API Manual of Petroleum Measurement Standards
Chapter 17.12

EI Hydrocarbon Management

HM 51

Procedures for bulk liquid chemical cargo inspections

3rd Edition, XXXX 2022

API MPMS CHAPTER 17.12/EI HM 51
PROCEDURES FOR BULK LIQUID CHEMICAL CARGO INSPECTIONS

3rd Edition

XXXX 2022

Published jointly by

API
and
ENERGY INSTITUTE, LONDON
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1 SCOPE

1.1 GENERAL

This document provides cargo measurement procedures for Chemicals for use primarily by inspectors and specifies procedures directed at minimizing cargo contamination and losses. In the absence of, or in conjunction with, specific instructions from principal(s), this document should be considered a summary of good practice used within the industry.

Where the term 'measurement' is used in a general sense, it should be taken to include all aspects of cargo inspection including (but not limited to) tank inspection/assessment, sampling, laboratory analysis and testing and other superintending activities, as required by the inspector's principals.

The points at which inspectors are required to make their measurements are described and definitions of the terms used throughout this document are provided in section 3. Where possible terms approved by API, EI and ISO/TC28 have been adopted.

The document also considers the purpose of a cargo survey and summarizes the responsibilities of those involved. These procedures may become contractual if reference to them is made in either a nomination or acknowledgement.

Safety matters and related responsibilities are defined, and emphasis is placed on the need for inspectors to be continually conscious that safety requirements take precedence over all other considerations.

The document describes the procedures which inspectors should follow and provides references to analytical test methods and calculations. Reference is made to alternative methods since it is recognized that opinions may vary regarding the use of test methods, and that different methods may be specified by the parties involved.

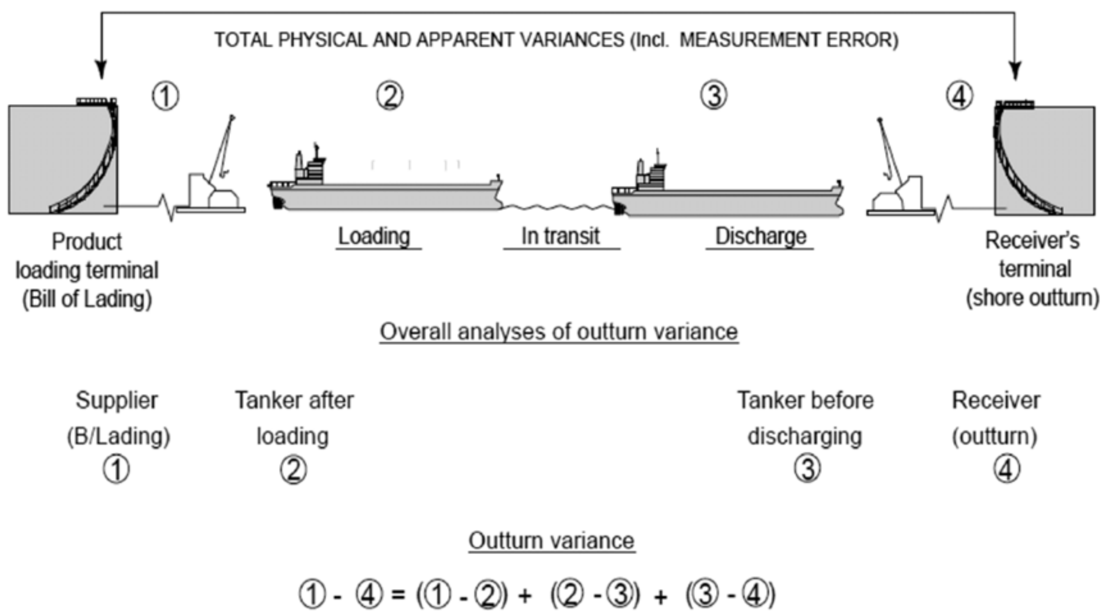
1.2 MEASUREMENT STAGES

When a cargo is transported by vessel from one shore terminal to another, measurements are normally made at four locations, as shown in Figure 1 for the purpose of establishing:

(a) the quantity of cargo delivered (i.e., to confirm the quantity of cargo shown on the Bill of Lading);
(b) the quantity of cargo loaded to the vessel;
(c) the quantity of cargo discharged by the vessel;
(d) the quantity of cargo received by the receiving terminal, and
(e) the difference between the quantities established under (a) to (d) above.

