transfer measurements:

- Measurement of hydrocarbon liquid or gas movements (deliveries or receipts) between Saudi Aramco and its customers, suppliers, or transport contractors.
- Measurement of hydrocarbon liquid or gas transfers between Saudi Aramco refineries, fractionation plants, bulk plants, terminals, pipelines, VELA ships, etc. where the measurement is used for accounting or loss control.

**Custody Transfer Point:** The demarcation between Saudi Aramco's facility and the facility of the customer, supplier or transport contractor "(i.e., point where responsibility for the commodity changes).

**Dynamic Sampling:** The process of obtaining a representative sample from a flowing stream.

**Delivery:** A custody transfer from a bulk plant, fractionating center, gas plant, refinery or terminal to a customer, marine vessel, pipeline or contract hauler.

**Extractor:** A device that removes a sample (grab) from a pipeline or fast loop.

**Fast loop:** The probe, piping and pump used to withdraw a representative portion of a stream from the mainline piping and re-inject it back into the mainline.

**Fast loop sampling:** Sampling performed from a low volume bypass diverted from the main pipeline.

**Flow Computer:** A dedicated off-the-shelf electronic device specifically designed for calculating and totaling metered volumes, and/or calculating meter factors during meter proving for one or more meters.

**Flow proportional sample:** A sample taken from a pipe at a rate that is proportional to the flow rate of the fluid in the pipe.

**Grab:** The volume of sample extracted from a pipeline by a single actuation of the sample extractor.

**Homogenous:** When a liquid composition is the same at all points in the container, tank, or pipeline cross section.

**Isokinetic sampling:** Sampling in such a manner that the linear velocity of the liquid through the opening of the sampling probe is equal to the linear velocity of the liquid in the pipeline at the sampling location and is in the same direction as the bulk of the liquid in the pipeline approaching the sampling probe.

**Inline sampling:** A type of automatic sampling in which the sample extractor draws the sample directly from the mainline.

**Jet mixer:** A power mixer in which a portion of the stream is withdrawn and re-injected into the main stream through one or more jet nozzles.

**Light Hydrocarbon Mixture:** “Mixed liquefied gas (LPG) (Saudi Aramco Specification [A-150](#)), natural gas liquids (NGL’s), natural gasoline, or condensate.

**Manual Sampling System:** An assembly (pipe or tubing, valves and a portable receiver) used to manually collect a sample of a single component liquefied petroleum gas (LPG) or light hydrocarbon mixture from a flowing stream in a pipeline.

**Meter Skid:** The field portion of a metering system consisting of the meters, strainers, density meter, flow-conditioning sections, block valves, control valves, piping, instruments, electrical equipment, and associated structural steel.

**Meter Station:** A facility that is primarily dedicated to the measurement of the quantity and quality of a liquid or gas hydrocarbon. The facility may include, but not be limited to storage tanks, pipelines, piping, regulators, valves, strainers/filters, flow straightening and conditioning equipment, samplers, measurement elements, provers, Remote Terminal Units (RTU), pumps, communications (data and SA telephone), metering shelter, UPS, area fencing, area paving, area lighting, ESD valve systems and associated instrumentation, alarms, computers with software programs, peripheral equipment and associated control functions.

**Metering Supervisory Computer (MSC):** Computer that performs supervisory functions (data archiving, report generation, system integrity checks, alarm logging and operator interface) for a metering system.

**Metering System:** A complete assembly of equipment that is designed to measure the quantity and quality of a liquid or gas hydrocarbon. The metering system includes, but is not limited to, the meter skid (meters, strainers, density meter, flow conditioning sections, valves), prover skid, samplers, and control system (flow computers, programmable logic controllers, metering supervisory computers, etc.).

**Parcel (batch) size:** The total quantity of hydrocarbon measured in a royalty or custody transfer.

**Power mixer:** A device that uses an external source of power to achieve stream conditioning.

**Probe:** A specially designed section of pipe that is inserted into the main stream for the purpose of directing a representative portion of the stream into a fast loop or sample container.

