



Engineering Standard

SAES-Y-101

31 January 2006

Custody Metering of Hydrocarbon Gases

Custody Measurement Standards Committee Members

Fadhl, Khalid Ahmed, Chairman

Britton, Richard Leo, Vice Chairman

Baines, Joga Singh

Buerkel, David William

Hijji, Abdullah Saleh

Marri, Saeed Mohammad

Sanna'A, Zaki Abbas

Roumi, Sulaiman Hamad

Shaikh Jaffar, Abdullah Mohammed

Rockwell Jr., William Allen

Grainger, John Francis

Morohen, Faisal Hashim

Trembley, Robert James

Lajami, Abdullah Ahmed

Far, Husain Salah

Bakhsh, Abduljalil Hamed

Saudi Aramco DeskTop Standards

Table of Contents

1	Scope.....	2
2	Conflicts and Deviations.....	2
3	References.....	2
4	Definitions and Acronyms.....	4
5	Delineation of Responsibility.....	5
6	Design Criteria.....	5
7	General Meter Station Design Requirements.....	7
8	Orifice Plates.....	8
9	Orifice Fittings.....	9
10	Orifice Meter Tubes.....	10
11	Straightening Vanes.....	11
12	Instrument Connection Taps.....	12
13	Block Valves.....	12
14	Control Valve.....	13
15	Field Instrumentation.....	13

Table of Contents (Cont'd)

16	Panel Mounted Instruments.....	14
17	Sampling System.....	16
18	Chromatograph.....	16
19	Fluid Conditioning Devices.....	16
20	Electrical.....	17
21	Painting.....	17
22	Testing and Inspection.....	17
23	Factory Acceptance Test (FAT).....	17
24	Documentation.....	18

1 Scope

This standard establishes the minimum requirements for the design, fabrication and installation of a custody transfer metering station for dry hydrocarbon gas service (natural gas and ethane rich gas).

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Saudi Aramco Materials System Specifications (SAMSSs), Standard Drawings, (SASDs), industry standards, codes, and forms, shall be resolved in writing through the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the Company or Buyer's Representative, who shall follow internal procedure SAEP-302 and forward such requests to the Manager, Process & Control Systems Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedures

SAEP-21

*Royalty/Custody Metering Facilities Execution
Guide*

*SAEP-302 Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

SAES-A-004 Pressure Testing
*SAES-A-301 Materials Resistant to Sulfide Stress Corrosion
Cracking*
SAES-H-101 Approved Protective Coating Systems
SAES-J-002 Technically Acceptable Instruments
SAES-J-003 Basic Design Criteria
SAES-J-005 Instrumentation Drawings and Forms
SAES-J-200 Pressure
SAES-J-400 Temperature
SAES-J-601 Emergency Shutdown and Isolation Systems
SAES-J-902 Electrical Systems for Instrumentation
SAES-L-008 Selection of Valves
SAES-L-109 Selection of Flanges, Stud Bolts and Gaskets
SAES-L-110 Limitations on Pipe Joints and Components
SAES-L-136 Pipe Selection and Restrictions
SAES-P-100 Basic Power System Design Criteria

Saudi Aramco Materials System Specifications

01-SAMSS-010 Fabricated Carbon Steel Piping
02-SAMSS-005 Butt Welding Pipe Fittings
34-SAMSS-711 Control Valves - General Services
34-SAMSS-820 Instrument Control Cabinets - Indoor
34-SAMSS-831 Instrumentation for Packaged Units

Saudi Aramco Standard Drawings

AB-036019 Assembly & Detail of Thermowell
*AC-036233 Instrument Piping Details- Flow Meter
Instrumentation - (Gas and Vapor Service)*

<i>AB-036965</i>	<i>Standard Straightening Vanes and Pipe Spools for Flow Meter Orifice Runs</i>
<i>AB-036094</i>	<i>Standard Orifice Plates</i>
<i>AD-036961</i>	<i>Field Mounting Details for Instruments</i>

3.2 Industry Codes and Standards

Orifice Metering of Natural Gas

<i>AGA Report 3</i>	<i>Gas Measurement Committee Report No. 3- Orifice Metering of Natural Gas</i>
<i>API MPMS 14</i>	<i>Manual of Petroleum Measurement Standards, Chapter 14, Natural Gas Fluids Measurement</i>

Comentary Note:

The above two publications are identical.

