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PURPOSE AND SCOPE

This instruction sets policy guidelines and application requirement for custody measurement of liquid hydrocarbons. Application of this GI is necessary to ensure proper accountability and to minimize losses. For measurement applications where Royalty is paid, or credit for Royalty payments is determined please refer to GI-405.007.

Custody Transfer Measurement is 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 hydrocarbon commodities. This includes measurement of hydrocarbon liquid movements (deliveries or receipts) between Saudi Aramco and its customers, suppliers, joint ventures and transport contractors including VELA ships.

The current hydrocarbon liquids custody measurement applications in Saudi Aramco are:

- Marine loading/ unloading, deliveries or receipts including inter-company transfers
- Truck loading/ unloading, deliveries or receipts including transfer via hauler trucks
- Weigh scales, deliveries or receipts
- Air fueling operations, deliveries or receipts except by pipeline
- Pipeline operations, deliveries or receipts excluding intra-company transfers.

1. REFERENCES

Saudi Aramco Engineering Standards and Manuals

SAES-Y-103	Royalty/Custody Metering of Hydrocarbon Liquids
SAEP-21	Project Execution Requirements for Saudi Aramco Royalty/Custody Metering Systems
SAEP-22	Tank Calibration Requirement

SAEP-50 Project Execution Requirements for Third Party Royalty/Custody Metering Systems
The "Static Measurement Manual"

API Manual of Petroleum Measurement Standard (API MPMS):

Chapter 3	Tank Gauging
Chapter 4	Proving systems
Chapter 5	Metering
Chapter 6	Metering Assemblies
Chapter 7	Temperature Determination
Chapter 8	Sampling
Chapter 9	Density Determination
Chapter 10	Sediment and Water
Chapter 12.2	Calculations of Petroleum Quantities

GPA 8186 Measurement of Liquid Hydrocarbon by Truck Scales
GPA reference bulletin 187-72

2. UNITS OF MEASUREMENT

2.1 Depending upon the facility and the application, either the U.S. Customary (USC) or metric (SI) system of units shall be used:

Item	US Customary	Metric
Volume	Barrels, Gallons	Liters or Cubic Meters
Temperature	Degree Fahrenheit (^oF)	Degree Celsius (^oC)
Pressure	Pounds per square inch (psi)	Kilo Pascal (kPa)
Density	Pounds per cubic ft. (lb/cu.ft.)	Kilograms/Cubic meter (kg/m^3)
Flow rate	Barrels/hour (bbl/hr)	Liters/hour (Lt/hr)
Level	inches	mm or cm
Weight	Pounds	Kilograms

For Pipelines Originating at Gas Plants: All liquid hydrocarbons shall be measured using equipment registering in U.S. Customary (USC) units. All volumes shall be expressed in barrels.

For Refineries, Terminals & Fractionating Centers: All liquid hydrocarbons shall be measured using equipment registering in U.S. Customary (USC) units. All volumes except that of bunker fuel shall be expressed in barrels. Bunker fuel volumes shall be expressed in barrels or gallons.

For Distribution Bulk Plants & Air Fueling Units: Crude oil volumes shall be measured using equipment registering in the U.S. Customary (USC) units and shall be expressed in barrels. All refined

liquids (e.g., gasoline, diesel, kerosene, Jet A1, JP4, JP8, and fuel oil) shall be measured using equipment registering in metric (SI) units. Refined liquid volumes shall be expressed in liters, dekaliters or cubic meters. Jet A1 and JP4 sales volumes may also be expressed in kilograms.

2.2 Equipment used in the custody measurement shall be consistent with the designated system of units used in the transfer. For example; If metric system of units are used in the custody transfer measurement, then tanks calibration tables shall be in centimeters and millimeters, hydrometer shall be graduated in kg/m^3, thermometer shall be in ^oC.

3. REFERENCE CONDITIONS

When required by the purchase/ sales agreement or company accounting procedures, all observed liquid volumes shall be corrected to the reference temperature and pressure appropriate, for the system of units. Reference to correction tables to be used is made in SAES-Y-103, "Static Measurement Manual" for Dynamic measurements and static measurements respectively.

Item	Metric (SI)	U.S. Customary (USC)
Reference Temperature	15°C	60°F
Reference Pressure	101.325 kPa (abs) = (0 kPa (ga))	14.696 psia = (0 psig)

If required by the purchase/ sales agreement or deemed necessary by company accounting procedures, commodity units may be converted to or expressed in different units other than original output of measurement device.