NOTE 1 For a particular voyage involving more than one loading port or discharge port, measurements should be made at all such additional ports in order that a reliable comparison can be made between the cumulative quantities shown on the Bill of Lading, outturn and ship's figures.

NOTE 2 For ship to ship (STS) transfer operations please refer to Annex D.



Shore to shore difference, (4-1) = (2-1) + (3-2) + (4-3)
Note: by convention, losses have a negative sign

Figure 1: Marine transfer measurement points

1.3 QUALITY CONTROL

It is recognized that contamination may occur during the various transfer and transportation stages of cargo movement.

Procedures and recommendations for a sampling and testing schedule are given which should identify potential problems at the earliest opportunity.

1.4 SUMMARY OF DATA TO BE REPORTED

It is recognized that cargo inspection companies and their principal(s) each have their preferred way of recording the data to be reported, particular forms; therefore, they are not prescribed by this procedure. However, for information, a listing of the typical information sufficient to define a cargo loading or discharge operation is provided in section 9. This listing represents a consensus of several cargo inspection companies and their principal(s). The detailed format of these forms should be agreed with principal(s) when contracts are being arranged.

2 NORMATIVE REFERENCES

The following referenced documents are indispensable for the application of thisdocument. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API *MPMS* Chapter 17.9 / EI HM 49, *Vessel Experience Factor (VEF)*

3 TERMS AND DEFINITIONS

The terms used in this document are defined in this section. A complete set of currentterms and definitions can be found in EI HM 0 *Hydrocarbon management terms and definitions* or the API *MPMS* Chapter 1, *Online Terms and Definitions Database.*

3.1 ACCURACY

The closeness of agreement between a measured quantity value and a true quantity value of a measurand.

3.2 BALLAST

Water taken onboard when a vessel is empty or partly loaded/discharged to increase draft to properly submerge the propeller and maintain stability and trim.

3.3 CAPACITY TABLE, TANK

Table showing the liquid volume capacities, on an innage or ullage (outage) basis, and the corresponding vapor space capacities, in a tank, tank car or vessel compartment, at various liquid levels, which are measured at the reference gauge point: from the datum up to the liquid surface level for innage gauges; or, from the reference gauge point down to the liquid surface level for ullage (outage) gauges.

3.4 CRITICAL ZONE

The vertical range, marked on the tank capacity table, between the point where a floating roof is resting on its normal supports and the point where the roof is freely floating.

3.5 DENSITY

The mass of a substance per unit of volume at a specified temperature and pressure.

3.6 DENSITY, RELATIVE

The ratio of the mass of a given volume of liquid at a specific temperature to the mass of an equal volume of pure water at the same or different temperature. Both reference temperatures shall be explicitly stated.

3.7 DIP (INNAGE)

Taking an innage reading or the depth of liquid in a storage tank.

3.8 DRAFT

The depth of a vessel below the water line measured from the surface of the water to the bottom of the vessel's keel.

3.9 DRAFT MARKS

The vertical column of numbers on each side of the vessel at each end and amidships to indicate the distance from the lower edge of each number to the bottom of the keel.

3.10 DISPLACER (TANK GAUGING)

Surface-detecting element which is suspended from a level gauge and moves in a vertical direction to follow the change in liquid level.

3.11 FLOATING COVER

A lightweight covering of either metal or plastic material designed to float on the surface of the liquid in a tank. Alternatively, a floating cover may be supported by a float system so that it is just above the free-liquid surface. The device is used to minimize the evaporation of volatile products in a container.

3.12 FLOATING ROOF TANK

A tank in which either an external or an internal roof floats freely on the surface of the liquid contents except at low levels when the weight of the roof is transmitted by its supporting legs to the tank bottom.

3.13 METER

A meter is the assembly of a primary element, a differential producer holder with the upstream and downstream meter tubes that will generate a differential pressure when placed in a flow stream. The differential pressure is monitored by secondary device(s) to derive the flow rate.

3.14 TANK GAUGING

A process for determining the height of liquid in a tank or container by measuring the vertical distance from the bottom or fixed datum up to the liquid surface level when using innage gauging, or by measuring the vertical distance from the gauge reference point down to the liquid surface level when using ullage (outage) gauging.