American Gas Association

<i>AGA Report 5</i>	<i>Gas Measurement Committee Report No. 5, Fuel Gas Energy Metering</i>
<i>AGA Report 8</i>	<i>Compressibility and Supercompressibility for Natural Gas and Other Hydrocarbon Gases</i>

American Petroleum Institute

<i>API MPMS 21.1</i>	<i>Manual of Petroleum Measurement Standards, Chapter 21.1, Electronic Gas Measurement</i>
----------------------	--------------------------------------------------------------------------------------------

National Fire Protection Association

<i>NFPA 70</i>	<i>National Electric Code</i>
----------------	-------------------------------

4 Definitions and Acronyms

Meter Station: An assemblage of equipment designed for gas metering and composed of, but not limited to the orifice meter(s), associated piping, fluid conditioning device(s), automatic sampling system and required instrumentation.

Primary Industries Metering Stations: Metering systems using 6" and larger meter runs.

Secondary Industries Metering Stations: Metering systems using 4" and smaller meter runs.

Custody Transfer Metering: A specialized form of metering which is the basis for selling or transferring custody of oil, gas and products from Saudi Aramco to customers.

Orifice Meter: An orifice meter is a fluid flow measuring device that produces a differential pressure to infer flow rate. It consists of a thin, concentric, square-edge orifice plate, mounted in a single or double chamber orifice flanges and equipped with differential pressure sensing taps.

Orifice Meter Tubes: The straight upstream pipe and fittings between the orifice plate and the upstream pipe-end or flange and the similar down-stream pipe and fittings between the orifice plate and the pipe-end or flange.

Sales Gas: Natural gas or ethane rich gas that is produced directly or has been processed.

Accuracy: The degree of conformity of an indicated value to a recognized accepted standard value, or ideal value.

Accuracy Rating: A number or quantity that defines a limit that errors will not exceed when a device is used under specified reference conditions.

Commentary Note:

Accuracy rating includes the combined effects of linearity, hysteresis, dead band and repeatability errors.

MMSCF: Million Standard Cubic Feet

MSCFH: Thousand Standard Cubic Feet per Hour

MMSCFD: Million Standard Cubic Feet per Day

BTU/SCF: British Thermal Unit per Standard Cubic Feet

MMBTU: Million British Thermal Unit

5 Delineation of Responsibility

The delineation of responsibilities of various Saudi Aramco organizations and design contractors during the execution of the project shall be as per SAEP-21, Royalty / Custody Metering Facilities Execution Guide.

6 Design Criteria

6.1 Engineering Units

This standard uses the SI units except for measurement signals, volume

calculations and reporting as noted in paragraph 6.2 below. Conventional English System equivalents are shown in parentheses immediately following each SI Metric unit used.

6.2 Units for Measurement in Calculations and Reporting

The following conventional units shall be used for the measurement signals, calculations and final reporting for billing purposes.

Volume	MMSCF
Flow Rate	MSCFH, MMSCFD
Static Pressure	PSIG
Differential Pressure	Inch WC
Temperature	°C
Heating Value	BTU/SCF
Total Heating Value	MMBTU

6.3 Standard (Base) Conditions

Base Pressure = 101.560 kPa (abs) (14.73 psia)

Base Temperature = 15.56°C

Commentary Note:

AGA Report 3 formulas are based on the above standard conditions.

6.4 Gas Composition

The gas composition is expected to vary depending on the source, summer and winter conditions. However, the following range may be used as the design basis. More specific requirements for a project should be obtained from OSPAS.

