MATERIAL STANDARD

FOR

MEASUREMENT OF LIQUID HYDROCARBONS

(CUSTODY TRANSFER)

ORIGINAL EDITION

OCT. 1996

This standard specification is reviewed and updated by the relevant technical committee on Nov. 2012. The approved modifications are included in the present issue of IPS.

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

Standards and Research department

No.17, Street14, North kheradmand

Karimkhan Avenue, Tehran, Iran.

Postal Code-1585886851

Tel: 88810459-60 & 66153055

Fax: 88810462

Email: Standards@ nioc.ir

GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the “Company" where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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1. SCOPE

This Standard presents general and minimum requirements for materials used in metering stations of volumetric liquid measurement in petroleum industry.

Volumetric meters such as positive displacement meters, turbine meters and ancillary equipment such as provers are covered in this Standard.

Note

This standard specification is reviewed and updated by the relevant technical committee on Nov. 2012. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No 364 on Nov. 2012. These modifications are included in the present issue of IPS.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

BSI (BRITISH STANDARDS INSTITUTION)

BS 6169	"Volumetric Measurement of Liquid Hydrocarbon"
Part 1	"Displacement Meter System (Other than Dispensing Pumps)"
Part 2	"Turbine Meter Systems"
BS 1414	"Steel Wedge Gate Valves Flanged and Butt Welding Ends"
BS 1501	"Steels for Pressure Purposes: Plates, Sheet and Strip"
BS 1503	"Steel Forgings for Pressure Purposes"
BS 1504	"Steel Castings for Pressure Purposes"
BS 1506	"Carbon, Low Alloy and Stainless Steel Bars and Billets for Bolting Material to be Used in Pressure Retaining Applications"
BS 1560	"Steel Pipe Flanges and Flanged Fittings for the Petroleum Industry"
BS 3293	"Carbon Steel Pipe Flanges for Petroleum Industry"
BS 3799	"Forged Steel Pipe Fittings, Screwed and Socket Welding for Petroleum Industry"

API (AMERICAN PETROLEUM INSTITUTE)

RP 550	"Manual on Installation of Refinery Instruments and Control Systems"
CHAPTER-3.1B	"MPMS Standard Practice for Level Measurement of Liquid Hydrocarbon in Stationary Tanks by Automatic Tank Gauging"
CHAPTER-5	"Manual of Petroleum Measurement Standards Liquid Metering"
CHAPTER-4	"Proving Systems"
CHAPTER-6	"Metering Assemblies"

API 5L	"Specification for Line Pipe"
API Spec. 6D	"Specification for Pipeline Valves"
API Std. 598	"Valve Inspection and Test"
API Std. 600	"Steel Gate Valves"
API Std. 602	"Compact Carbon Steel Gate Valves"
API Std. 1104	"Standard for Welding Pipelines and Related Facilities"
MPMS 21.1, 21.2	"Flow Computers"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI B 1.20.1	"Pipe Threads"
ANSI B 16.5	"Steel Pipe Flanges and Flanged Fittings"
ANSI B 31.3	"Chemical Plant and Petroleum Refinery Piping"
ANSI B 31.4	"Liquid Petroleum Transportation Piping Systems"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME-Sec. VIII	"Rules for Construction of pressure Vessels"

ISA (INSTRUMENT SOCIETY OF AMERICA)

RP 31.3	"Specification, Installation, and Calibration of Turbine Meters"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-IN-120	"Temperature Instrument"
IPS-M-IN-130	"Flow Instrument"
IPS-E-IN-240	"Measurement of Liquid Hydrocarbons Custody Transfer"

IP (THE INSTITUTE OF PETROLEUM)

Part 9- Sec. 1	"Positive Displacement Meters"

3. UNITS

This Standard is based on International System of Units (SI), except where otherwise is specified.

4. POSITIVE DISPLACEMENT METERS

In principle, positive displacement flow meters repeatedly entrap a known quantity of fluid as it passes through the flow meter. When the number of times the fluid is entrapped is known, the quantity of fluid that has passed through the meter is also known.

4.1 Meter Components

Positive displacement meters contain certain basic components in their overall design:

a) Measuring element

b) Drive train

c) Pressure vessel

4.1.1 Measuring element

The measuring element is the heart of a positive displacement meter. Its function is to precisely segregate the flowing stream into discrete segments, count them, and return them to the flowing stream.

4.1.2 Drive train/adjustors

The drive train shall include an adjustor which is used to compensate for manufacturing tolerances. Mechanical adjustors provide a means by which the totalizer reading can be brought to unity meter factor.

4.1.3 The pressure vessel

The pressure vessel containing internal parts of PD meters can be varied to meet a variety of process applications. Basic materials of construction shall be selected to assure product compatibility and wall thickness shall be increased to insure safe operation at operating pressures. Process connections shall be flanged raised face unless otherwise specified.

4.2 Types of Positive Displacement Meters

4.2.1 Oval gear positive displacement meters

Oval gear PD meters are accurate displacement meters with precision matched oval-shaped gear as metering element. Close machining tolerances insure minimum slippage and high measurement accuracy.

4.2.1.1 The body shall be made of steel, stainless steel or alloy 20 according to specified fluid measured. The O-ring material should be viton, Buna-N and Teflon according to process condition.

4.2.1.2 The rotors rotate on their shafts due to the forces exerted by the upstream pressure and the flow of liquid through the meter. As the rotors must mesh and form a seal with each other as well as with the flow meter body, these parts shall be manufactured to tight tolerances that must be maintained over the life of the flow meter. Rotors shall be manufactured with different cuts and wider tolerances for higher viscosity service due to reduced slippage that occurs at higher operating viscosities. The materials shall be suitable for process conditions. The materials which should be used in fabrication of rotors are listed in Table 1 as a typical.