4. RESPONSIBILITIES

4.1 Operating Organization

The Operating Organization that maintains or operates the facility of custody transfer of liquids shall be responsible for the implementation of this General Instruction. The Operating Organization shall designate trained personnel to maintain, monitor and assist in the implementation of this General Instruction. The assigned personnel shall go through continuous training program to keep his knowledge up to date on measurement systems maintained or operated by the Operating Organization. The Operating Organization shall ensure that measurement methods used are per this GI. The Operating Organization shall obtain P&CSD approval for any deviation from this mandatory document.

The Operating Organization shall ensure that all gaugers, operators, laboratory, technicians, operating foreman, supervisors, etc. are responsible for understanding and adhering to all relevant safety and health precautions when performing their custody measurement duties.

The Operating Organization shall ensure that:

4.1.1 All required custody measurements equipments are available, maintained and operated properly per the written maintenance and operation procedure. Failure to meet this requirement due to any reason such as shortage of qualified manpower, planning and scheduling requirements, failure of metering or verification equipments shall be reported to Operating Organization management whose signature authority level is to concur on this GI. Proper course of action shall be taken to rectify the situation.

4.1.2 The measurement requirements as specified in the supply or sales agreement are complied with.

4.1.3 In case of disagreement between Aramco figures and the figures of the customer/supplier, a formal investigation where the disputed figures are accounted for is initiated. Resolution of this dispute should be implemented by the Operating Organization. The investigation procedures should be followed per sales agreement and OIM.

4.1.4 Custody measurements (proving, tank gauging, etc.) performed by others (e.g., customers and suppliers, etc.) are witnessed and approved, unless it is required otherwise by sales agreement.

4.1.5 Traceable certified reference equipment such as provers or master meters are stored and maintaining in good condition.

4.1.6 Records are maintained to ensure the integrity of the operation and maintenance of equipment used in transfer. Also, ensure that adequate monitoring and record keeping for control and auditing purposes are accomplished for each transfer per section 4.1.17.

4.1.7 The continuous validity of the measurement which will include reviewing measurement tickets, proving reports, flow computer data, etc. are checked by the plant designated engineer. In case of any technical problem which requires assistance of Custody Measurement Unit of Process & Control Systems Department (P&CSD/ CMU), they may be contacted with an official support request details of the problem.

4.1.8 Annual overall health check on the complete custody transfer measurement process is performed and the records are maintained for verification. Operating Organization may request P&CSD/ CMU to provide a list of tasks for this Annual health check for their particular measurement station. These tasks maybe different for each type of custody transfer station.

4.1.9 Operating Instruction Manuals are prepared and revised every five years or less to reflect measurement accuracy, sound practices, and accountability in the transfer of liquids. These new operating instructions shall be reviewed by P&CSD/ CMU for concurrence prior to their approval and implementation. If Operating Instruction Manual is related to static measurement then the “Static Measurement Manual” shall be the reference for compliance. In this case no need for P&CSD review.

4.1.10 All instrument calibration equipment (e.g., dead-Weigh tester, decade box, volt-ohm-ammeter, etc.) being handled by Saudi Aramco (or outside contractors) are calibrated/verified and certified by a third party calibration agency accredited by an authoritative body like SASO or NIST every year. All instrument calibration equipment that are out of calibration or overdue shall be taken out of service till validated.

4.1.11 Ensure that sufficient numbers of certified instrument calibration equipment are available.

4.1.12 The frequency of calibration and/ or checking of instruments and their accessories such as Portable Electronic Thermometers (PET), Glass thermometers, Hydrometers and Densitometers are established using the recommendation of the calibration agency but only after conducting at least two or more consecutive recalibration or checking.

4.1.13 Field test measures used to calibrate meter provers are maintained and handled in such a manner so as to prevent damage. Their volumes are certified in accordance with API MPMS Chapter 4.7 by an approved weights and measures agency (NIST, etc.) at intervals not to exceed 5 years.