3.15 INERT GAS

A gas that does not undergo an undesired chemical or physical reaction under a set of given conditions.

3.16 INHIBITORS

Compound (usually organic) that retards, controls, or stops an undesired chemical reaction, such as corrosion, oxidation, or polymerization.

3.17 LIST (HEEL)

(a) The leaning or inclination of a vessel, expressed in degrees port or degrees starboard;
(b) The transverse deviation of a vessel from the upright position, expressed in degrees.

3.18 MASS

An absolute measure of a particular quantity of matter. Mass is defined in terms of a standard mass, and therefore the mass of an object is simply a multiple of the mass standard. The mass of an object remains constant regardless of its location. The metric unit of mass is kilogram (kg).

3.19 MEASUREMENT

Process of experimentally obtaining one or more quantity values that can reasonably be attributed to a quantity.

3.20 METER FACTOR
MF

A factor used to correct the indicated volume (IV) of the meter at operating conditions to the gross volume (GV) of the meter at operating conditions.

3.21 METER FACTOR 2

Ratio of the K-factor obtained on proving a meter to the original or nominal (maker's figure) K-factor.

NOTE Flow computers may use the original K-factor and then apply a meter factor to calculate measured volumes. Alternatively, a new K-factor may be used in the calculation and no meter factor applied.

3.22 METERING OR MEASUREMENT SYSTEM
A combination of primary, secondary, and/or tertiary measurement components necessary to determine the flow rate.

3.23 ON BOARD QUANTITY
OBQ

Refers to materials present in a vessel's cargo tanks, void spaces, and/or pipelines before the vessel is loaded. Onboard quantity includes a combination of water, oil, slops, oil residue, oil/water emulsion, sludge, and sediment.

3.24 OUTTURN

Quantity of a cargo, as measured by the receiving terminal or facility.

3.25 PORTABLE MEASUREMENT UNIT
PMU

Intrinsically-safe device used in conjunction with a vapor control valve to obtain required liquid level and/or temperatures under closed or restricted system conditions.

3.26 REFERENCE GAUGE HEIGHT

The vertical distance, noted on the tank capacity table and stenciled on the tank near the hatch, between the reference gauge point on the gauge hatch and the datum strike point on the tank floor or the gauge datum plate.

3.27 REPRESENTATIVE SAMPLE

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

3.28 RESTRICTED GAUGING

Process of taking measurements within a tank using equipment which is designed to reduce substantially or minimize the vapor losses that would occur during open gauging, but where the equipment is not completely gas-tight.

3.29 SAMPLING

All the steps required to obtain a sample that is representative of the contents of any pipe, tank, or other vessel, based on established error, and to place that sample into a container from which a representative test specimen can be taken for analysis.

3.30 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.

3.31 SOUNDING

See 3.7 DIP

3.32 SPOT SAMPLE

A sample taken at a specific location in a tank or from a flowing stream in a pipe at a specific time.

3.33 STRIPPING

Removal of the final contents of a cargo tank using equipment additional to the main cargo pumps.

3.34 TAPE

Graduated or non-graduated metal ribbon or wire.

3.35 TRIM

Refers to the condition of a vessel in terms of its longitudinal position in the water. Trim is the difference between the forward draft and the aft draft and is expressed by the head or by the stern to indicate the end of the vessel that is deeper in the water.

3.36 TRIM CORRECTION

The correction applied to the volumes or gauge observed in a vessel's tank when the vessel is out of trim, provided that the liquid is in contact with all bulkheads in the tank. Trim correction may be accomplished by referring to the trim correction tables for each of the vessel's tank or by mathematical calculation.

3.37 ULLAGE (OUTAGE) VOLUME

The volume of available space in a tank or container unoccupied by liquid contents.

3.38 ULLAGE (OUTAGE) GAUGE

The vertical distance from the reference gauge point downward to the liquid surface in a tank.

3.39 VESSEL EXPERIENCE FACTOR
VEF

A compilation of the history of the total calculated volume (TCV) vessel measurements, adjusted for onboard quantity (OBQ) or remaining onboard (ROB), to the TCV shore measurements. Separate VEFs should be developed for both load and discharge terminals. Preferably, information used in calculating a VEF should be based on documents that follow accepted industry standards and practices, such as inspection company reports.