**Receipt:** A custody transfer to a bulk plant, fractionating center, gas plant, refinery or terminal from a supplier, marine vessel, pipeline or contract hauler.

**Representative sample:** A portion extracted from a total volume that contains the constituents in the same proportions that are present in the total volume.

**Royalty Measurement:** A specialized form of measurement that is used as the basis for paying royalty to the Saudi Arabian Government.

**Sample Collection Tap:** A connection in the mixing loop where a small sample is withdrawn into laboratory glassware or a portable sample container.

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**Sample Pacing Meter:** A meter specifically provided to generate a flow signal for the purpose of obtaining a flow proportional sample.

**Sample Receiver:** A fixed or portable vessel in which the sample from the extractor is collected.

**Sample Mixing System:** A system used to homogenize a hydrocarbon sample in a sample receiver in preparation for collecting an aliquot(s) for laboratory analysis and/or retention. The system generally includes a circulation pump, static mixer, piping and sample collection tap.

**Sampling Rate:** The volume of hydrocarbon transferred for which each grab taken by sample extractor is representative (cubic meters per grab or barrels per grab).

**Single Component Liquefied Petroleum Gas (LPG):** Propane or butane.

**Static mixer:** A device that utilizes the kinetic energy of the flowing fluid to achieve stream conditioning.

**Stream conditioning:** The mixing of a flowing stream so that a representative sample may be extracted.

**Time proportional sample:** A sample taken from a pipe at a rate that is proportional to a uniform time interval.

**Vendor:** The party that supplies or sells integrated metering systems, metering equipment, or components.

**Worst case conditions:** The operating flow rate, viscosity and density that produce the most non-uniform dispersion of the stream's constituents at the sample probe or extractor.

*Commentary Note:*

*The combination of lowest flow rate, density and viscosity normally pose the worst case conditions.*

## 4.2 Abbreviations

**API MPMS** - American Petroleum Institute *Manual of Petroleum Measurement Standards*

**EC** - European Community

**EU** - European Union



## 5 General Requirements

### *Commentary Note:*

*This section contains requirements which generally apply to all sampling applications. Specific requirements for each sampling application and sampling equipment are provided in Sections [6](#) and [7](#), respectively.*

### 5.1 General

At a minimum, the following data shall be provided and used to design the sampling system and associated equipment:

- Type of operation (tank gauging; pipeline; marine loading or unloading transfer)
- Fluid properties (e.g., specific gravity, viscosity, vapor pressure from the Saudi Aramco product specification or other source)
- Operating temperature and pressure
- System maximum and minimum flow rate
- Maximum and minimum parcel (batch) size
- Available utilities (e.g., electrical power, instrument air)
- Pipe I.D. and line pressure at the sample point

Sampling systems and equipment shall be furnished from approved vendors as specified in [SAES-Y-100](#).

Pipe, fittings and gaskets shall be furnished from approved vendors as specified in [SAES-L-101](#). Valves shall be furnished from approved vendors as specified in [SAES-L-102](#). Instruments and electrical equipment shall be furnished from approved vendors as specified in [SAES-J-002](#) and [SAES-P-101](#), respectively.

Walkways, stairways, platforms, and material handling equipment shall be provided in accordance with [SAES-B-054](#).

### 5.2 Environmental Conditions

Equipment shall be suitable for installation in the applicable environment as specified in [SAES-A-112](#) and shall meet the environmental conditions specified in [SAES-J-003](#).

### 5.3 Layout

The layout of equipment shall provide for unencumbered access for operations and maintenance, and shall permit easy removal of equipment. Space shall be

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provided to permit installation or removal of the sample extractor from the main piping using any required extraction tool.

Each sampling device shall be installed in a single pipe carrying the entire hydrocarbon stream to be transferred and located physically as close as possible to the custody transfer point.

Each sampling device shall be located at a point in the main stream where the pressure is sufficient to maintain the hydrocarbon in a liquid state and, if provided, to ensure proper operation of the sample extractor. Installation of a back pressure control valve(s) downstream of the sampling point may be required to meet this requirement.