4.1.14 Required spare parts are kept and stored appropriately in accordance with the manufacturer's recommendation.

4.1.15 The integrity of valves critical to accurate measurement are routinely checked and documented as suitable for custody measurement. The integrity of all double block-and-bleed valves critical to custody measurement shall be verified on a monthly basis. The integrity of all connection valves located between the primary measurement device (tank or metering system) and custody transfer point(s) shall be verified every year or during the routine preventive maintenance, whichever occurs first.

4.1.16 All recommendations and action items proposed by P&CSD/PASD/CMU are complied with or closed with P&CSD/PASD/CMU concurrence.

4.1.17 The following documents records are available and retained as recommended below:

Document/ record	**Minimum Retention period ***
Prover Calibration certificate (SVP, online prover, master meter and tank prover)	At all times, plant should have current certificate in paper format plus ALL previous as an e-copy
Standard calibration equipments/ Instruments certificates	2 years
Meter calibration curves	At all times, plant should have current certificate in paper format plus ALL previous as an e-copy

Meter proving records	2 years through e-copy
Transfer records documentation	2 years
PET calibrations certificates	2 years
Valve integrity check records	2 years
Sampling records	2 years
Sampler certificates	At all times, plant should have current certificate
Temperature and pressure elements calibration records	2 years
Densitometers and hydrometers certificates	2 years
Dip tapes certificates	2 years
Cup-case thermometers certificates	2 years
Tank calibration table	At all times, plant should have current certificate in paper format plus ALL previous as an e-copy
Automatic level tank gauges records	2 years
Averaging tank thermometers records	2 years
Weigh scale certificates	2 years
Original flow computer configuration file	Life time (include hard and soft copy)
Installed versions for flow computer and preset controller firmware	2 years
Records of complete custody measurement system health check	5 years
P&CSD recommendations /action items documents.	One year after closure

* These retention periods are in effect upon the approval date of this GI revision.

4.2 Custody Measurement Unit/PASD/P&CSD

Custody Measurement Unit/PASD/P&CSD shall:

4.2.1 Provide technical guidance to all concerned for implementing this instruction, and shall be the controlling entity for this document.

4.2.2 Support Internal Auditing by answering their technical queries and providing interpretation to this GI.

4.2.3 Assist Operating Organization in reviewing special training offered by vendors or by offering courses through PEDD or special sessions as needed.

4.2.4 Have the overall responsibility to ensure consistent approach to the design of new measurement transfer systems or major upgrades across the company.

4.2.5 Provide engineering-level services as second line support to technical engineering services of each Operating Organization.

4.2.6 Review and Propose needed modifications to operating instructions that are newly developed or have been through major modifications.

4.2.7 Offer training to company corporate entities that are involved with custody measurement process. This is to ensure proper implementation of this GI.

4.2.8 Review the measurement provisions in purchase/sales agreements

4.3 Domestic Sales and Logistic Department (DSLD)

DSLD shall:

4.3.1 Ensure that sales agreement for each custody transfer measurement process to a customer is written and in place. A copy of all sales agreement shall be available with DSLD.

4.3.2 Ensure that each sales/ transport agreement includes:

a) Allowable Deviation tolerances between Saudi Aramco and its suppliers or customers as applicable.

b) Allowable reconciliation tolerances for transport contractors.

c) The process and method for resolving any measurement discrepancy in the custody transfer measurement process.

4.3.3 Coordinate with customers to address and resolve contractual concerns.

4.3.4 Ensure that technical clauses in sales/ service agreement related to measurement of quantity and quality are reviewed by Custody Measurement Unit/PASD/P&CSD.

4.3.5 Ensure that the Sales Agreement or Operations & Maintenance (O/M) Agreement is reviewed and concurred by the Operating Organization.

4.4 Product Sales and Marketing Department (PSMD)

As applicable to custody measurement, PSMD shall:

4.4.1 Ensure that sales agreements for all custody transfer measurement process to customers are written, in place and in compliance with applicable industry standards and company standards/ GI.

4.4.2 Ensure that each sales/ transport agreement includes:

a) Allowable deviation tolerances between Saudi Aramco and its customers or suppliers

b) The process for resolving any measurement discrepancies

4.5 Crude Oil Sales and Marketing Department (COSMD)

As applicable to custody measurement, COSMD shall:

4.5.1 Ensure that sales agreements for all custody transfer measurement process to customers are written, in place and in compliance with applicable industry standards and company standards/ GI.