TABLE 1 - TABLE OF MATERIAL OF OVAL METERS

PARTS MATERIAL				
ROTORS	BEARINGS	SHAFT	O-RING	SERVICE
316 St. St.	Carbon	S.S 316	Buna-n	Chemical products, crude oil
Cast Iron	Cast Iron	S.S 316	Buna-n	Oils, petroleum products
Cast Iron	Carbon	S.S 316	Buna-n	Caustic soda

4.2.1.3 The rotors require bearings, which shall be pressed into the body. Bearings shall be hard carbon. For high temperature applications, special bearings shall be proposed.

4.2.1.4 Oval gear meters (½ inch. to 14 inches sizes) shall be pressure and temperature limited by the flange ratings and the temperature ratings of the bearings and O-ring material.

4.2.1.5 Maximum temperature required for meter should be 120°C.

4.2.1.6 Maximum pressure for stainless steel meter should be 14 bars.

4.2.1.7 In order to maintain service life of meter, it shall be essential that right material be selected for outer housing as pressure vessels relative to respective pressure ratings.

4.2.1.8 Low pressure meters (up to 14 Bar) shall have the single case construction and high pressure meters shall have double case construction.

4.2.1.9 Sensing system shall employ driving magnets embedded in the rotor to rotate a following magnet external to the flowmeter, which can drive a local indicator, totalizer or transmitter.

4.2.1.10 Flange sizes of oval meters shall be from ½ inch to 16 inches.

4.2.1.11 Every oval meter shall be equipped with a register that accurately records the volume of liquid metered in proper unit. The register shall be from 5-digit totalizer up to 8-digit totalizers.

4.2.1.12 The automatic temperature compensator shall employ a device which automatically and continuously corrects a register to indicate the volume that a metered delivery would occupy at a base temperature 15°C, (60°F).

Operating temp, compensating range	10°C to 150°C
Specific gravity range	0.58 to 1
Ambient temp, compensating range	As specified
Base temperature	15°C, (60°F)
Compensating accuracy	±0.2%

4.2.1.13 To remove all foreign matter from the liquid, strainers shall be installed ahead of and close to the meters. Low pressure strainers (Max. pressure 14 bar):

Body material	Cast iron
Screen and basket material	SS 304 or SS 316 as specified
Flange bore	The size shall follow the meter size

High pressure strainers (Max. pressure 42 Bar and more):

Body material	Cast steel
Screen and basket material	SS 304 or SS 316 or as specified
Flange bore	The size shall follow the meter size

4.2.1.14 Wherever the liquid to be measured may contain air or vapor, this air or vapor shall be removed from the liquid before reaching the meter. Otherwise air will be measured as liquid, or pockets of air may spin the meter too fast. The following specifications shall be used for air eliminators:

Max. capacity	10 up to 1000 m^3/hr
Body material	Welded steel
Flange bore	The size shall follow the meter size

4.2.2 Rotary positive displacement meters

In principle the rotational velocity of a rotary PD meter is proportional to the number of times the fluid is entrapped into the meter and passed through it.

4.2.2.1 Rotary PD meter bodies shall be generally in carbon steel, stainless steel or as otherwise specified.

Material of Construction:

Outer housing	Cast steel (Ferrous)
and cover	Hard anodized aluminum (Non-ferrous)

	Inner unit, Cast iron (Ferrous)
Housing	Hard anodized aluminum (Non-ferrous)

4.2.2.2 The internal parts of the meter shall be manufactured to tight tolerances that must be maintained over the life of the meter. Where more than one part rotates, the parts shall be geared together.

4.2.2.3 Material of measuring mechanism shall be as follows unless higher grades are specified:

Rotor and block	Close Grained Cast Iron, Aluminum
Bearings	Stainless Steel
Pins and rollers	Stainless Steel
Cam shaft	Steel
Gears	Steel Nodular Iron
Blades	Anodized High Tensile Aluminum Alloy, Close Grained Cast Iron
Bushings	Sintered Iron
Packing gland	Steel and Buna
	Steel and Teflon or Steel and Viton Can be Used on Special Cases.

4.2.2.4 The double case rotary type PD meters shall be straight through type meters. Some versions may be designed for vertical mounting of the meter and 90° angle type meters.

4.2.2.5 Rotary PD meters shall measure volumetric flows with an accuracy ±0.1 to 0.2 percent rate.

4.2.2.6 Rotation of the internal parts of the meter shall be mechanically coupled, either by gears or by the shaft of one of the rotating parts, external to the meter. The rotation of the shaft may be sensed by a transmitter that typically outputs a pulse for each revolution of the shaft.

4.2.2.7 Rotary PD meters should be provided with numerical counters with five figure reset and seven figure non-reset totalizers and/or six figure reset and eight figure non-reset totalizers depending upon meter capacity. Ten figure nonreset totalizing register plus one tenth and one hundredth indicator may be used as option.

4.2.2.8 Rotary PD meters should be provided with direct geared calibrators (not clutch type) to enable meter factor adjustment. The calibrator should be protected from dirt and foreign matter, and may be sealed against unautorized tampering. Standard manual calibrators should be linear, infinitely variable, non-cyclical over 5% rang. Adjustment in increment of 1/20 of 1% may be provided for manual adjusters.

4.2.2.9 Rotary PD meters may be optionally provided with Automatic Temperature Compensators (ATC) with gravity selection facility. Range of temperature compensation shall be 10°C to 150°C and specific gravity of 0.58 to 1.

4.2.2.10 Standard printers which may be provided with rotary PD meters should be five figure "O" start print out, or seven figure accumulative print out, or, high capacity six figure "O" start print out or eight figure accumulative print out. Printers should be provided with product identification. It should be explosion proof certified for use in hazardous areas Class 1-Groups IIA and IIB and the enclosure protection shall be IP 65.