3.40 VOLUME CORRECTION FACTOR
VCF

The ratio of the density of a liquid at a given temperature and pressure to its density at a reference temperature and pressure.

3.41 GROSS OBSERVED VOLUME
GOV

The total observed volume (TOV) of all petroleum or chemical liquids and sediment and water (S&W), excluding free water (FW), at observed temperature and pressure.

3.42 GROSS STANDARD VOLUME
GSV

The gross volume (GV) or gross observed volume (GOV) corrected to base temperature and pressure conditions.

3.43 NET STANDARD VOLUME
NSV

The gross standard volume (GSV) corrected to exclude non-merchantable components such as sediment and water (S&W).

3.44 TOTAL CALCULATED VOLUME
TCV

The gross standard volume (GSV) plus the free water (FW).

3.45 FREE WATER
FW

Water that exists as a separate phase.

3.46 WATER CUT

The volume percentage of water in a combined hydrocarbon and water stream.

3.47 WEDGE FORMULA

A mathematical formula, for approximating the small quantities of liquid and solid cargo and free water on board before a vessel is loaded and after its cargo is discharged, that is based on cargo compartment dimensions and vessel trim, and that is applicable only when a wedge exists and when the liquid does not touch all bulkheads of the vessel's tank.

4 SAFETY RECOMMENDATIONS

4.1 GENERAL

This section makes reference to a wide range of recommendations and requirements designed to enable inspectors to perform their duties in a safe manner. Operating conditions are often beyond the control of the attending inspector. If any aspect of the operation is considered unsafe, a stop work authority shall be adopted.

Particular attention is drawn to the International Safety Guide for Oil Tankers and Terminals (ISGOTT), Safety of Life at Sea (SOLAS), Oil Companies International Marine Forum (OCIMF), Energy Institute Safety study on electrical equipment publications, and any relevant API publications should be consulted for applicable safety precautions. The precautions given in this section should be taken whenever they do not conflict with local or national regulations which should, in any event, always be followed.

Careful consideration should be given to the nature and known hazards of the material being handled. Personnel should be made aware of the potential hazards and be given instructions in safety precautions to be observed which are detailed in safety data sheets and risk assessments.

All regulations covering entry into hazardous areas shall be observed.

Particular care should be taken when accessing vessels and shore tanks.

Suitable personal protective equipment shall be used to provide protection against all known hazards associated with the operations.

4.2 SAFETY ASPECTS OF EQUIPMENT

The inspector should use equipment which complies with all applicable safety codes. Portable equipment such as mobile phones, tablets, and computers, should not be operated exceptin designated areas.

All portable test apparatus, lamps, flashlights, and other equipment such as portable electronic temperature devices (PET) or portable electronic gauging devices (PEGD) should be intrinsically safe and of an approved type suitable for the electrical classification of the area and, where required by the legislator, should carry a valid safety certificate. The changing of batteries should only be done in a non-hazardous area.

Sample receivers and containers should be designed to meet the requirements of the cargo being sampled. Cleaning and leak testing as appropriate for sample containers should be performed at regular intervals.

All sampling and measurement equipment used should be effectively bonded and securely earthed to the structure of the ship (or shore tank) before it is introduced into the tank and should remain earthed until after it has been removed from the tank. Sample cords used for lowering sampling equipment should be electrically conductive and should not be made from man-made or synthetic fibers. Natural fibers such as manila, cotton, or sisal should be used.

Sample containers should be carefully handled to prevent accidental leakage and should be carried in such a manner that they cannot be inadvertently dropped. Sample containers should be protected during transit by the use of boxes, carrying frames, or special baskets. This applies to both filled and empty sample containers. Samples shall be carried in such a way that personnel have one hand free at all times when using gangways, ladders, or stairs.

4.3 SAFETY AT SAMPLING POINTS

Sampling points should be provided which enable samples to be taken in a safe manner.

It is the terminal and/or the vessel's responsibility to ensure that safe access ladders, stairways, platforms, and handrails are adequately lit and have been maintained in a structurally safe and clean condition (i.e., free of cargo residues to prevent slipping hazards).

Adequate and safe containment for all draining and flushing requirements should be provided by vessel(s) and/or the terminal.

Any spillages or defects in equipment should be reported immediately.