4.5.2 Ensure that each sales/ transport agreement includes:

a) Allowable deviation tolerances between Saudi Aramco and its customers or suppliers

b) The process for resolving any measurement discrepancies

5 QUANTITY CALCULATIONS

All the measurement Calculations shall be performed in accordance with SAES-Y-103. For static measurement calculations, it shall be performed in accordance with the "Static Measurement Manual". Unless otherwise stated in sales agreement and with the exception of asphalt, hydrocarbons delivered to local customers are billed based on gross volume loaded. Asphalt is billed based on net weight loaded.

6 STATIC MEASUREMENT

6.1 In general, Static Measurement is the least preferred method versus Dynamic Measurement. Static Measurement shall be performed by Manual Tank Gauging, Automatic Tank Gauging or by Weigh Scale. Tank Gauging may become an optimum choice at some locations provided an economical analysis is performed to confirm that static measurement is more cost effective than dynamic measurement. Considerations for analysis are listed in attachment I. If requested by the Operating Organization, P&CSD/ CMU may provide clarification(s) for the technical requirement(s) in the subject attachment.

6.2 Tank gauging shall only be used when the tank can be isolated for a single delivery or receipt. Running gauges shall be prohibited.

6.3 Tanks used in the transfer of liquids shall be calibrated by an Independent Inspection Agency in accordance with SAEP-22 Tank Calibration Requirement. Tanks shall be calibrated in conjunction of every T&I but not to exceed 10 years between calibrations. A new set of calibration tables shall be developed whenever the tank internals are modified. Copies of the tank's capacity tables shall be available in the control rooms.

6.4 Manual Tank Gauging

Manual Tank Gauging shall be done by a certified tape for level measurement and by a thermometer or PET for temperature measurement. The certificate validity of these shall not be more than one year. Detailed measurement procedures in Manual Tank Gauging and the certification of gauge tapes (procedure, tolerance, certification equipment) shall be in accordance with the "Static Measurement Manual".

6.5 Sampling and Density Determination

Samples shall be collected by either:

a) Manual sample collection from the tank per the static measurement manual.
b) Automatic pipeline sample from the loading line used for custody transfer per API chapter 8.2.

Density is determined at the observed temperature using a glass hydrometer as per standard API MPMS chapter 9, Density Determination. The hydrometer shall be checked before initial use by the Saudi Aramco Laboratory or as specified in the sales agreements.

6.6 Automatic Tank Gauging:

Automatic Tank Gauging (ATG) shall be performed in accordance with API chapter 3 and below requirements:

a) ATG system to pass the factory, field calibration and initial verification per API MPMS Ch.3.1B.
b) Reference height shall be verified each month at liquid levels between 0 and 20%, and between 80 and 100% of the working height. If the maximum difference between the measured reference height at these liquid levels exceeds 3 millimeters (1/8-inch) or the difference between any of reference height measurements and the official reference height for the tank exceeds 3 millimeters (1/8-inch), the ATG shall not be used for custody measurement.
c) The ATG system shall be provided by an approved supplier as per SAES-J-002, until this commodity is added to SAES-Y-100, RVL for Custody Measurement.
d) The initial verification and at least one subsequent verification per year for the ATG (level and temperature) shall be performed by a third party inspector and the certificate shall be reviewed by the Operating Organization to ensure the performance is within the allowable tolerances as stated in API chapter 3.1B.
e) Initial and subsequent verifications of Automatic Tank Thermometers (ATT's) shall be per API MPMS Chapter 7.

6.7 Truck Weigh Scale

In applications where the liquid can't be metered or tank gauged, Weigh Scale by trucks maybe used. Installation, operation, testing and verification of Weigh Scale shall be in accordance with GPA 8186 or by GPA reference bulletin 187-72 and "Static Measurement Manual". The Weigh Scales shall be calibrated using the procedure C901. The Weigh Scale shall be calibrated by a third party agency once every six months and the certificate shall be reviewed by the Operating Organization to ensure the performance is within the allowable tolerances per the applicable industry standards as stated previously.

7 DYNAMIC MEASUREMENT

The design of custody measurement stations shall be in accordance with SAES-Y-103, Royalty & Custody Metering of Hydrocarbon Liquids. Unless stated otherwise in this section, meter calibrations and meter proving and prover calibrations shall conform to API MPMS Chapters 4.5, 4.8, 12.2.3 and 12.2.4.