4.2.2.11 Rate of flow indicator, if provided, should be 150 mm (6 inches) dial gage for direct reading of flow in litres, barrels or cubic meters.

4.2.2.12 Pulser may be used on rotary PD meters. If specified pulsers shall be dry reed, wet reed, magnetic proximity or photo electric types and shall be used for remote read-out and meter proving. Pulsers shall be explosion proof and certified for use in Class 1- Groups IIA and IIB. The enclosure protection shall be IP 65.

4.2.2.13 The Strainers shall be of the flanged vertical type complete with suitable sized air eliminators. Maximum allowable pressure drop when tested with water, with clean strainer element

should be less than 0.17 bar. Differential pressure instrument shall be considered to measure this pressure drop.

Air eliminators shall be provided with air actuated check valve to prevent liquid flow when eliminator float drops. These check valves should be ANSI RF 150 in sizes 2", 4", 6" and 8", depending upon air eliminator sizes. Stainless steel mesh 80 should be used for rotary PD meters. Meshes of 4, 10, 20, 40, 100, 200 may be used on special requirement.

4.2.3 Oscillating piston positive displacement meter

In principle, the rate of flow is proportional to the rotational velocity of the piston which oscillates smoothly in a circular motion between the two plane surfaces of top and bottom heads. A division plate which guides the travel of the piston in its motion separates the inlet and outlet ports.

4.2.3.1 Materials of construction should be limited to those that exhibit the property of low expansion due to temperature changes. The recommended material of the main parts and their temperature limits are shown in Table 2 as a typical.

TABLE 2 - MATERIAL OF OSCILLATING PD METER

PARTS MATERIAL			
BODY	IRON	STEEL	ST.ST 316
Piston	Aluminum (135°C) NI-resist (150°C) Rubber (27°C)	Aluminum (135°C) NI-resist (150°C) Rubber (27°C	TEFZEL (110°C)
Chamber	NI-resist	NI-resist	S.S 316

4.2.3.2 O-ring shall be constructed of materials such as Viton, BUNA-N, Neoprene and Teflon. Materials of construction of each component must be compatible with the fluid being measured.

4.2.3.3 The registers used with oscillating piston meters should read as liters. Five figures for reset capacity and seven figures for totalizer capacity should be provided.

4.2.4 Helical gear positive displacement meters (bi-rotor meter)

The principle of operation is simply that the meter divides the volume being measured into segments, separates each segment from the flowing stream momentarily then returns it to the stream and counts the segments. This is accomplished by two spiral-fluted rotors. The spaces between the lobes of the rotors are the chambers in which the segments are momentarily isolated.

4.2.4.1 Bodies shall be made of stainless steel and carbon steel. Rotors shall be constructed of stainless steel or aluminum in smaller sizes, and either carbon steel or aluminum in larger sizes. Bearings shall be made of stainless steel.

4.2.4.2 All meters of 14 bar and larger shall be of double case construction.

4.2.4.3 The materials of construction for single case meters for up to 10 bars working pressure should be as follows unless higher grades are specified:

Outer housing	Cast iron
Counter base plate	Aluminum
Rotors	Aluminum
Rotor shafts	Stainless steel or ground and polished Nitralloy
Rotor bearings	Ball-bearing stainless steel
Counter drive gears	Stainless steel

Counter drive shaft	Stainless steel
Counter drive shaft bushing	Carbon filled teflon

4.2.4.4 The materials of construction for double-case meters should be as follows unless otherwise specified:

Outer housing	Welded steel construction combining steel castings and rolled or drawn steel plate
Counter base plate	Aluminum for meters rated 150 psi, steel for higher rating
Measuring unit body and end covers	Nickel cast iron, cadmium plate
Rotors	Heat treated aluminum, Nickel cast iron
Rotor shafts	Ground and polished Nitralloy
Rotor bearing	Stainless steel ball bearing
Gear covers	Heat treated aluminum or stainless steel
Counter drive gears	Nylon worm wheels, stainless steel worm gear
O-ring	Viton
Counter drive shaft	Stainless steel
Drive shaft bushings	Carbon filled Teflon

4.2.4.5 The meters which should be selected from 2" up to 16" sizes shall be pressure and temperature limited by the flange ratings.

4.2.4.6 Large numerical counters (or counter/printer) with five figure reset and seven figure totalizer or six figure reset and eight figure totalizer shall be used with this meter unless otherwise specified.

5. TURBINE METERS

Fluid flow through the meter impinges upon the rotor blades which are free to rotate about an axis along the center line of the turbine housing. The rotational velocity of the turbine rotor is directly proportional to the fluid velocity through the turbine. The output of the meter is taken by an electrical pickup mounted on the meter body. The output frequency of this electrical pickup is proportional to the flow rate.

5.1 Wetted Parts

Flow meter bodies shall be made of aluminum, steel and stainless steel, but other materials such as hastelloy, monel, titanium may also be considered. Rotors shall be stainless steel, although rotors can be made compatible with body materials of construction where more exotic materials are specified. Rotor bearing types and materials of construction shall be stainless steel ball bearing, tangston carbide sleeve bearings and graphite sleeve bearing.

5.1.1 The body is where the rotor assembly and sensing system are mounted. Vanes that are used to aid in characterizing the flow at the flowmeter inlet shall be welded into the body. Meter housing shall be of non-magnetic stainless or carbon steel. When carbon steel is specified a non-magnetic stainless insert is used for containing the pickup coil.

Meter body	SS 304 (corrosive service), Carbon steel (petroleum service) or SS 316

5.1.2 The rotor is the part of the turbine meter that rotates at a velocity that is proportional to the fluid flow. Rotors shall be generally designed to be as light as possible. The rotor shall contain the optimum number of blades properly contoured to provide desired torque and speed. A light-weight

stainless steel rim with small paramagnetic buttons should be provided for a greater resolution of flow if required.