All equipment and materials used by the inspector, especially waste or rags, should be removed on completion of the operation. Rags containing oil or chemical products are liable to spontaneously combust.

Floating-roof tanks should be sampled from the top platform. The space above a floating roof constitutes a confined space. Under certain conditions toxic and flammable vapors may accumulate above the roof. The following are some of the conditions which may render the atmosphere above the roof hazardous:

- the roof is not fully floating, and
- the roof seal is faulty.

In exceptional circumstances when a Permit To Work (PTW) has been granted for anyone to access the floating roof to take samples, refer to section 4.6

NOTE It is strongly recommended that no operations are performed on the floating roof.

4.4 STATIC ELECTRICITY

All gauging / sampling equipment should be grounded / earthed prior to use.

Some cargoes have a tendency to accumulate a static charge during the loading or discharge process and need a relaxation time for the charge to dissipate before measurement equipment can be safely introduced into the tank. In addition, static inhibitors may be added to some cargoes to reduce the risk of static charge. To determine which cargoes are accumulators and for special considerations to be taken during the measurement and sampling of them, refer to ISGOTT and the cargo's SDS for full details.

If the tank is in a non-inert condition, specific precautions will be required with regard to safe measurement and sampling procedures when handling static accumulator cargoes. Equipment for gauging or sampling shall not be introduced into or remain in the tank within 30 minutes, subject to local requirements, after the completion of operations.

Measurement and sampling should not be carried out during lightning or hailstorms.

4.5 HEALTH HAZARDS

Chemical vapor dilutes oxygen in the air and may also be toxic. Chemical vapors may cause unconsciousness or death. During and after the opening of a vapor control valve (VCV), personnel should position themselves to minimize exposure to any gas which may be released. Harmful vapors or oxygen deficiency cannot always be detected by smell, visual inspection, or judgement. Appropriate precautions should be used for the protection against toxic vapors or oxygen deficiency. It is recommended that users always wear gas monitors relevant to the operation. Alarm limits should be set as determined by the relevant national authority or as referred in ISGOTT.

Procedures should be developed to provide for the following:

- exposure monitoring;
- selection of appropriate personal protective equipment
- personnel level to be determined by risk assessment, and
- emergency rescue plan.

When necessary, and subject to a risk assessment / PTW, suitable breathing equipment should be worn prior to entering the gauge site and during the gauging and sampling procedure.

This discussion on safety issues is not exhaustive and the appropriate API or EI publications, together with the ISGOTT, Safety of Life at Sea (SOLAS), and Oil Companies International Marine Forum (OCIMF) publications should be consulted for applicable safety precautions.

4.6 ENTRY INTO CONFINED SPACES

It is the responsibility of vessel(s) and terminal personnel to identify confined spaces and to establish procedures for safe entry. Pump rooms, deck tunnels, cargo tanks, cofferdams, double bottom tanks, shore tanks, floating roofs or any confined space may be subject to oxygen deficiency as well as the presence of hydrocarbon or toxic gas.

Inspectors shall consult the responsible vessel officer or terminal operator to determine whether entry into such confined spaces is permitted and shall be supervised and accompanied by a representative of the vessel and/or the terminal, as appropriate, at all times.

Suitable notices should be prominently displayed to inform personnel of the precautions to be taken when entering tanks or other confined spaces and of any restrictions placed upon the work permitted there.

Extra care should be taken when moving around inside tanks as surfaces may be slippery and lighting may be poor.

Entry into enclosed spaces and tanks shall only commence on the production of a valid permit issued by responsible Terminal or Vessel personnel. The entry permit should confirm that the atmosphere has been tested to be safe on all occasions immediately prior to entry. In addition to the entry permit the responsible person should ensure that:

- The appropriate atmosphere checks have been carried out.
- Effective ventilation shall be maintained continuously while personnel are in the confined space.
- Lifelines and harnesses are ready for immediate use. Where possible, pump room lifelines should be already rigged, and an unobstructed direct lift provided.
- Approved and pre-tested breathing apparatus and resuscitation equipment are ready for use at the entry to the confined space.
- Respective PPE (helmets, eye protection, clothing, footwear etc.) should be worn at all times.
- Where possible, a separate means of access is available for use as an alternative means of escape in an emergency.
- A responsible member of the crew is in constant attendance outside the confined space in the immediate vicinity of the entrance and in immediate contact with a responsible officer.
- A means of communication between persons inside confined spaces and those outside should be established prior to entry and frequently tested. Where possible, the responsible person outside the confined space should be in permanent visual contact with the personnel inside the closed space.
- Users of breathing apparatus shall be suitably trained and competent in its use.