7.1 Meter Type

7.1.1 Meters shall be of types in the approved list by Custody Measurement Standards Committee. The use of any other type of meters shall be with prior approval of Chairman, Custody Measurement Standards Committee to obtain approval.

7.1.2 Turbine meters shall be operated between 40 and 100% of their maximum flow rate. All new or recently repaired turbine meters shall be calibrated and have their linearity verified to be ± 0.15 % or better over a 6:1 turndown ratio (maximum flow rate: minimum flow rate) for acceptance of their calibration curve.

7.1.3 Positive displacement meters shall be operated between 20 and 85 % of their maximum flow rate. All new or recently repaired positive displacement meters shall be calibrated and have their linearity verified to be ± 0.15 % or better over an 8:1 turndown ratio (maximum flow rate: minimum flow rate) for acceptance of their calibration curve. The meter shall be calibrated using the liquid for which it is intended or by a liquid whose properties are similar to the liquid for which it is intended to be used.

7.1.4 The meters shall be operated and maintained in accordance with the plant Operation Instruction Manual. The meter shall be operated above their minimum operational back pressure and within their design flow rate.

7.2 Meter Calibration

7.2.1 For custody transfer applications the minimum number of calibration points for a given size meter are:

Meter size (nominal)	**No of points**
4 inch & below	5
6 inch to 12 inch	8
16 inch and larger	12

A calibration curve for each product to be measured shall be established for each meter prior to placing the meter into service and after the meter is repaired. At any instance, if the meter fail test #1 per SAES-Y-103, then it shall be taken out of service till it is fixed. The calibration points shall be established at evenly spaced intervals beginning with a flow rate not to exceed 10% of the meter's maximum normal linear flow rate and ending at the meter's maximum operating flow rate.

For truck loading/ unloading meters, air fueling meters one calibration point (proving) is sufficient due to constant flow rate

7.2.2 The following are approved calibration methods:

a) In-line pipe proving

b) In-line master meter

c) Calibration using portable pipe prover/ small volume prover

d) Atmospheric portable Tank prover

The application of each method is per SAES-Y-103. For certain applications, the meter may be sent to a central proving facility for its calibration. The flow range of the central facility must satisfy the flow range of the meter.

7.3 Meter Proving

7.3.1 All liquid meters that are in service shall be proved in accordance with the suggested proving schedule stated below:

Metering Application	**Proving Intervals**
Batch Pipeline or marine cargo	every batch
Single hydrocarbon pipeline	every month
Marine vessel fueling	every year
Truck loading, unloading	every 4 months
Aircraft refueling, defueling & dispensing	every 4 months*

*Flow meters with less than 1 million liters per month of throughput may be proved (calibrated) every 6 months.

In location where:

- Proving is done by in-line Master Meter, the proving is preformed at least once every six months.
- A Transportable Prover is used, meters shall be proved at least once every six months.

Meters that are out of service or mothballed, shall be proved prior to returning to service. At any instance, if the meter fail test #1 per SAES-Y-103, then it shall be taken out of service till it is fixed.

7.3.2 Proving shall be done as close as possible within 10% of the normal operating flow rate.

7.3.3 In the truck loading/unloading application, the operating flow meter is proved before putting back to service. The resultant meter factor will be used until the next proving is conducted. The new meter factor should be compared with the previous meter factor. If the difference within 0.15%, the preset controller shall be updated with the new meter factor. If the difference exceeds the 0.15%, the meter will be taken out of service for check and repair, if required.

7.3.4 Dynamic slip test is required for aircraft refueling, defueling and dispensing flow meters. The meter factor (MF) at 20 % of meter maximum rated flow should not deviate than ± 0.15% from MF at normal flow rate.

7.4 Prover calibration

A prover shall also be recalibrated if:

1. Piping of calibrated section has been modified or worked on.
2. Flanges(s) of calibrated section have been disconnected.
3. Detector switches have been repaired or removed.
4. Evidence of prover volume change is seen
5. Design modifications affecting the prover volume are applied
6. The prover is relocated from its original site.
7. Calibration certificate expired in accordance with table below

The minimum frequency requirements for prover calibrations and methods by prover type are as follows:

Prover Type	**Calibration Method**	**Frequency**
Pipe prover	Water Draw	5 years
Pipe prover	Master Meter Method	3 years
Small Volume Prover	Water Draw	3 years
Tank Prover	Water Draw	3 years
Master Meter Prover	Displacement Prover/Tank Prover	6 months

For Approval Criteria for prover calibration result, refer to attachment II

Except for master meter provers, provers calibrations shall be performed/witnessed by a third party inspector. When a volumetric (displacement or tank) prover is calibrated using any of the approved methods, the new base volume from the previous calibration base volume shall not exceed ±0.05%. If the new volume exceeds this limit, an investigation shall be performed to determine the cause of this shift.