Rotor (Rim type)	Hy-mu 80
	SS 304
	SS 316
Rotor (Blade type)	SS 430
	SS 300
	Stainless Steel 17 pH
	SS 316

5.1.3 Rotor bearings are the parts of meter on which the rotor rotates. Turbine meter bearings shall be usually selflubricating. The journal bearings shall be designed and selected to insure long service. Bearings shall be made of cemented tungsten carbide, and are finely lapped to a smoothness of one or two micro-inches.

Journal bearing	883 tungsten carbide

5.1.4 The materials of construction for other parts of the turbine meters should be as listed bellow:

Stators or Cones	Anodized aluminum (petroleum service)
	SS 300 (corrosive service)
	SS 304
	SS 316
Deflector ring	Carbon steel
	SS 304
Shaft	SS 304
	SS 316
Nuts	SS 304
	Cadmium plated steel
Bearing washers	883 Tungsten carbide
Shaft washers	Chrome-vanadium steel
Sleeve	SS 304
Cotter pins	SS 300

5.2 Turbine Meter Performance Data

5.2.1 The following specifications should be provided for turbine meters unless otherwise specified:

Linearity	±0.15% (20% up to 80% range)
	±0.25% (10% to 90% range)
Repeatability	±0.02%
Pressure drop	0.3 bar at maximum flow range

5.3 Sensing Systems (Pick-Up Coil)

5.3.1 The pick-up coil shall be attached to the meter by threads. It shall be able to convert rotational motion of the meter's rotor to electrical sine wave type pulses.

The typical material of pick-up coil:

Body	SS 304
Construction	Heliarc welded-hermetically sealed
Recommended connecting	Three conductor shielded cable 0.75 Sq. mm
Insulation resistance	100 Meg-Ohm min. 500 V dc between coil and shell

5.3.2 The amplitude and frequency of output pulses shall be compatible with read-out devices or preamplifiers input circuits.

5.3.3 A preamplifier shall be provided with pick-up coils, specially for long distances between meter and read-out (over 500 m).

Materials of Preamplifiers:

Elect. Connection	M20 × 1.5
Preamplifier case	Suitable for use in hazardous locations Class 1, Groups IIA, IIB, IIC, Zone 1

6. ACCESSORY EQUIPMENT

6.1 Mechanical Accessory Equipment

6.1.1 Strainers and air eliminators

The strainers should be used only to remove solids that might otherwise damage a meter or create uncertainty of measurement. Strainers used in crude oil services should be equipped with a coarse basket (usually four mesh is sufficient) to protect the meter-straightening vane and prover from damage by foreign material.

The filter shall be of the basket type and designed to allow easy removal, cleaning and replacement from the top of strainer. The replacement of the filter should not necessitate draining the strainer chamber. The strainer shall be equipped with an air release mechanism of the float type, complete with valve.

The strainer housing shall be equipped with differential pressure gage and/or differential pressure transmitter.

Material of Construction shall meet the piping material specification (PMS). The following material may be considered as a guide:

Body material	Carbon steel pipe or rolled plate
Flange	Carbon steel raised faced per ANSI B 16.5
Basket material	SS 304 or SS 316 or Carbon steel perforated plate -5/16 inch dia.Holes on 3/8 inch Staggered centers 65% open area with adjustable handle for Hold down and easy removal of basket.
Closure	Quick opening closure complete with air release assembly 'swing' bolt, hinged style for max.
Basket mesh	Stainless steel as specified.
Basket differential pressure taps	½ inch NPT
Air vent	Size shall be specified by project specification
Drain size	Size shall be specified by project specification

Note: Air eliminator based on the service condition should be considered.

6.1.2 Flow straighteners

Each turbine and ultrasonic meter run may be equipped with upstream flow straighteners if required. The flow straightener shall be made as inserts, as a complete flow straightening assembly. Flanged sections should be 150, 300, 600, 900 ANSI.

Material of inserts	Carbon steel with phosphate coating or stainless steel complete with grooved retaining rings for alignment purpose and adjustment screws to insure centering of the insert

6.1.3 Inlet and outlet block valves

Raised face flanged twin seal, block and bleed gate valve with the following specifications:

Body material	Carbon steel
Gate material	Carbon steel with stainless steel facing, solid wedge disc
Stem	Coated carbon steel or stainless steel
Flanges	Forged carbon steel, ANSI ratings
Seal plates	Cast Ni-resist
Seals	Nitrile or viton
Seats	Stainless steel
Actuator	Handwheel or electric
	Actuator with suitable
	Housing for based on IEC, 400 Volt, 3 phase 50 Hz.

6.1.4 Registers

Meter registers shall totalize and display deliveries and transactions in easy-to-read figures. Utilizing a geared drive with proper ratios, the meter register shall record in practically any unit of liquid measure.

Specifications:

Number of figures	Delivery display 5, Totalizer 8
Color of figures	Black on white
Reset	Right hand knob
Operating temperature range	-40°C to 70°C
Gearing	1:1 through 42:1 on request
Cover	Cast aluminum
Wheels, pinion and clutch	Acetal resin

6.1.5 Meter registers and printers

Meter register and printer combine to produce detailed records of fluid deliveries and transactions. The printer shall accept proper sized carbon packs and receipt tickets. They shall be accumulative or zero start.

Specifications:

Number of Figures	Meter register: 5

	Meter register totalizer: 8
	Meter register printer, zero start: 6
	Meter register printer (Accumulative): 7
Reset	Right hand, single reset knob
Gearing	1:1 through 42:1 on request
Cover and sub-frame	Cast aluminum
Wheels, pinions and clutch	Acetal resin

6.1.6 Set-Stop and control valve

It shall consist of a meter to close a quantity control valve after a predetermined quantity of liquid has been measured by the meter. After a preset quantity of liquid has been measured, the set stop counter shall actuate the valve to close it in two stages.

