

MEASUREMENT DEFINITIONS

Until relatively recently, different terms for oil volumes were used on ship and ashore leading to confusion and built-in accounting discrepancies. The accurate determination of cargo quantities on board a vessel is extremely important for safety, commercial and legal reasons. Calculating ship/shore and shore/shore cargo differences is also very important. One of the biggest necessities in being able to effectively account for large volumes of oil within the industry is a uniform set of terms and definitions for oil measurement.

The following is a compilation of most of the standard measurement terms and definitions that should be used ashore and on oil tankers today

A

Accuracy - The ability of a measuring instrument to indicate values closely approximating the true value of the quantity measured.

Alternate Innage - See GAUGING

Alternate Ullage - See GAUGING

All Levels Sample - See SAMPLING

Ambient Temperature - The temperature of the surrounding medium such as the atmosphere.

API - The American Petroleum Institute, founded in 1919, was the first oil trade association to include all branches of the petroleum industry.

API Gravity (Relative Density) - A means used by the petroleum industry to express the density of petroleum liquids. API gravity is measured by a hydrometer instrument having a scale graduated in degrees API. The relation between API gravity and relative density (formerly called specific gravity) is:

$$\text{API Gravity at 60 Deg. F.} = \frac{141.5}{\text{Relative Density 60F/60F}} - 131.5$$

Automatic Sample - See SAMPLING

Automatic Sampler - A device used to extract a representative sample from the liquid flowing in a pipe. The automatic sampler generally consists of a probe, sample extractor, flow meter, controller, and sample receiver.

B

Barrel (BBL) - A unit of volume equal to 42 U.S. gallons or 9702.0 cubic inches.

Bottom Sample - See SAMPLING

C

Calibration - The process of adjusting, or of measuring the performance of a device.

Calibration Of An Instrument - The process or procedure of adjusting an instrument, such as a meter or an electronic thermometer, so that its indication or registration is in satisfactorily close agreement with a reference standard.

Calibration Of A Container - The process or procedure of determining the exact volume capacity or partial capacities of a standard capacity measure, a tank prover or a pipe prover.

Calibration Tables (Gauge Or Tank Tables, Innage/ Ullage Tables) Tables developed by recognized industry methods that represent volumes in each tank according to the liquid (innage) or empty space (ullage) measured in the tank. The tables are entered with linear measurements (for example, feet, inches, meters, centimeters) to obtain calibrated volumes (for example, barrels, cubic meters or cubic feet).

Capacity - The volume of a container or tank filled to a specified level.

Cargo Quantity Option Certificate - A certificate signed by vessel and shore representatives acknowledging the amount of cargo intended to load.

Clingage - The residue that adheres to the inside surface of a container, such as a ship's tank or shore tank, after it has been emptied.

Closed Gauging System - A method of obtaining measurements of the tank contents without opening the tank. This may be accomplished by using automatic tank gauges or by taking measurements through a pressure/vapor lock standpipe. This type of gauging is done extensively on vessels with inert gas systems.

Closed System Gauging Unit - Closed gauging system measurement equipment specially designed to be used with a specific type of standpipe/vapor lock. The unit may have a single purpose such as taking temperature, ullages, watercuts or samples, or may be a combined unit capable of performing all necessary measurement functions.

Coalescer - A device used to cause the separation and removal of one liquid from another such as water from a petroleum liquid.

Composite Meter Factor - See METER FACTOR

Composite Sample - A sample made up of equal portions of two or more spot samples obtained from a tank or pipeline.

Critical Zone - A term used to define the liquid level in a floating roof type storage tank from the point where floating of the roof begins to the point where the roof is fully floating. Sometimes known as the "inaccurate zone" or "partially floating region." The critical zone is identified on tank calibration tables where appropriate.

Cup Case - A holder for a mercury-in-glass thermometer incorporating a small metal container in which the bulb of the thermometer is inserted, and which serves to contain a small volume of the liquid.

Custody Transfer Measurement - A measurement which furnishes quantity and quality information which can be used as the basis for a change in ownership and/or a change in responsibility for materials.