7.5 Temperature and Pressure Measurement

7.5.1 The temperature of the hydrocarbon liquids in the meter run shall be taken either from the temperature transmitter installed on the upstream header of the metering skid or from the transmitter installed on the individual meter run for computation. If an outlet header temperature transmitter is installed, it should be used for checking purposes only.

7.5.2 Temperature instruments shall be checked monthly against ASTM certified glass stem thermometer and calibrated, if they differ by more than 0.1 °C (0.2 °F). Thermometers whose mercury column is split shall "not be used for measurement and shall" be properly disposed.

7.5.3 The pressure of the hydrocarbon liquids in the meter run shall be taken either from the pressure transmitter installed on the upstream header of the metering skid or from the transmitter installed on the individual meter run for computation. If an outlet header pressure transmitter is installed, it should be used for checking purposes only.

7.5.4 Pressure instrument shall be checked quarterly (every 3 month) with a hand held precision pressure calibrator or a dead Weigh tester and calibrated if they differ by more than 10 kPa (2 psig).

7.5.5 The checking/ verification frequency stated above may be relaxed based on waiver by P&CSD/CMU if historical PM records supports performance stability. The Operating Organization must submit a request supported by historical data to CMU P&CSD/CMU approval.

7.6 Quality measurements

7.6.1 Sediment and Water Measurement shall be performed in accordance with the "Static Measurement Manual".

7.6.2 Except for LPG, density and Relative Density Determination shall be in accordance with API chapter 9. For LPG Relative Density Determination shall be in accordance with ASTM D2163 and ASTM D2598.

7.7 Sealing Requirements

The following items shall be sealed after each calibration:

7.7.1 Meters
Calibration or gear adjuster, temperature compensation, totalizer/printer head, head counter.

7.7.2 Instruments
Local or remote totalizer, electronic Preset/meter K factor knob if applicable.

7.7.3 Valves
Valves on lines that bypass a meter shall be sealed closed. Valves on lines that are not in normal use shall be blinded or sealed closed. Seals on connection valves between the metering system and custody transfer point shall be installed and inspected.

7.7.4 Prover

Seals are installed with unique identifiers on critical prover components (e.g., prover switches, tank prover neck scales, etc.) and to record the seal identification numbers on the prover calibration certificate.

7.7.5 Applicable sealing requirements shall apply to situations where the measurements are conducted by others (non-Aramco organizations) or contactors acting on Saudi Aramco or customer's behalf."

7.8 Sampling

7.8.1 Samples may be collected from the tanks before the liquid is transferred using the method described in the "Static Measurement Manual".

7.8.2 If samples are obtained from flowing stream in pipelines, sampling shall be per API Manual of Petroleum Measurement Standards, Chapter 8.1 - Manual Sampling of Petroleum and Petroleum Liquids and Chapter 8.2 - Automatic Sampling of Petroleum and Petroleum Liquids. This standard does not cover Liquefied Petroleum Gases (LPG) or liquids that are gases at ambient temperature and pressure (Reid vapor pressure above 110 kPa (16 psig). For sampling LPG, refer to ASTM D 1265, Sampling of Liquefied Petroleum Gases.

7.8.3 The automatic sampling system shall be checked during each transfer for the following:

- Sample containers are filling
- No leaks
- The grab rate set is correct and is applied
- Proper quantity of sample is being collected

8. TOLERANCES:

Ship/ shore reconciliation tolerances are covered in GI-405.008. For other applications, tolerances shall be based on contractual agreements. In case of deviation from these reconciliation tolerances, Operating Organization shall be responsible to investigate and resolve.

Approval authority of figures used to resolve these deviations shall be in accordance with the contractual agreement. If it is not covered in the contractual agreement, Operating Organization may seek the Accounting Department approval.