Unless otherwise approved by the Chairman, Custody Measurement Standards Committee, each sample extractor, fast loop probe and sample probe shall be mounted in the horizontal plane.

The inlet of each sample extractor, fast loop probe or sample probe shall be positioned in the center one-third of the pipe and shall be oriented in the upstream direction.

Whenever an automatic sampling system and a manual sampling system or manual sample probe are required, consideration should be given to positioning the manual sampling system or manual sample probe immediately downstream of the automatic sampling system extractor or fast loop probe.

*Commentary Note:*

*This arrangement eliminates the need to provide separate stream conditioning devices for individual sampling devices.*

Sample receivers shall be located as close as possible to the sample extractor.

The sampling system controller may be located with the sampling system, in a Process Interface Building (PIB) or control room.

#### 5.4 Piping

Piping and pressure containing components other than that furnished under [34-SAMSS-525](#) (e.g., piping associated with a jet mixer or a fast loop, etc.) shall be designed and constructed in accordance with [SAES-L-100](#) and [SAES-L-310](#).

Pipe, fittings and valves shall conform to the requirements of [SAES-L-105](#). Valves shall be furnished in accordance with [SAES-L-108](#).

Tubing shall conform to the requirements specified in [34-SAMSS-831](#).

Thermal relief valves shall be provided in accordance with the requirements of [SAES-L-140](#).

Vents discharging to a safe location shall be provided at high points in the piping to facilitate removal of trapped air or vapor following initial installation and equipment maintenance.

Provisions shall be included for draining of the sampling system, fast loop piping and jet mixer piping, as applicable. Drain piping shall discharge to an oily water sewer or other suitable location for disposal or processing.

#### 5.5 Instrumentation/Electrical

Instruments and electrical equipment shall be designed for the electrical area classification as determined by [SAES-B-068](#).

Design and installation of instruments and electrical equipment shall conform to the requirements of ANSI/NFPA 70, [SAES-J-902](#), [SAES-P-104](#), and [SAES-P-111](#).

Sample controllers and communications equipment shall be powered by a UPS system which conforms to the requirements of [SAES-J-902](#) and [SAES-P-103](#).

Instrument cabling shall conform to [34-SAMSS-913](#).

Field junction boxes shall conform to the requirements of [SAES-J-902](#) and shall be installed in accessible locations. Conduit and cable connections shall enter each junction box from the bottom. Each conduit shall be sealed with a weather-tight seal at the entrance to a field junction box.

#### *Commentary Note:*

*Installation of weather-tight seals as described above is required to prevent or minimize the introduction of moisture from long conduits into field junction boxes and is not required for safety.*

The original physical structure of each cable shall extend at least 50 cm above the entry point of a junction box or marshaling cabinet. The cable shall be centered at the entry point.

Electrical and electronic equipment shall carry the EC conformity mark (“CE”) designating compliance with EU Directive 89/336/EEC. An authorized agency shall also have tested and certified the equipment is immune to electromagnetic interference, electrostatic discharge, radio frequency interference, surge and fast transients, voltage dips and interruptions at Performance Level A in accordance with IEC 61000-6-2. Tests shall have been performed to confirm the equipment is immune to radiated, radio frequency and electromagnetic emissions in accordance with IEC 61000-4-3 using Test Level 3.

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## 5.6 Stream Conditioning

Each sampling device shall be located at a point where the hydrocarbon stream is homogeneous under the worst case conditions. One of the following methods shall be used to create a homogeneous stream for sampling:

- Jet mixer
- Static mixer
- Mixing elements (tees, elbows, reducers, reduced diameter pipe)

See [Section 7](#) for specific requirements.

## 6 Application Requirements

### *Commentary Note:*

*This section outlines requirements for particular applications.*

### 6.1 Crude Oil

An automatic sampling system and manual sampling probe shall be provided for each application involving crude oil.

### 6.2 Refined Products

A manual sampling probe shall be provided for each custody measurement application involving a refined product.

An automatic sampling system shall also be provided for each application where refined product is sold for export.