Cut - The oil level on the tape or bob or the water level marking on a tape or bob coated with water indicating paste. "Taking a cut" is taking a measurement of the oil or water level.

Crude Oil Washing (COW) - See TANK WASHING

D

Datum Plate - A level metal plate located directly under the reference gauge point to provide a fixed contact surface from which liquid depth measurement can be made.

Datum Point - The point from which all measurements for the calibration of the tank are related.

Deadwood - Any tank fitting, appurtenance or structural member which affects the capacity of the tank. Deadwood is positive if it increases tank capacity or negative if it decreases capacity.

Density - The density of a homogeneous substance is the ratio of its mass to its volume. The density varies as the temperature changes and it is usually expressed as the mass per unit volume at a specified temperature.

Absolute Density - The mass of a substance per unit volume at a specified temperature.

Relative Density - The ratio of the mass of a given volume of fluid to the mass of an equal volume of pure water at the same temperature and pressure. Relative density replaces the term "specific gravity".

Relative Density At 60° - Fluid relative density measured against water with both materials at 60 degrees F and reference pressure of 14.696 psia (or equilibrium pressure). Equivalent to "RD 60/60".

Deviation - Any departure from a true value.

Dip - A term used to designate either the depth of liquid in a storage tank or the taking of the measurements of such liquid level. (See GAUGING)

E

Emulsion - An oil/water mixture that does not readily separate.

F

Flow Proportional Sample - See SAMPLING

Free Water (FW) - The water present in a container that is not in suspension in the contained liquid (oil).

G

Gauge Hatch - The opening in the top of a tank through which gauging and sampling operations are carried out.

Gauge Point - See Reference Point

Gauge Table - See Calibration Table

Gauging - A process of measuring height of a liquid in a storage tank usually using a weighted graduated steel tape and bob. See OPEN GAUGING SYSTEM and CLOSED GAUGING SYSTEM.

Alternate Innage Gauge - The innage obtained by subtracting the measured distance between the surface of the liquid in the tank and the reference point from the official reference height of the tank.

Alternate Ullage Gauge - The ullage obtained by subtracting the measured height of the liquid in the tank from the official reference height of the tank.

Innage Gauge (Dip, Sounding) - The height of the liquid surface from the bottom of the tank (or datum plate).

Swing Gauge - See Alternate Innage

Ullage (Outage) Gauge - The distance from the liquid surface to the top of the tank (or reference point).

Gross Observed Volume (GOV) - See Volume

Gross Standard Volume (GSV) - See Volume

Gross Standard Weight (GSW) - The total weight of all petroleum liquids and sediment and water (if any), excluding free water, determined by applying the appropriate weight conversion factors to the gross standard volume.

I

Independent Inspector (Surveyor) - See Inspector

Indicated Volume - See Volume

Innage Gauge - See Gauging

Inspector - A person assigned to determine the quantity and/or the quality of a commodity.

Company Inspector - A Company employee given the responsibility of determining the quantity and/or the quality of a volume of oil being moved or stored.

Independent Inspector (Surveyor) - A person or organization of persons, acting independently, but on behalf of, one or more parties involved in the transfer, storage, inventory or analysis of a commodity

for purposes of determining the quantity, and/or quality of a commodity. They may also be assigned to the calibration of various measurement instruments and/or storage tanks ashore or on vessels.

L

List Or Heel - The leaning or inclination of a vessel expressed in degrees port or starboard.

List (Heel) Correction - The correction applied to the observed gauge or observed volume when a vessel is listing, provided that liquid is in contact with all bulkheads in the tank. Correction for list may be made by reference to the vessel's list correction tables for each tank or by mathematical calculations.

M

Marine Custody Transfer (MCT) - A custody transfer activity involving marine tank vessel(s). Loading, discharging or lightering a ship or barge is a marine custody transfer.

Marine Custody Transfer Measurement (MCTM) - The measurement activity involving a marine custody transfer (MCT).

Meter - A device used to measure fluid flow.

Custody Transfer Meter - A meter designed, installed, and operated to meet the requirements for custody transfer measurement. Within most companies, this refers to any meter used to account for fluids purchased, sold, or custody transferred to or from any facility where a change in ownership and/or responsibility for materials occurs.