Valve material	Stainless steel or ductile Iron
Valve operator	Piston type

6.2 Electrical and Electronic Accessory Equipment

6.2.1 Tachometer generator

Tachometer generator which is a dc permanent magnet tachometer generator should be in an explosion proof housing. The transmitter shall be actuated by the meter output drive and a gear train within the housing providing a dc voltage output propotional to meter flow rate.

Meter/generator ratio	1:1, 1:2, 1:4.48, 1:9.6
Ingress protection	IP 65

6.2.2 Rate of flow indicator

Rate of flow indicators should be used in conjunction with tachometer generators.

Mounting	Panel mounted
Scale range	As specified
Full scale	1.5 V dc
Accuracy	±2% of full scale

6.2.3 Pulse transmitter

Pulse transmitter is used to transmit electronic pulses from a meter register to a remote display, electronic counter or any data system.

Housing	Die cast explosion-proof
	Class 1, Group IIA, UL or equivalent certified
Pulse frequency	1 or 10 pulses per revolution of input shaft
Swith type	SPST
Speed	0 to 3000 pulses per minute
Temperature range	-30°C to 70°C
Leads	0.75 Sq. mm min.

Connection	M20 × 1.5 gland
Ingress protection	IP 65

6.2.4 High frequency pulse generator

High frequency pulse generator is a device used to mechanically link the output shaft of the meter to the register and to provide an electrical output signal proportional to unit volume.

Frequency	0-5000 cycle per second, Max.
Amplitude	0-10 volt
Temperature range	-30°C to 70°C
Connection	M20 × 1.5 gland
Enclosure	Explosion-proof
	Class 1, Group IIA, Zone 1 and weather proof

6.2.5 Photo-Electric pulse transmitter

Photo-electric pulse transmitters are devices that convert meter output shaft revolution into high resolution electrical pulses to drive electronic counters, electronic combinator, flow rate indicator (through frequency convertor), etc.

Frequency output	1 pulse/revolution or 1000 pulse/revolution
Ingress protection	IP 65
Operating range	-30°C to 70°C

6.2.6 Pulse totalizer

Pulse totalizer is simply a pulse counter which may be connected to a pick-up coil or other compatible transducer. It shall accept high frequency pulses and divide it by 1, 10, 100 or 1000, so that display shall be 1, 1/10, 1/100 or 1/1000 of the total pulses received.

Frequency range	0 to 6.5 kHz
Accuracy	±1 pulse
Count capacity	999,999
Power requirement	110 V ac ±15%, 50 Hz, 24 V dc
Temperature range	0°C to 70°C

A five digit, thumb-wheel type switch may be provided for setting a system factor into the totalizer so that the read-out is automatically modified in engineering units.

6.2.7 Combinating totalizer (pulse combinator)

A digital combinator shall provide a running summation of total pulses received simultaneously from pulse producing flow meters, combines inputs digitally and displays the sum on a six-digit resettable totalizer. A selector switch should be provided that enables each input signal to be connected to a remote proving totalizer.

Number of inputs	4,8 or 10 inputs
Accuracy	±1 count per channel
Pulse voltage level	3 to 24 volt peak-to-peak
Count capacity	6-digit mechanically resettable (with reset lock)

Temperature range	0°C to 70°C
Power requirement	110 V ac ±15%, 50/ Hz, 24 V dc

6.2.8 Prover totalizer

Prover totalizer should be a self contained electronic counter which should be connected to a pick-up coil or other compatible transducers. Prover input circuitry shall gate the input "on" and "off ".

Frequency range	0-6500 Hz
Accuracy	±1 count
Count capacity	6-digit or as otherwise specified
Power requirement	110 V ac ±15%, 50 Hz, 24 V dc
Temperage range	-30°C to 70°C
Start/stop switch	Toggle switch to disable the input or test signal in stop position
Reset switch	Push-button on front panel

6.2.9 Temperature compensating totalizer

This totalizer shall provide temperature compensation using a temperature signal from a resistance type temperature probe to correct pulse inputs from the flow meter.

Accuracy	±1 count
Probe accuracy	±0.25°C
Power requirement	110 V ac ±15%, 50 Hz, 24 V dc
Temperature range	0°C to 70°C
Frequency	0-2500 Hz
Wetted parts of probe	Stainless steel

6.2.10 Remote ticket printer

Remote ticket printer shall receive signals from a single remote location, total the pulses, and on command, print the data on a ticket. A common pulse transmitter should be used for signaling.

Specifications:

Voltage	110 V ac ±15%, 24 V dc
Figures Ticket	7 figures for non-reset totalizer
Reset	Start print and finish accomplished electrically
Environment temperature	0-70°C

7. PROVERS

7.1 Pipe Provers

7.1.1 Provers shall be fabricated for not less than 150 lb ANSI rating.

7.1.2 Piping for prover barrel shall be perfectly round and free from bars, grooves, pits or dents. If welding of pipe or fittings is required, the weld must be a full penetration weld and must be ground smooth.

7.1.3 Flanges used in the measuring section of the prover should be match bored and machined for metal to metal surface contact with a tongue and groove 'O' ring fit.

7.1.4 Internal surface of the entire length of the prover barrel shall be coated to reduce frictional drag on the sphere and protect the measuring section from rust or pitting. The coating must have a hard, smooth, long lasting finish and must be applied only after the internal surface of the prover barrel has been sandblasted to a white metal base NACE-No.1 and then be coated with baked on phenolic or air-cured epoxy system. Coating thickness shall be in 4-7 mils range.

7.1.5 The Bi-directional prover shall be complete with inlet and outlet flanged connections not less than class 150 lb ANSI rating for fitting a 4-way diverter valve along with displacer stops, drains and vents.

7.1.6 The uni-directional prover shall be complete with an interchange valve controlled by an actuator system, explosion proof type and fitted with local and remote operating facilities.