### *Commentary Note:*

*A retained sample from an automatic sampling system is required to resolve any possible dispute pertaining to the quality of exported product.*

### 6.3 Single Component Liquefied Petroleum Gases (LPG's)

A manual sampling system shall be provided for each application involving a single component liquefied petroleum gas (LPG).

### 6.4 Light Hydrocarbon Mixtures

Except where an online gas chromatograph is provided, an automatic (composite) sampling system shall be provided for each application involving a light hydrocarbon mixture.

If an automatic sampling system is not required, a manual sampling system shall be provided.

## 7 Equipment Requirements

### *Commentary Note:*

*This section outlines requirements for sampling equipment in support of the aforementioned application requirements.*

### 7.1 Automatic Sampling Systems

#### 7.1.1 General Design Requirements

The automatic sampling system shall employ an isokinetic inline-type extractor except where a fast loop system has been approved by the Chairman, Custody Measurement Standards Committee. In applications involving crude oil or refined products, a fast loop sampling system may only be considered where the relative elevations between the sampling point and receivers is not sufficient to permit free and complete flow of the sample to the sample receivers or the receivers cannot be positioned in close proximity to the sample extractor.

Automatic sampling systems in crude oil or refined product service shall conform to the requirements of API Manual of Petroleum Measurement Standards, Chapter 8.2 and [34-SAMSS-525](#).

Automatic (composite) sampling systems in light hydrocarbon mixture service shall conform to the requirements for an injection pump composite sampling system as specified in ASTM D3700.

#### 7.1.2 Stream Conditioning

For applications involving crude oil, the method of stream conditioning shall be selected based on the requirements of API Manual of Petroleum Measurement Standards Chapter 8.2, Table 1 and Appendix B using the worst case conditions.

For applications involving refined products, the method of stream conditioning shall be selected based on API Manual of Petroleum Measurement Standards, Chapter 8.2, Table 1.

For applications involving single component liquefied petroleum gases (LPG's), mixing elements (tees, elbows, reducers, reduced diameter pipe) shall be installed upstream of the sampling point to provide the required stream homogenization.

For applications involving light hydrocarbon mixtures, a static mixer shall be installed upstream of the sampling point to provide the required stream homogenization. The static mixer installation shall conform to the manufacturer's recommendations.

#### 7.1.3 Sample Pacing

The sample extractor shall be paced uniformly in proportion to the total flow rate of the hydrocarbon stream from which the sample is taken.

If a royalty or custody metering system is provided, the flow signal shall be generated by the metering system flow computer(s) unless otherwise approved by the Chairman, Custody Measurement Standards Committee.

If a royalty or custody metering system is not provided (e.g., transfers where tank gauging is used for the volume determination), the flow signal for sample pacing shall originate from an independent orifice meter, insertion turbine meter or insertion ultrasonic meter. If an orifice meter is used, it shall be designed and installed in accordance with [SAES-J-100](#). If an insertion turbine meter or ultrasonic meter is used, it shall have a linearity of  $\pm 2\%$  over a flow turndown of at least 10:1 and a repeatability of  $\pm 0.2\%$  or better.

For applications involving crude oil and refined products, the design sampling rate shall be sufficient to provide a minimum sample volume of 10 liters (2.64 gallons) for the minimum batch (parcel) volume and at least one sample per volume contained within 25 meters (82 feet) of the pipe carrying the stream from which the sample will be taken.

For applications involving light hydrocarbon mixtures, the design sampling rate shall provide a sample volume which is less than 80% of the sample receiver capacity over the maximum sampling period.

#### 7.1.4 Sample Controller

A controller shall be furnished to activate the sample extractor at the design sampling rate using the signal from the sample pacing device.

#### 7.1.5 Sample Receivers

For applications involving crude oil and refined products, the design sample volume shall be equal to or greater than 1.25 times the sample volume required when sampling at the design sampling rate for a transfer equal to the maximum batch (parcel) volume.

For applications involving crude oil and refined products, portable sample receivers are preferred if the design sample volume is equal to or less than 19 liters (5 gallons). Otherwise, stationary receivers shall be provided.