6.4.1 Natural Gas:

Component	Expected range (Mole %)
C1	66.0 - 91.0
C2	8.0 - 33.0
C3	0.3 - 10.0
C4	0.0 - 3.0
C5+	0.0 - 1.0

COO	0.0 - 1.5
N ₂	0.5 - 6.0
Helium	< 0.1
Hydrogen	< 0.1
Water	< 7.0 lbs/MMCF
H ₂ S	< 1.0 grain/100 SCF

6.4.2 Ethane Rich Gas:

Component	Expected range (mole%)
C1	0.0 - 2.5
C2	95.0 - 100.0
C3	0.0 - 2.5
CO ₂	< 1500 PPM
Total Sulfur	< 600 PPM
Water	< 7.0 lbs/MMCF

6.5 Environmental Conditions

Selected equipment shall be suitable for operation in accordance with the "Environmental Conditions" as per Saudi Aramco standard SAES-J-003, Basic Design Criteria.

6.6 Packaged Unit Concept

The packaged unit concept shall be used, with a single vendor experienced in the design and manufacture of gas custody transfer metering systems, to be assigned total project responsibility.

7 General Meter Station Design Requirements

- 7.1 Orifice meters shall be selected for all custody transfer applications of Sales gas. Any other type of meter, if considered, requires prior approval from the Technical Director, Custody Measurement Unit, Process Instrumentation Division, Process & Control Systems Department (CMU/PID/P&CSD).
- 7.2 The metering station shall be skid mounted, fully automated system. It shall be designed for unattended operation and measurement.

- 7.3 All gases shall be conditioned if necessary to ensure that there are no free liquids or solid particles that will collect and change the operation of a meter or be large enough to damage metering the elements.
- 7.4 Meter station piping arrangements shall be designed with a minimum number of bends and fittings.
- 7.5 If the initial station capacity is less than the projected ultimate station capacity, pipe header stubs or additional straight pipe length (as per paragraph 10.5), shall be provided in the original design.
- 7.6 Where total shutdown of the meter station to add additional meter runs is acceptable, a blind flange at the end of each stub shall be provided.
- 7.7 For a meter station that cannot tolerate a total shutdown to install future meter runs, a manually operated block valve with blinded outlet shall be provided at the end of each stub.
- 7.8 Equipment arrangement shall ensure convenient access for operation, maintenance and/or replacement. Equipment (transmitters, gauges etc.) shall be located at convenient working heights from top of any platform/skid work surface, i.e., grating, and will not be accessed by crossing piping or other fixed structures. Where equipment are located above normal working heights, access steps or ladders shall be provided.
- 7.9 When handling other than sweet gas, critical parts of orifice fittings must be made of a corrosion-resistant material such as type 316 stainless steel or better per SAES-A-301 requirements.
- 7.10 Primary Industries Metering Stations shall be equipped with vent lines for depressurization. Vent lines shall extend at least 3 meters above the highest operating platform and shall be properly supported.
- 7.11 Full opening drain valves shall be installed on the upstream and downstream sides of the orifice fittings.
- 7.12 Maximum ratio of Differential Pressure to Flowing pressure (hw/P_f) shall not exceed 0.2 (in/PSI).

8 Orifice Plates

- 8.1 Orifice plates shall be removable concentric disc type designed for use in orifice fittings. They shall be constructed of type 316 stainless steel or better. Weep holes shall not be used. Refer to standard drawing AB-036094, Standard Orifice Plate.
-

- 8.2 Orifice plate shall be flat. Deviation from flatness shall be less than 1 percent of dam height as illustrated in AGA Report 3.
- 8.3 Orifice diameters shall be calculated based on AGA Report 3. The plate shall be bored to the nearest size and tolerance as published in AGA Report 3. In all cases orifice diameters shall be bored to the nearest 3 mm increment on orifice diameters through 100 mm, to the nearest 6 mm increment on 101 mm through 300 mm diameter and to the nearest 12 mm increment on larger diameters. The measured orifice bore diameter (d_m) is defined as the average of four or more equally spaced diameter measurements. The calculated reference diameter (d_r) at the reference temperature is obtained by the equation:

$$d_r = d_m [1 + \alpha (T_r - T_m)] \quad (1)$$

- where: α = linear coefficient of expansion of orifice plate material
 T_m = temperature of the orifice plate at time of diameter measurement
 T_r = reference temperature, 60°F.