7.1.7 The 4-way valve shall be flanged constructed with pressure rating of not less than 150 lb ANSI. The 4 way valve shall be fitted with a mechanical position indicator and a manually gear operated hand-wheel.

7.1.8 Prover should be supplied with one displacing device as a minimum. When elastomer spheroid is used as a displacer, it should be hydrostatically filled with water and glycol. Material of sphere should be neoprene, polyurethane or nitrile rubber according to the application. For MTBE services Teflon may be used.

7.1.9 The prover should be coated with external protective coatings such as primers, paint, mastic, epoxies, etc. which can be applied to the prover exterior surface.

7.1.10 The provers shall be externally insulated for temperature stability.

7.1.11 Spades and spacer rings shall be provided on the inlet and outlets of the prover for maintenance purposes.

7.1.12 The minimum nominal pipe thickness shall be 3/8 inch.

7.1.13 Standard accessory equipment on all provers shall be as follows (Fig. 1):

a) Two 150 mm diameter pressure gages (½" NPT) with ½" NPT isolation valves.

b) Two industrial style thermometers with suitable temperature range and scale. If temperature indication is in °F the divisions shall be in ½ degree and if it is in °C the divisions shall be in ¼ degree.

c) One pressure relief valve, with suitable isolation valve, 1" NPT, with pressure rating and setting in accordance with the prover ANSI rating.

d) Two or more ½" NPT steel vent valves located at high points in prover. Vent closed loop and common vent are not acceptable. For LPG liquid the closed loop may be used but must be equipped with sight glass.

e) Two 1" NPT steel gate valves at lowest points in prover loop for draining. Drain valves which are piped into a drain system should be double block and bleed.

f) Blind flanged can be provided (recalibration connections)

7.1.14 Materials of construction should be as follows:

Pipe	Carbon steel, Grade B
	ASTM A53, Grade B or API 5L, Grade B
Flanges	Carbon steel A 105
	ASTM A 105-71or A 181-68, Grade I or II
Elbows and tees	Carbon steel, Grade B
Internal coating	4-7 mils thick using air dried epoxy-resin paint or equivalent

Note: Air eliminator based on the service condition should be considered.

7.1.15 The detector switch repeatability shall be as low as possible to make the overall repeatability of the system within 0.02%. The housing for electrical connections shall be explosion-proof.

Specifications:

Electrical switch	DPDT, UL certified or equivalent suitable for use in hazardous Locations based on IEC
Cap, flange and Shaft end	Stainless steel or as specified
Shaft	Stainless steel
Shaft spring	Inconel
'O' ring	Viton

7.2 Volumetric Tank Prover

The prover is a top graduated-neck prover which can be supplied with either a 'drain to zero' bottom or with a bottom gage glass (or weir). The tank should be manufactured from heavy gage steel plate and should be lined with epoxy resin (Fig. 2). Sizes should be 100, 200, 500, 1000, 1500, 2000 liters. Primary measures shall be provided for calibrating volumetric provers and may be 20, 40, 60, 100, 200 liters capacity.

7.3 Small Volume Prover Systems

The small volume prover is available in several different configurations that allow a continuous and uniform rate of flow. All types operate on the common principle of the repeatable displacement of a known volume of liquid in the calibration section of a pipe or tube. A displacer travels through a calibrated section with its limits defined by one or more highly repeatable detectors. The corresponding metered volume simultaneously passes through the meter, and the whole number of pulses is counted. Precise calculations are made using a pulse-interpolation technique.

The two types of continuous-flow small volume provers are unidirectional and bidirectional. The unidirectional prover allows the displacer to travel and measure in only one direction through the proving section and has a means of returning the displacer to its starting position. The bidirectional prover allows the displacer to travel and measure first in one direction and then in other and is capable of reversing the flow through the prover section.

Both unidirectional and bidirectional small volume prover must be constructed so that the full flow of the stream passing through the meter being proved will pass through the prover.

7.3.1 Equipment

The small volume prover must be suitable for the intended fluids, pressures, temperatures, and type of installation. The materials used must be compatible with the fluid stream and the location where the prover will be installed.

A small volume prover will normally consist of the following elements:

a) A precision cylinder.

b) A displacer piston, spheroid, or other fluid separation device.

c) A means of positioning and launching the displacer upstream of the calibrated section.

d) A displacer detector or detectors.

e) A valve arrangement that allows fluid flow while the displacer is traveling from one position to the opposite position.

f) Pressure-measurement devices.

g) Temperature-measurement devices.

h) Instrumentation with timers, counters, and pulse interpolation capability.

7.3.2 Materials and Fabrication

The materials selected for a prover shall conform to applicable codes, pressure ratings, corrosion resistance, and area classifications.

The calibrated volume-measurement section of the prover, located between the displacer-position sensors, must be designed to exclude any appurtenances such as vents or drains.

Flanges or other provisions should be included for access to the inside surfaces of the calibrated and prerun sections. Care should be exercised to ensure and maintain proper alignment and concentricity of pipe joints.

Internally coating the prover section with a coating or plating material that will provide a hard, smooth, long-lasting finish will reduce corrosion and prolong the life of the displacer or displacer seals and the prover.

8. DOCUMENTATION

8.1 At Quotation Stage

Suppliers shall provide the following drawings and data in English at the time of quotation:

- Metering system comprehensive catalogues, technical data, outline drawings, exploded views, proposed test procedure,

- Electrical wiring schematic diagram consisting of control panel wiring diagram, system interconnection and type of cables,

- HMI graphic display,

- Valves control and interlocking system wiring diagram,

- Control panel details and drawings,

- Declaration of conformation with standards and/or clear indication of deviations from the standards and specifications,

- List of recommended commissioning and two years spare parts with prices,

- Details of any special tools required with price.