Displacement Meter - A meter in which the measuring element measures a volume of liquid mechanically separating the liquid into discrete quantities of fixed volume and by counting the quantities in volume units.

Turbine Meter - A meter in which the measuring element is a multiblade rotor that rotates with a velocity proportional to the mean velocity of the fluid stream. Measured volume is registered by counting the rotor revolutions.

Meter Factor (MF) - A ratio of the corrected prover volume to the corrected meter volume. For subsequent metering operations, the actual throughput is determined by multiplying the indicated volume registered by the meter by the meter factor.

Composite Meter Factor (CMF) - A meter factor used for meter applications where the gravity, temperature, and pressure remain constant during the ticket period.

Meter Accuracy - A ratio of the volume registered by the meter to the actual prover volume. The meter accuracy is the reciprocal of the meter factor.

Meter Factor Forward Method - A documentation method in which the meter factor obtained from a periodic meter proving is used to measure custody transfer movements until the next meter proving.

Meter Factor Retroactive Method - A documentation method in which the meter factor obtained from a periodic meter proving is used to measure custody transfer movements between the previous meter proving and the current meter proving.

Meter Performance - A general expression used to describe the relationship between the volume registered by a meter and the actual volume that passed through the meter. Meter performance can refer to meter measurement errors, meter factor, meter accuracy, or other criteria.

Meter Proving - The procedure required to determine the relationship between the true volume of liquid measured by a meter and the indicated meter volume.

N

NBS - National Bureau of Standards. (Renamed in 1989 - see NIST)

Net Standard Volume (NSV) - See VOLUMES

Net Standard Weight (NSW) - The total weight of all petroleum liquids, excluding sediment and water and free water, determined by deducting the S&W weight from the Gross Standard Weight (GSW).

NIST - National Institute of Standards and Technology. Formerly the National Bureau of Standards (NBS).

Notice Of Apparent Discrepancy - See LETTER OF PROTEST

O

Observed Reference Height - The distance actually measured from the tank bottom or datum plate to the established reference point.

Off-Specification Product/Cargo - Refined products or other cargo that does not meet normal quality requirements and therefore require special handling and restraints to assure separation from specification products/cargo.

Official Numbers (Volumes) - Those values which are used to determine the Marine Custody Transfer volumes. Such values would be those volumes reported on the Bill of Lading, certificate of shore receipts, vessel ullage reports, and quality analysis reports. The actual numbers to be used as well as the method of obtaining them are usually detailed in an appropriate marine custody transfer contract.

On Board Quantity (OBQ) - See VOLUME

Open Gauging Method - This is a method of obtaining measurements of the tank contents through an open gauge hatch. This is the traditional method of performing static measurements.

P

Pour Point - The lowest temperature at which oil will remain liquid.

Pressure - The amount of force exerted on a unit of area by a fluid.

Absolute Pressure - The pressure referenced to a perfect vacuum as zero pounds per square inch absolute.

Atmospheric Pressure - The pressure exerted by the atmosphere. Although this pressure varies with altitude, barometric pressure and humidity, the atmospheric pressure can be defined in custody transfer contracts, or by state and federal authorities. Atmospheric pressure is most often stated as 14.696 pounds per square inch absolute.

Back Pressure - The operating pressure level measured upstream from a control valve.

Gauge Pressure - That pressure measured relative to atmospheric pressure as zero, usually designated psig.

High Vapor Pressure - A fluid which, at the measurement or proving temperature, has a vapor pressure that is equal to or higher than atmospheric pressure.

Low Vapor Pressure - A fluid which, at the measurement or proving temperature, has a vapor pressure that is less than atmospheric pressure.

Reid Vapor Pressure - The vapor pressure of a fluid at 100 degrees Fahrenheit as determined by test method ASTM D 323-58.

Static Pressure - The pressure in a fluid that is exerted normal to the surface. In a moving fluid, the static pressure is measured at right angles to the direction of flow.

Pressure/Vapor Lock System Or Unit - See STANDPIPE

R

Reference Height - The distance from the tank bottom and/or datum plate to the established reference point or mark.