The reference diameter (d_r) shall be stamped on the plate.

- 8.4 The calculated orifice plate beta ratio shall be within 0.2 to 0.6.
- 8.5 Alignment pins or other devices shall be provided to position the orifice plate so that the plate is centered relative to the upstream section of the meter tube and pressure tap.
- 8.6 Protrusions resulting from orifice plate gasket or seal devices are not permitted. The recess depth shall not exceed 0.25 inch.

9 Orifice Fittings

- 9.1 For single tube installations, orifice fittings shall be double chambered type in order to allow for orifice plate inspections and changes without interrupting the gas flow. Single chamber type may be used only in multitube installations, or where it is possible to isolate and depressurize the fitting without interruption of the station flow.
- 9.2 Orifice fitting shall be purchased from approved manufacturers per Saudi Aramco standard SAES-J-002, Technically Acceptable Instruments.
- 9.3 Fittings shall be of the type that have the upstream end welded to the upstream section of the tube and the down-stream end flanged to the downstream section of the tube. The internal diameter of the fitting shall be matched to that of the tube, within specified tolerances specified in AGA Report 3.
-

- 9.4 Flanges on orifice fittings shall be the male-female self-aligning type or shall be doweled with a minimum of three (3) alignment pins.
- 9.5 For mechanical strength of the assembly, all double chambered fittings 12 inch and above shall be installed in an upright position.
- 9.6 Orifice fitting shall be equipped with bottom chamber drain valves to allow chamber blowdown and cleaning. These valves connections shall not be seal welded.
- 9.7 Orifice fitting assemblies larger than 16 inch size shall be equipped with lifting davits to enable both orifice plate and carriers to be lifted to and from the top of the fitting.

10 Orifice Meter Tubes

- 10.1 Fabrication - Field fabrication of meter tubes are not allowed). They shall be purchased from approved manufacturers per SAES-J-002, Technically Acceptable Instruments.
- 10.2 Pipe Selection - Pipe selection shall be as per Saudi Aramco standard SAES-L-136, Pipe Selection and Restrictions and specification 01-SAMSS-010, Fabricated Carbon Steel Piping. The upstream and downstream meter tube sections shall be constructed of seamless pipe or cold drawn seamless tubing. (Seamed pipe may be used for 24 inch and 30 inch tubes if the internal longitudinal welds are ground flush and smooth). The tube shall be as nearly cylindrical as commercially possible with out-of-roundness deviations (difference between the maximum and minimum I.D. measurements) not to exceed 0.5% for upstream sections and 1% for downstream. The upstream and down stream meter tube tolerances for the diameter shall be as specified in AGA Report 3. The design pressure of the meter run shall match that of its interconnecting piping.
- 10.3 Pipe Wall Finish - The inside pipe walls shall be as smooth as commercially practicable, wall roughness shall not exceed 7.6 micrometers AARH by visual comparison. Pipe walls may be machined, ground, coated, honed and/or polished.
- 10.4 Connected Fittings - Pipe fittings shall be selected according to Saudi Aramco standard SAES-L-110, Limitations of Pipe Joints and Components. Welding shall be according to Saudi Aramco specification 02-SAMSS-005, Butt Welding Pipe Fittings. Flanges and orifice fittings welded to meter tubes shall have internal weld joints ground to a smooth finish, flush with the internal diameter of the pipe and free of sharp edges or abrupt changes in surface level or diameter.

There shall be no pipe connections within the upstream-downstream meter tubes other than the thermowells.

- 10.5 Length of Tubes - To allow flexibility and possible future capacity expansion a beta ratio of 0.75 shall be used as the basis for estimating the meter tube length according to AGA Report 3.
- 10.6 Spacer Rings - Upstream meter tube ends shall be flanged and equipped with a spacer ring or jack screw so that the tube sections can be easily removed for inspection and cleaning. When the meter run has a flange-type straightening vane, the spacer ring is to be installed at the straightening vane flange and be wide enough (when removed) to allow for the uncoupling of male-female flanges if the orifice fitting is so equipped.