If the application involves sampling from successive pipeline batches, the number of sample receivers shall be sufficient to ensure that empty and clean sample receivers are always available for collecting samples. The number of sample receivers required may be determined from the pipeline capacity, minimum parcel (batch) size and average time between sample analyses as follows:

$$\text{No. of Receivers} = \text{PC} / \text{PV}_{\text{min}} * \text{TBA} \quad (1)$$

Where:

PC = Pipeline capacity, m<sup>3</sup> or barrels / day

PV<sub>min</sub> = Minimum batch (parcel) volume, m<sup>3</sup> or barrels

TBA = Time between analyses, days

*Commentary Note:*

*Two (2) to four (4) sample receivers will normally be adequate in most pipeline batch sampling applications.*

For applications involving light hydrocarbon mixtures, the receiver shall be a 316 stainless steel constant pressure (floating piston) cylinder with a minimum capacity of two (2) liters, and shall conform to the specifications published in the U. S. Department of Transportation Regulations (U.S. CFR 49). An integral mixer or separate mixing system shall also be provided for preparing the sample for analysis.

## 7.2 Manual Sampling System

### 7.2.1 General Design Requirements

Manual sampling systems shall conform to the requirements of ASTM D1265.

### 7.2.2 Stream Conditioning

For applications involving single component liquefied petroleum gases (LPG's), mixing elements (tees, elbows, reducers, reduced diameter pipe) installed upstream of the sample point for stream homogenization.

For applications involving light hydrocarbon mixtures, a static mixer shall be installed upstream of the sample point shall be used for stream homogenization.

### 7.2.3 Sample Receiver

The receiver shall be a 316 stainless steel cylinder with a minimum capacity of two (2) liters, and shall conform to the specifications published in U. S. Department of Transportation Regulations (U.S. CFR 49).

## 7.3 Manual Sample Probe

### 7.3.1 General Design Requirements

Manual sample probes shall be designed in accordance with API Manual of Petroleum Measurement Standards, Chapter 8.1, Section 8.4.2 and Figure 8C. The entrance to the probe shall have a 45-degree beveled, opening facing upstream and positioned in the center one-third of the main pipe. A ball or gate valve shall be provided at the exit of the probe. A short open-ended tube or pipe with a maximum diameter of  $\frac{3}{4}$  inch shall be provided on the discharge from the valve. The opening of this tube or pipe shall face downward to permit collection of a sample in a portable sample container or bottle.

### 7.3.2 Stream Conditioning

The stream shall be conditioned in accordance with API Manual of Petroleum Measurement Standards, Chapter 8.1, Section 8.4.3 and Chapter 8.2, Section 8.

## 7.4 Other Equipment

### 7.4.1 Block Valves

Gate valves shall conform to [04-SAMSS-001](#) and ball valves shall conform to [04-SAMSS-051](#).

### 7.4.2 Double Block and Bleed Valves

Double block-and bleed valves shall be of the expanding plug type design and shall meet the requirements of [04-SAMSS-041](#).

### 7.4.3 Control Valves

Control valves shall meet the requirements specified in [SAES-J-700](#) and [34-SAMSS-711](#).

### 7.4.4 Valve Motor Operators

Electric motor operators shall meet the requirements of [34-SAMSS-718](#).

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Each electric motor operator shall be sized to operate the valve with a differential pressure across the valve equal to the valve maximum operating pressure.

Limit switches shall be provided to permit local and remote indication of valve position.

#### 7.4.5 Thermal Relief Valves

Thermal relief valves installed as part of plant piping shall conform to the requirements of [SAES-J-600](#) and [SAES-L-140](#).

## 8 Testing and Inspection

Piping and piping components shall be hydro-tested in accordance with the requirements for plant piping specified in [SAES-L-150](#).

Automatic sampling systems shall undergo tests as specified in the Purchase Order or [34-SAMSS-525](#), as applicable. Unless otherwise specified, such tests shall be witnessed and approved by a Saudi Aramco representative.

For applications involving crude oil, a water injection test shall be performed for each automatic sampling system. The test shall be conducted in accordance with API Manual of Petroleum Measurement Standards, Chapter 8.2. Test results from the water injection test shall be approved by the Chairman, Custody Measurement Standards Committee prior to placing the system in service.