Reference Point (Gauge Point) - The point from which the reference height is determined and from which the ullages/innages are taken.

Relative Density - See DENSITY

Remaining On Board (ROB) - See VOLUME

Repeatability - The closeness of the agreement between the results of successive measurements of the same quantity carried out by the same method, by the same person, with the same measuring instrument/equipment at the same location, over a short period of time. Specifically it would be the ability of a meter and prover system to repeat its registered volume during a series of consecutive proving runs under stable operating conditions or a gauger getting the same gauge three times in succession.

Representative Sample - A small portion extracted from the total volume of material that contains the same proportions of the various flowing constituents as the total volume of liquid being transferred. The precision of extraction must be equal to or better than the method used to analyze the sample. See SAMPLING.

Reproducibility - The closeness of the agreement between the results of measurements of the same quantity where the individual measurements are made by different methods, with different equipment, by different observers, at different locations after a long period of time; or where only some of the factors are different. Specifically it is the ability of a different set of meters or different gauger using different equipment to measure a volume and arrive at the same volumes as the first meter or gauger.

Running Sample - See SAMPLING

S

Sampling - The process of obtaining a sample of the material in the tank, container or pipeline to use for testing or other purposes. This can be achieved by automatic or manual means. See Representative Sample. The following are the most common types of samples taken:

All-Levels Sample - A sample obtained by lowering a weighted, stoppered bottle or beaker or bottle to a point 1 foot (0.3 meter) above the free water level and then, with a sharp jerk of the line opening the sampler and raising it at a rate that it is about 75% full (a maximum of 85% full) as it emerges from the liquid.

Automatic Sample - A sample taken by automatic means. The two basic types of automatic samples are:

Flow-Proportional Sample - A sample taken by an automatic sampler from a pipeline at a rate that is proportional to the liquid flow rate.

Time-Proportional Sample - A sample taken from a pipeline at regular intervals during a batch transfer period.

Bottom Sample - A spot sample taken from the material at the bottom of the tank.

Lower Sample - A spot sample obtained at the midpoint of the lower third of the tank contents.

Middle Sample - A spot sample obtained at the midpoint of the middle of the tank contents.

Running Sample - A sample obtained by submerging an unstoppered beaker or bottle from the surface of the liquid to a point as near as possible to the shore tank draw off point or about one foot above the level of the free water in a ship tank, and then raising it without letting it rest, at a rate so that it will be about 75% full as it emerges from the liquid.

Spot Sample - A sample taken at a specific spot within a tank using a stoppered bottle or beaker and

lowering it to the level of desired sample then opening it and allowing it to remain at that level until full. A thief or a zone sampler may also be used to obtain spot samples.

Tap Sample - A sample taken from a valve or connection on a tank or pipeline.

Upper Sample - A spot sample obtained at the midpoint of the upper of the tank contents.

Upper, Middle, Lower Samples - Spot samples taken from the upper third, the middle and lower thirds of the liquid in the tank. The samples so taken may then be composited or analyzed separately.

Sample Container - A receptacle used for crude oil or product sample storage and/or transport.

Type I Sample Container - A portable sample container used with a centrally located circulation-type sample mixing system. A Jiskoot sample container is an example of a Type I sample container.

Type II Sample Container - A portable sample container such as bottles and cans are considered Type II sample containers. The contents must be shaken by hand or mixed by mechanical agitation.

Sample Grab - The liquid volume taken from the pipeline by a single actuation of the sample extractor.

Sample Handling - The extraction, transport, mixing, and transfer of the representative sample from the pipeline to analytical glassware or centrifuge tubes.

Sample Preheater - A device used to heat samples before S&W or API gravity or related density tests are performed.

Sample Receiver (Receptacle) - A receptacle that is usually part of an automatic sample system to contain the collected sample.

Sediment And Water (S&W) - The nonhydrocarbon solid material and water in suspension in a petroleum liquid.

SI - International System of Units.

Slops - Oil, oil/water/sediment, and emulsions contained in slop tanks or designated cargo tanks. The mixture usually results from tank stripping, tank washing, or dirty ballast phase separation.

Sludge - A highly viscous mixture of oil, water, sediment, and residue.