Spacer ring internal diameter shall be 3 mm larger than the meter tube internal diameter and the OD's shall be 1.5 mm smaller than the inside bolt circle of the flange.

- 10.7 Flanges and Gaskets shall be as per Saudi Aramco standard SAES-L-109, Selection of Flanges, Stud Bolts and Gaskets. Gaskets shall be purchased or trimmed to have at least a 10 mm larger inside diameter (bore) than the meter tube for 12 inch tube size and above. For 10 inch and below, gasket internal diameter shall be at least 6 mm larger.

Commentary Note:

This is to preclude the gasket from protruding into the tube interior through misalignment or compression.

- 10.8 Identification - The averages of upstream and downstream meter tube internal diameter micrometer reading shall be stamped on a stainless steel data plate which will be permanently attached to the upstream meter tube.
- 10.9 Flow direction shall be indicated on the meter tube close to each side of the orifice plate.

11 Straightening Vanes

- 11.1 Straightening vanes shall be inserted in the upstream section of the meter tube to minimize flow pattern disturbances.
- 11.2 Straightening vanes and their flanges shall be constructed of carbon steel (stainless steel is acceptable) in accordance with Saudi Aramco drawing AB-036965, Standard Straightening Vanes and Pipe Spools for Flow Meter Orifice Runs.

11.3 Either flange type or line type straightening vanes are acceptable.

12 Instrument Connection Taps

12.1 Differential Pressure - Differential pressure taps shall be "Flange Taps", having the center of the upstream tap hole placed 25 mm from the upstream face of the orifice plate. The center of the downstream tap hole shall be 25 mm from the downstream face of the orifice plate.

Commentary Note:

Tap nipples shall not be seal welded in orifice fittings. The tap holes shall be located at the 25 mm dimension within plus or minus (\pm) the tolerances given in AGA Report 3.

12.2 Static Pressure - Static pressure measurements shall be taken from the downstream flange tap static pressure line.

12.3 Sampler - A one inch NPT tap fitting for a sampler connection shall be installed 300 mm downstream of the second thermowell or at some point on the header from where a representative sample can be taken.

12.4 Thermowells - Two thermowells of type 316 stainless steel shall be installed in 1 inch NPT tap fittings located on the meter tube. They shall be in accordance with Saudi Aramco drawing AB-036019, Assembly & Detail of Thermowell. The thermowells shall be placed on the downstream side of the orifice plate and not closer than the dimension "B" nor farther than "4B" as per AGA Report 3.

13 Block Valves

13.1 Primary Industries Metering Stations

Each meter station shall be equipped with isolating block valves located outside the meter skid. The upstream valve shall be an automated valve with remote control using solenoid valve per SAES-J-601. The downstream valve shall be manual, full bore ball valve. Block valves shall be selected per Saudi Aramco standard SAES-L-008, "Selection of Valves". It shall have manual override for opening and closing, with or without air or gas pressure.

13.2 Secondary Industries Metering Stations

Depending on the piping distances involved, a manual, full-bore ball valve shall be installed at the inlet of the meter skid. Block valves shall be selected per Saudi Aramco standard SAES-L-008, "Selection of Valves". For downstream protection, a pilot-operated overpressure regulator type isolation valve with manual reset, per 34-SAMSS-711 can be used.

14 Control Valve

Control valve, if required shall be pilot operated over- pressure regulator type with anti-cavitation trim for gas service. Valves shall be according to Saudi Aramco specification 34-SAMSS-711, Control Valves - General Services.

15 Field Instrumentation

15.1 General Requirements

15.1.1 Field instrumentation shall be provided for measuring the differential pressure, static pressure and temperature. They shall be installed as per Saudi Aramco Standard Drawing AD-036961, Field Mounting Details for Instruments. Measurement and control piping shall not be mixed. One set of orifice fitting taps with a dedicated transmitter shall be used for measurement purpose only. Also refer to Saudi Aramco specification 34-SAMSS-831, Instrumentation for Packaged Units.

15.1.2 For ease of calibration, all transmitters (differential pressure, pressure and temperature) shall be grouped at a single point on the metering skid. A fixed calibration table shall be provided adjacent to the single point for setting calibration equipment.