## 9 Shipping Requirements

All necessary repairs, replacements or modifications to hardware, firmware, and software, shall be completed by the Vendor prior to shipment.

The Vendor shall be responsible for ensuring the equipment is properly prepared for shipment, including, but not limited to, the requirements specified hereafter.

### 9.1 General

All equipment and internals being shipped shall be braced and temporary supports shall be provided, if required, to prevent damage during shipment.

Equipment shall be marked with water-soluble materials that will not attack or damage the equipment at either ambient or operating temperatures. Marking materials shall be free of lead, sulfur, zinc, cadmium, mercury, chlorine and all other halogens.

Markings for export shall conform to the requirements specified on the purchase order.

## 9.2 Fabricated Equipment

### 9.2.1 Internal Protection

The internals of all piping, fabricated and assembled equipment shall be completely cleaned and dried to the satisfaction of the Saudi Aramco Inspector.

A non-toxic vapor phase corrosion inhibitor (CORTEC VCI-309 or VCI-307, or equivalent approved by Coordinator, CSD/Materials Engineering & Corrosion Control Division) shall be applied to the internal surfaces of all piping, fabricated and assembled equipment.

*Commentary Note:*

*Vendors are cautioned to allow sufficient lead-time for the purchase and delivery of the vapor phase corrosion inhibitor. Lack of planning by the Vendor will not constitute justification for a waiver of this requirement.*

The application rate for the inhibitor shall be 1 kg/m<sup>3</sup> of equipment.

The inhibitor shall be blown through the equipment using air with a dew-point that is the lower of the following: 1) -1°C or 2) 5°C below the lowest ambient temperature to be encountered in shipment from the point of manufacture to the final destination. Application of the inhibitor shall continue until the powder can be seen blowing out of the opposite end of the equipment.

Following application of the inhibitor, equipment openings shall be sealed vapor tight with steel covers in accordance with the requirements for external protection.

### 9.2.2 External Protection

All external surfaces shall be prepared and coated in the shop with the complete Saudi Aramco coating system (primer and final coats) as specified in [SAES-H-001](#). If the specified Saudi Aramco approved coating is unavailable or unusable at the Vendor's site, an alternative coating system may be used with the concurrence of the Coordinator, CSD/Materials Engineering and Corrosion Control Division.

All bolts and nuts shall be coated with a temporary protective coating (MIL C16173, Grade IV, or Denso paste or equivalent).

Permanent blind flanges or covers shall be installed with the gaskets and bolts required for service.

The faces of open, flanged connections shall be coated with a temporary protective coating (MIL C16173, Grade IV, or equivalent) which can be easily removed prior to equipment installation. Following application of the protective coating, each connection shall be fitted with a neoprene gasket, and vapor tight steel cover. The cover shall be held in place by a minimum of four equally spaced bolts.

### 9.3 Electronic and Electrical Equipment

The Vendor shall determine if electronics and instruments are susceptible to damage from shock, weather or extremes of temperature during shipment. If required, such items shall be removed after the functional test and shipped separately.

Electronic equipment shall be prepared and protected for shipment in accordance with the manufacturer's recommendations. As a minimum, the equipment shall be fitted with a vapor phase inhibitor emitter (CORTEC VCI-101, VCI-105, VCI-110 or equivalent).

Electrical boxes shall be fitted with vapor phase inhibitor emitters (CORTEC VCI-101, VCI-105, VCI-110 or equivalent).

## 10 Documentation

Project drawings shall conform to the requirements of [SAES-J-004](#) and [SAES-J-005](#).

Project documentation shall be developed, reviewed, approved and distributed in accordance with [SAEP-21](#) or [SAEP-50](#), as applicable.

Documentation shall also be furnished in accordance with the purchase order(s) and relevant material specifications.

### Revision Summary

12 February 2013	Revised the "Next Planned Update." Reaffirmed the content of the document, and reissued with editorial revision.
1 October 2013	Editorial revision to change the primary contact persons.