Sounding - See GAUGING

Standpipe - The vessel's deck fitting through which closed system measurements are taken. It contains the necessary valves and fittings to allow the closed system measurement unit to be lowered into an inerted, pressurized, vessel tank to take the required measurements. It is also referred to as a pressure or vapor lock system.

Stationary Sample Receiver - See SAMPLE RECEIVER

Stop Gauge - The final gauge reading for a transfer to or from a shore tank or vessel.

T

Tank Capacity Table - See CALIBRATION TABLE

Tank Washing - The cleaning of a vessel's tanks. It is divided into two types of activities:

Water Washing - The use of a high-pressure water stream to dislodge clingage and sediment from the bulkheads, bottom, and internal tank structures of a vessel.

Crude Oil Washing - The use of a high-pressure stream of the crude oil cargo to dislodge or dissolve clingage and sediment from the bulkheads, bottom, and internal tank structures of a vessel during the discharge operation.

NOTE: Regulatory agencies require that a vessel's tanks be inerted before this tank cleaning method is used.

Total Calculated Volume (TCV) - See VOLUME

Total Observed Volume (TOV) - See VOLUME

Trim - The condition of a vessel with reference to its longitudinal position in the water. It is the difference between forward and aft drafts and is expressed as vessel being "by the head" or "by the stern."

Trim Correction - The correction applied to the observed gauge or observed volume in a vessel's tank when a vessel is not on an even keel provided that the liquid is in contact with all bulkheads in the tank. Correction for trim may be made by referencing trim tables for each tank or by mathematical calculation.

U

Ullage Gauge (OUTAGE) - See GAUGING

V

Verification - Periodic or routine performance checks that ensure that operational requirements continue to be met. Verification can be accomplished by comparing information from two or more devices sensing a given variable. An examples would be a master thermometer compared to a temperature transmitter output.

Vessel Experience Factor (VEF) - A compilation of the history of the total calculated volume (TCV) vessel measurements, adjusted for on-board quantity (OBQ) or remaining on board (ROB), compared with the TCV shore measurements.

Volume - The amount of space occupied by a fluid at certain conditions of temperature and pressure. Various types of VOLUMES used in marine custody transfer are defined as follows:

Gross Observed Volume (GOV) - The total volume of all petroleum liquids and sediment and water, excluding free water, at observed temperature and pressure.

Gross Standard Volume (GSV) - The total volume of all petroleum liquids and sediment and water, excluding free water, corrected by the appropriate volume correction factor (CtI) for the observed temperature and API gravity, relative density, or density to a standard temperature such as 60°F or 15°C and also corrected by the applicable pressure correction factor (CpI) and meter factor.

Indicated Volume - The change in meter reading that occurs during a receipt or delivery.

Net Standard Volume (NSV) - The total volume of all petroleum liquids, excluding sediment and water and free water, corrected by the appropriate volume correction factor (CtI) for the observed temperature and API Gravity, relative density, or density to a standard temperature such as 60°F or 15°C and also corrected by the applicable pressure correction factor (CpI) and meter factor.

On Board Quantity (OBQ) - The material remaining in vessel tanks, void spaces, and/or pipelines prior to loading. On-board quantity includes water, oil, slops, oil residue, oil/water emulsions, sludge, and sediment.

Remaining On Board (ROB) - The material remaining in vessel tanks, void spaces, and/or pipelines after discharge. Remaining on board quantity includes water, oil, slops, oil residue, oil/water emulsions, sludge, and sediment.

Total Calculated Volume (TCV) - The total volume of all petroleum liquids and sediment and water, corrected by the appropriate volume correction factor (CtI) for the observed temperature and API gravity, relative density, or density to a standard temperature such as 60°F or 15°C and also corrected by the applicable pressure factor (CpI) and meter factor, and all free water measured at observed temperature and pressure (gross standard volume plus free water).

Total Observed Volume (TOV) - The total measured volume of all petroleum liquids, sediment and water, and free water at observed temperature and pressure.

NOTE: Where the term 60°F or 15°C is used, it is referring to two different reference standards and does indicate that the two temperatures are equal.