15.1.3 Where possible, consideration should be given to utilize instrument air system available from the customer plant (gas user) in lieu of sales gas for the control system.

15.2 Differential Pressure Transmitters

15.2.1 Differential pressure transmitters shall be fitted with 5-valve manifolds and mounted as close to the orifice fitting as practical, preferably within 6 m. See drawing AC-036233.

15.2.2 All transmitters impulse lines shall be ½ inch type 316 stainless steel tubing, installed with a slope of not less than 1:12 toward the orifice fitting. Condensate chambers shall be installed at all gauge line low points, if the lines do not drain directly back into the orifice fitting.

15.2.3 Smart electronic type D/P transmitters with 4 to 20 mA DC output and with an overall accuracy of $\pm 0.2\%$ of span or better shall be used. Refer to Saudi Aramco standard SAES-J-200, Pressure.

15.3 Static Pressure Transmitters

Smart electronic type pressure transmitters with 4 to 20 mA DC output with an

overall accuracy of $\pm 0.25\%$ of span or better shall be used. Refer to Saudi Aramco standard SAES-J-200, Pressure.

15.4 Temperature Transmitters

Platinum Resistance Temperature Detectors (RTD) sensors with DIN curve shall be used. They shall be smart electronic type utilizing ambient temperature drift compensation for output signal. The output signal from the transmitter shall be 4 to 20 mA DC and an accuracy of $\pm 0.2\%$ of span or better. Normal range setting shall be -18°C to 66°C . Refer to Saudi Aramco standard SAES-J-400, Temperature.

16 Panel Mounted Instruments

16.1 Control Panels

Control panels shall be in accordance with Saudi Aramco specification 34-SAMSS-820, Instrument Control Cabinets - Indoor.

16.2 Flow Computers

16.2.1 The system shall provide for the direct calculation of gas volume at standard condition and total energy through the use of dedicated real time flow computers.

16.2.2 The flow computers shall receive signals from the following:

- Differential pressure transmitters.
- Static pressure transmitter
- Temperature transmitter (or directly from RTD).
- Composition data from a on-line gas chromatograph (if provided).
- Manually entered data.

16.2.3 The flow computers shall calculate flow rate and accumulate standard volume and energy units. The calculations shall be in accordance with the methods of AGA Report 3 and AGA Report 5. The supercompressibility factors shall be as per AGA Report 8.

16.2.4 The calculations frequency, algorithm and data retention for establishing an audit trail shall be in accordance with API MPMS 21.1 (Manual of Petroleum Measurement Standards Chapter 21.1, Electronic Gas Measurement).

- 16.2.5 The flow computer shall be capable of performing calculations while the instruments are being calibrated. During the calibration mode the flow computer should freeze the last signal and use this value in the calculation.
- 16.2.6 The flow computers shall be capable of displaying the following data:
- Instantaneous Flow Rate.
 - Accumulated volume.
 - Instantaneous Temperature.
 - Static Pressure.
 - Differential Pressure.
 - Accumulated Heating Value.
 - All factors used in the flow equations.
 - All Operator entered constants.
- 16.2.7 The following additional functions should be performed by the flow computers, as applicable:
- Provide output signal to increment standard volumetric flow and energy content to two counters.
 - Provide output signal to actuate meter station block valves.
 - Provide output signal to printer.
 - Provide analog output for remote set point to flow/pressure controllers.
- 16.2.8 The flow computer shall be provided with an RS232 interface and shall be able to communicate standard poll information including the data given in section 16.2.6 and 16.2.7 with a host computer using MODBUS ASCII protocol.
- 16.2.9 Flow computers shall have non-volatile memory for power loss protection. The application program and data shall be retained in battery-backed RAM for a minimum of 30 days.
- 16.2.10 Flow computers shall be provided with a keypad to access data and other functions and shall have password and keylock protection for data security.

16.3 Printer

A panel mounted printer shall be provided. The printer shall print a minimum

40 column with full 96 ASCII characters.