- P&ID

- Packing and shipment procedure

8.2 At Ordering Stage

Suppliers shall provide the following drawings and data for approval immediately following the placing of the order.

5 sets of drawings and data for approval:

- Piping, wiring, dimensional outline drawings and foundation plans and recommended installation details.

- Electrical wiring schematic diagram consists of:

a) Internal wiring of control panel;

b) System interconnection wiring diagram;

c) Control panel details and outline drawings;

d) HMI graphic display;

e) Valves control logic and interlocking system schematic wiring diagram.

- Proposed test procedures for approval.

8.3 Final Drawings and Data

Suppliers shall provide the following drawings and literatures in form of electronic and hard copy before delivery.

- Final metering system details, piping, dimensional outline drawings and foundation plants sizing etc.

- Final electrical wiring schematic diagram consisting of:

a) Internal wiring of control panel.

b) Final system interconnection complete with connection terminal Nos. and type of cable.

c) Panel details and dimensions.

d) HMI graphic display,

e) Valve control logic and interlocking system wiring diagram.

- Codes and standards compliance certificates.

- Installation, operation and maintenance manuals.

- Factory test certificates, including test data and calculated results.

- Illustrated and numbered parts list and two years running spare parts list.

- As built P&ID

9. GUARANTEES

The supplier shall guarantee his equipment during commissioning and one year operation starting from the completion of seven days continuous service test in site at full load, against the following defects as minimum:

- All operational defects.

- All material defects.

- All constructional and design defects.

All defective parts shall be replaced by the supplier in the shortest possible time free of charge, at site during the guarantee period. Furthermore, the supplier shall guarantee the provision of spare parts for a minimum period of 15 years from the date of dispatch. In the event the supplier can not supply the required spares within the period of time, the cost of complete replacement unit shall be borne by supplier.

10. TESTING AND INSPECTION

10.1 General

Supplier shall conduct performance tests and pressure tests of the meters and calibration and pressure tests of the provers prior to shipment, and shall supply the user with certified performance curves and test certificates as applicable. Performance and calibration tests shall be carried out by an approved authority whose standards are acceptable. Purchaser representatives shall have access to Vendor works for attendance during inspection and test.

10.2 Factory Acceptance Tests (FAT)

10.2.1 Meters

Each meter shall be factory tested over full contractual flow range, including extended range, with correct pipe configuration up and down stream of meter. Tests shall be, for each meter, at ten different flow rates and shall establish pressure drop over the meter and verify that repeatability and linearity are within the requirements of the specification. Repeatability shall be based on minimum three consecutive runs within minimum five rate of each flow.

Positive displacement meters shall be tested with mechanical registration equipment attached. The testing medium shall be either water, (subject to Purchaser Approval) kerosene or other liquid approved by the Purchaser.

10.2.2 Provers

Each prover shall be calibrated by the water draw method in accordance with API Manual Chapter 4, Section 9 (latest edition) calibration repeatability for the prover volume shall be within 0.02% for three consecutive round trips, plus one additional round trip at a rate change of 25 percent.

10.2.3 Hydrostatic testing

The hydrostatic testing shall be done by means of approved liquids. All ancillary pipe work such as drain and vent system shall be included. Continuous recording of pressure and ambient temperature shall be provided during the test. All internal valves shall be in open position and end of piping shall be closed by blind flanges or threaded plugs. Test pressure shall be 1.5 × design pressure. Minimum stand time at test pressure shall be two hours or more. All instrumentation shall be removed or isolated during this test.

10.2.4 System

Each assembled metering station shall be connected up to the associated panels and a functional test with approved liquid carried out covering the following:

- Correct function of prover equipment
- Correct function of local prover panel
- Correct function of pulse registration and other instruments
- Remote control/indication of meter station valves, local control/indication of motor operated valves
- Verification of interlocks

10.3 Site Acceptance Tests (SAT)

The performance tests shall be carried out on totally assembled packages by Vendor. The tests for each system shall include but not necessarily limited to:

- Prover.
- Complete meter runs, header, etc.
- Valves.
- Controls, control panels and fiscalization equipment.
- interlocks.

10.3.1 Hydrostatic testing

Hydrostatic testing shall be applied as per Section 10.2.3.

10.3.2 Provers

Each prover shall be re-calibrated, with approved liquid after installation on site using the water draw method or the master meter method. These calibration methods shall comply with the requirements as stated in API Manual Chapter 4, Section 9 (latest edition).

10.3.3 System

After completion of station and panel installation, equipment calibration and prover re-calibration, each metering station shall be performance tested with product using the station prover and associated station instrumentation/control equipment. The tests shall include but not necessarily limited to:

- Full flow test of each meter cover the entire range via the total meter station. Each meter shall be tested in conjunction with the full registration equipment including associated line instrumentation. The test shall be at minimum 5 different flow rates distributed over the contractual flow range to establish that linearity and repeatability are within the requirements of the specification when using product.

- Total metering station throughput capacity as per specification requirement shall be verified.

- All interlocks shall be verified.

- All instrument and panel function shall be verified i.e. station valve control, meter pulse registration, etc.

11. PACKING AND SHIPMENT

11.1 Metering systems, control panels, accessories shall be suitably packed and protected against all damages or defects which may occur during handling, and shall be properly prepared for ocean transport and ware- housing.

11.2 If metering stations are subjected to overseas transit or exposed to storage under adverse conditions, the following minimum specification is given as a guide to the degree of protection required:

- The units shall be sealed in suitable plastic envelopes, humidity indicators filled and sufficient desiccant for 12 months open storage enclosed.

- Metering stations shall be bolted to the base of the packing case with interposed shock proof mountings, and cushioned with an adequate thickness of packing material on sides, ends and lid.

- The framed base, sides and ends of packing case shall be constructed of 22 mm thick tongued and grooved close boarding and lined with reinforced waterproof paper.