9. APPROVALS

RECOMMENDED BY:

_____ Date: _____
Manager, Process & Control Systems Department

CONCURRED:

_____ Date: _____
Vice President, Marketing Supply & JV Coord.

_____ Date: _____
Vice President, Southern Area Oil Operations

_____ Date: _____
Executive Director, Pipelines Dist & Terminals Ops

_____ Date: _____
Vice President, Refining & NGL Fractionation

_____ Date: _____
Manager, Marine Department

APPROVED BY:

_____ Date: _____
Vice President, Engineering Services

Attachment I (Analysis Considerations for Static Measurement)

The analysis in 6.1 above shall include the following items:

i. Capital cost for the complete system including installation and validation of the equipment and instruments. The capital costs shall include all required equipment, including, but not limited to:

   1. For ATG, including ATG to measure liquid level, temperature, and density and to be installed per API recommendations.
   2. Requirement of double block-and-bleed functionality on tank valves to verify that tanks are sealing the liquid.
   3. Installation of sufficient number of tanks to permit isolation of each tank for individual transfers and performance of measurement tasks. Those tasks such as settling (up to 24 hours) and performing T&I's without degraded measurement, sampling, installation and verification of seals on all connection valves between each tank and the custody transfer point(s). A tank should only be receiving or delivering liquid to a single recipient at a time. No "running gauge" is allowed.
   4. The number and size of tanks necessary to support operations shall be based on working volumes of tanks, not tank capacities (volume of contents).

ii. Operation and maintenance cost.
   The operating and maintenance costs shall include:
   1. Provisions for manpower for manual gauging of free water, manual sampling
   2. Installation and checking of seals on all connection valves between tank and custody transfer points
   3. Additional testing of samples associated with tank gauging
   4. Equipment calibrations and verifications, repair of connection valves, etc.

iii. The economic analysis shall account for costs associated with measurement inaccuracy over and above that of metering.

iv. International prices shall be used all assessments involving refined liquids.

v. Cost for continuous verification considering the level of automation of both systems and the necessary manpower.

vi. Other economical considerations that may seem necessary for the analysis.

Attachment II (Approval Criteria for prover/ MM calibration result)

Prover Type	Calibration Method	No of Runs		Acceptable Tolerance		Base Prover Volume / MF
Uni/Bi-Directional Conventional	Water Draw	2 at Normal Flow		±0.020%.		Average of the three runs
		1 at 25% Change to Normal Flow		±0.020%.		
Uni/Bi-Directional Conventional	Master Meter (MM)	Calibration set I	5 consecutive meter factors by Proving the MM with the master prover.	±0.020%.	CBV1	Average of CBV1, CBV2 and CBV3
			3 consecutive run volumes established by MM. Ave is CBV1	±0.020%.		
			5 consecutive meter factors shall be determined after the runs	±0.020%.		
		Change Flow by 25%				
		Calibration set II	5 consecutive meter factors by Proving the Master Meter with the master prover.	±0.020%.	CBV2	
			3 consecutive run volumes established by MM. Ave is CBV2	±0.020%.		
			5 consecutive meter factors shall be determined after the runs	±0.020%.		
		Change Flow by 25%				
		Calibration set III	5 consecutive meter factors by Proving the Master Meter with the master prover.	±0.020%.	CBV3	
			3 consecutive run volumes established by MM. Ave is CBV3	±0.020%.		
			5 consecutive meter factors shall be determined after the runs	±0.020%.		
Small Volume Prover	Water Draw	2 at Normal Flow		±0.020%.		Average of the three runs
		1 at 25% Change to Normal Flow		±0.020%.		
Tank Prover	Water Draw*	2 runs		±0.020%.		** see note below
		Adjust scale according to new volume				
		1 run		±0.010%.		
Master Meter Prover	Master Pipe Prover/ Tank prover	5 meter runs. MF shall be repeatable		±0.05%.		Ave of 5 runs

* For neck verification, follow steps in API chapter 4.9.2

** Following the adjustment of scale, if final calibration run is within 0.010% of the target volume (e.g., 500 gallons, 1000 gallons, etc.). In that case, the Base Prover Volume (BPV) is considered to be equal to the target volume. If no adjustments are made to scale, then Base Prover Volume (BPV) is the average value of three or more consecutive corrected volumes. The corrected volumes for three or more consecutive calibration runs shall agree within a range of 0.020%.