16.4 Counters

Two non-resettable electronic counters with LED/LCD displays shall be provided which will accept the standard volume and total energy content signals from the flow computer.

17 Sampling System

17.1 Gas samples are required to determine the gas composition, relative density and BTU content. Samples shall be collected at least once a week using automatic gas samplers.

Commentary Note:

If sample is collected at a common header supplying gas to several customers, then a separate sampling system need not be installed at each customer's metering station.

17.2 Sample collection control systems shall be time based in sampling rate. The sample rates or volumes shall be unaffected by variances in pipeline or sample cylinder pressures or temperatures.

17.3 ANSI 316 stainless steel sampler probes of 1/8 inch or 1/4 inch diameter tubing and of the single tube or dual pitot tube configuration shall be used. For pipes up to 12 inch size, the probe tips shall be located near the center of pipe and for pipe larger than to 12 inch in size, the probe tip shall be at least 1/6th of the pipe internal diameter.

17.4 Constant pressure sample cylinders shall be used.

18 Chromatograph

Chromatograph, if required shall be of a type approved for the purpose by the Technical Director, CMU/PID/P&CSD and the proponent organization and shall be installed in accordance with the manufacturer's recommendations.

19 Fluid Conditioning Devices

19.1 Fluid conditioning devices shall comply with the pressure and temperature ratings of the adjacent pipeline system.

19.2 They shall be so located as to provide convenient access for ease of inspection, removal and maintenance.

- 19.3 The combined area of the openings of screens and strainers shall equal at least 130% of the area of the meter inlet piping.

20 Electrical

- 20.1 Area Classification-Gas metering skids are classified under Class 1 Division 2.
- 20.2 Electrical power requirements shall be based on Saudi Aramco standard SAES-P-100, "Basic Power System Design Criteria" and SAES-J-902, "Electrical System for Instrumentation".
- 20.3 Wiring shall be in accordance with NEC (NFPA 70) Class 1 Division 2. All wiring shall be routed in PVC-coated conduit terminating in explosion proof junction box located at the end of the skid.

21 Painting

Protective coating shall be in accordance with Saudi Aramco standard SAES-H-101, Approved Protective Coating Systems.

22 Testing and Inspection

- 22.1 Meter station design and construction shall facilitate ease of field inspection and maintenance. See individual design sections and project specifications for special requirements.
- 22.2 The calibration (establishing dimensional measurements) of the critical points of orifice meter tubes, fittings and plates shall be done in accordance with AGA Report 3 requirements and shall be witnessed by Saudi Aramco or its agent.
- 22.3 The complete metering skid piping shall be hydro-tested in accordance with Saudi Aramco standard SAES-A-004, Pressure Testing.
- 22.4 All low points in the piping (the orifice fitting in particular) shall be drained after the hydrostatic test and dry air/gas blown through the meter tubes and piping to dry up residual water.
- 22.5 After the hydrostatic tests, a coating of rust-inhibiting oil shall be sprayed onto the inside surfaces of the meter tubes and fittings following the above drying process to inhibit corrosion.

23 Factory Acceptance Test (FAT)

- 23.1 Primary Industries Metering Stations: Prior to shipment, a Factory Acceptance Test (FAT) shall be conducted, to be witnessed by the buyer or his designated
-

representatives.

23.1.1 The FAT shall consist of functional test of all the components and checking calculations using actual field or simulated signals.

23.1.2 A FAT procedure shall be prepared and submitted through the Buyer's representative to the Technical Director, CMU/PID/P&CSD at least two months in advance of the FAT date for review.

23.2 Secondary Industries Metering Stations: Prior to shipment, the vendor shall conduct a functional test of the flow computer and associated equipment to ensure compliance to the functional system document (FSD).

24 Documentation

24.1 Drawings, specifications and forms shall be prepared as required by Saudi Aramco standard SAES-J-005, "Instrumentation Drawings and Forms", and submitted for review to the Technical Director, CMU/PID/P&CSD.

24.2 Operation and Maintenance manuals, product literature of all components shall be provided in the number stipulated in the project specifications.

Revision Summary

31 January 2006 Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with no other changes.