In the event of an emergency, under no circumstances shall the attending crew member enter the confined space before help has arrived. Prior to commencing confined space entry, the lines of communication for dealing with emergencies shall be clearly established and understood by all concerned.

Pump rooms and deck tunnels by virtue of their location, design, and operation, constitute a particular hazard and therefore necessitate special precautions. No-one shall enter a pump room or deck tunnel at any time without first obtaining the permission of a responsible officer.

It is the duty of the responsible vessel's officer in charge of cargo operations to ensure that there is adequate ventilation of the pump room or deck tunnel, and that the atmosphere is suitable for entry. Approved breathing apparatus and resuscitation apparatus should be available in an accessible location. At no time shall an inspector enter a pump room or deck tunnel unless supervised and accompanied by a responsible member of the vessel's staff.

4.7 PERSONNEL TRANSFER OFFSHORE

The inspector shall assess the risks and evaluate the effects of weather, sea state, darkness and any other relevant factors that affect the safe transfer to and from the vessel.

All transferring personnel shall be equipped with, and wear, full safety and personnel flotation devices.

It is recommended that the transfer of personnel between vessels is kept to an absolute minimum.

Where personnel transfers for ship to ship (STS) operations take place, the following should be taken into consideration;

- Gangways and open rung ladders **shall never be used** for personnel transfers between vessels.

- Workboat transfers shall only be undertaken using the appropriate pilot ladder/ accommodation ladder combinations taking into account the vessel's freeboard. At all times due consideration should be given to the sea conditions.

- Personnel transfer baskets shall only be used if confirmation is provided that all the associated lifting equipment is suitable for personnel transfer and adequate procedures are in place. This type of transfer should only be undertaken when it is not practicable to gain access by a less hazardous means. Transfer baskets should be of a suitable design with adequate buoyancy and the basket and lines should be in good condition.

5 GENERAL PRINCIPLES

5.1 THE PROCESS OF A CARGO INSPECTION

- Inspect/assess the vessel's tanks prior to loading to determine if the tanks meet requirements for cargo to be loaded.
- Inspect hoses or loading arms being used for the transfer of cargoes for cleanliness and previous use to ensure suitability for the transfer in question.
- Advise and assist in minimizing the extent to which procedural and/or measurement errors occur before, during, and after the loading or discharge or cargo transfer that could affect the quantity and quality of cargo recorded on documents issued at the port or place of load or discharge or cargo transfer.
- Ensure that all practicable steps are taken to prevent contamination from the ship or shore tank and line systems during the loading, discharge, or cargo transfer.
- When required verify the quality of the cargo to be discharged, loaded, or transferred.
- Verify cargo tank condition on completion of transfer operations.
- Maintain a detailed time log of operations including all delays.
- Identify to principal(s) in a timely manner any matter that may be relevant to the handling of the cargo.
- Provide a report that details the quantity and quality of each parcel at the point of load, discharge, or cargo transfer in a timely manner.

5.2 GENERAL RESPONSIBILITIES

In order to fulfil the process of the inspection as described above, the cargo inspection company and the inspector need to fulfil a number of tasks, some of a general nature and others of a highly specialized and clearly defined nature. The general responsibilities are described below, and the specialized responsibilities are addressed in subsequent sections

5.2.1 Communications, capabilities, and performance

In order to avoid misunderstandings, the cargo inspection company shall ensure to the best of their ability, that clear, written instructions are received from the principal(s) for whom the inspection is being performed.

The cargo inspection company shall ensure that briefed and trained inspection personnel are available on time as appropriate and as specifically required by the principal(s) for whom the inspection is being performed.

Details of the tank inspection, measurement, sampling, location and laboratory analytical methods and certification referred to in these procedures may be specified separately by the principals for whom the inspection is being performed. Principals should be notified of any differences with regard to instructions received for resolution prior to the operation commencing.

Before the start of any cargo operations the inspector shall meet all key personnel concerned with the operation to review and agree on the operational plan and procedures relating to the cargo transfer (See section 6 for key meeting information).