- The lid shall be lined with roofing felt backed by 3 mm plywood.

11.3 The supplier’s final packing specification shall be subjected to the user’s manual.

11.4 The shopping mark, purchase order number and any other particulars as requested in the requisition, shall be stencilled on each separate packing and/or on the outside of each wooden case or crate.

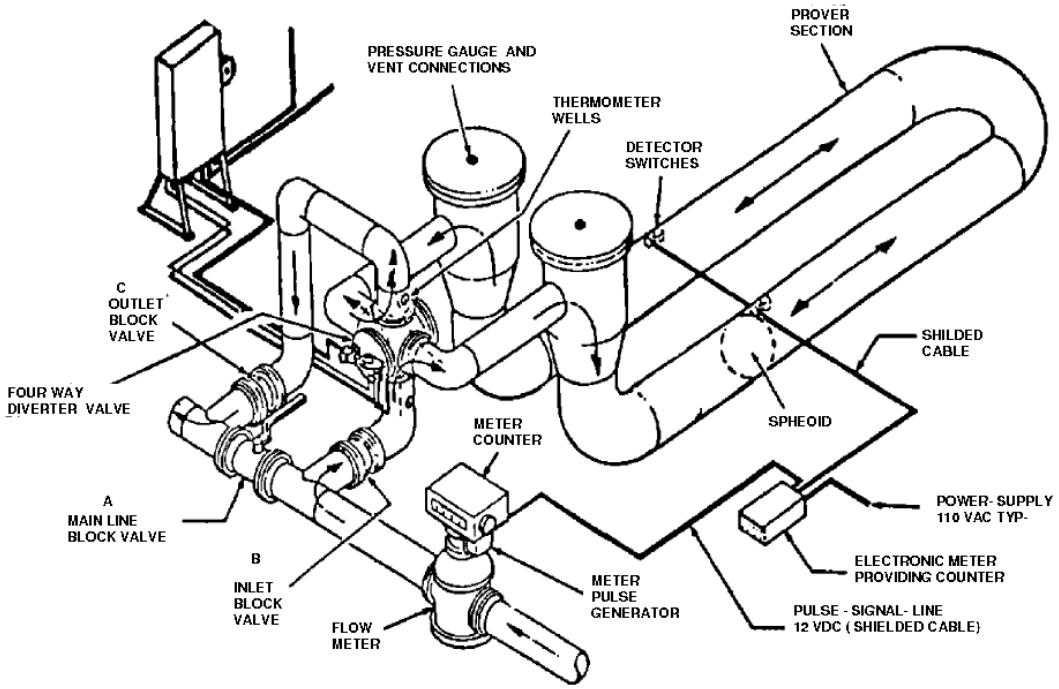
11.5 The supplier shall inform the user of the estimated total weight and dimensions of each shipping section of the cabinet and its termination rack, within four weeks of the acknowledgment of the Purchase order.

11.6 The Manufacturer shall provide a complete packing and handling specification to cover both skid and electronic panels.

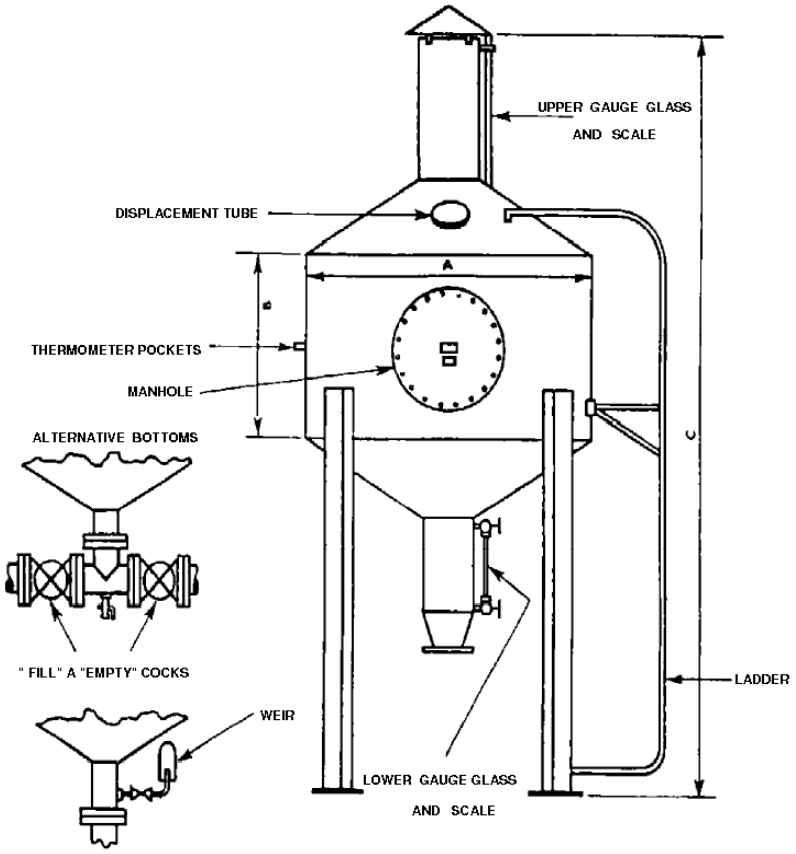
11.7 Prior to shipment, all high accuracy skid-mounted instruments shall be removed, packed separately and shipped with the skid.

Turbine meters shall be replaced with pipe spools and shipped with the skid.

11.8 Full consideration shall be given to the need for long-term preservation of the skid and metering electronics after testing has been completed. The Manufacturer shall furnish recommendations for long-term preservation at a designated site for the periods prior to installation and after installation.



TYPICAL BI-DIRECTIONAL U-TYPE SPHERE METER PROVER
Fig. 1



VOLUMETRIC PROVER TANK
Fig. 2