Any inspection procedure to be performed either on board a vessel or in the terminal shall be accomplished with either the vessel(s) or the terminal representative's explicit approval.

The inspector shall comply with all applicable governmental, local port authority, and terminal regulations in force at the port of loading or discharge.

The inspector shall also perform their required tasks in a safe manner in accordance with section 5 of this standard, and always in compliance with the inspection company's and terminal/vessel's specific safety requirements.

The inspector should have knowledge and experience of tank inspections to meet the requirements and expectation of the principal(s) (see section 7.1.7).

5.2.2 Equipment

Calibration and verification records shall be available for all measuring equipment.

Measurement and sampling equipment shall be clean, safe, and suitable for use and not become a source of contamination for cargo or sample. The materials from which the probe, tape, and sampling equipment are constructed shall be resistant against possible corrosive action by the chemical being measured.

Where vessels operate under closed or restricted conditions, the use of a portable electronic gauging device (PEGD) and closed/restricted sampling equipment should be used.

NOTE In the event that permission for the specified operations to be performed is refused, or there are other reasons why manual measurements cannot be made, written letters of protest should be submitted to the vessel(s) and/or terminal representative and the facts recorded in the inspector's report.

5.2.3 Letters of protest/notices of apparent discrepancy

A formal protest in writing should be submitted by the cargo inspectors to the terminal and/ or the vessel(s) when:

- Any occurrences conflict with current industry measurement standards.
- Any occurrences conflict with the interests of the principal(s) for whom the inspection is being performed.
- Operational or other restrictions make it impossible for the inspector to follow these procedures or the specific requirements of any of the principal(s) for whom the inspection is being performed.
- A quality or measurement discrepancy occurs or is suspected.
- Any of the contractual conditions governing the transfer of the cargo, which have been made known to the inspectors, are not met.

This above list is not all-inclusive.

Such protests should be issued in writing when the occasion for protest is first observed and whenever possible before the vessel sails from the loading or discharge port.

Any additional observations and comments supporting any of the events reported should be included in the inspector's report.

5.2.4 Reporting

The inspection report issued on completion of custody transfer operations should follow these guidelines and also be in accordance with any specific reporting instructions given by each party for whom the inspection is being performed.

5.3 POTENTIAL MEASUREMENT ERROR

Inspectors should record each occasion when they are required to take measurements under conditions which are not conducive to measurement accuracy. The following conditions are some examples where accuracy can be affected:

Flexing of tank bottoms
Bottom plating of vertical cylindrical tanks can be subject to flexing.

Gauging discrepancies
Gauging discrepancies can occur due to slight movement at the liquid surface level, or to the reading on a steel tape, which will tend to exaggerate inaccuracies in percentage terms where total change in liquid level is small. Other factors which can result in volumetric discrepancies include reference height variations, temperature measurement (product and tank shell), and calibrations that are outdated and/or incorrect.

The number of shore tanks used for loading and/or for discharging, for assessing Bill of Lading and/or Outturn quantity, should be kept to a minimum in order to prevent a greater exposure to measurement inaccuracy.

Temperature variation
Temperature layering or variation can have a significant impact on the final measured quantity. See also 7.1.1.3.

Floating roofs (internal and external)

Floating roofs should, wherever possible, be freely floating at the time of gauging. Liquid levels taken within the critical zone shown on the calibration tables are known to be inaccurate and shall not be used for custody transfer measurements.

Liquid levels taken near the critical zone shown on the calibration tables can be subject to significant inaccuracy.

Shore tank floating roofs should be in the same condition both before and after transfers. Accumulations of rainwater (for example) during the period between opening and closing gauges should be drained before any measurements are made.

Liquid levels in shore tanks

Liquid levels in shore tanks should be maintained above the datum or striking plate at all times so as to minimize calibration errors associated with those areas below the datum plate (coned down bottoms, for example). These recommendations apply to both fixed roof tanks (including internal floating cover types) and to floating roof tanks where the roof is landed on its legs and clear of any product. An empty shore tank before or after will increase the potential measurement error.

For more details, refer to API *MPMS* Chapter 17.5 / EI HM 64 [7].

6 OPERATION PLANNING (LOADING AND DISCHARGE)

6.1 KEY MEETING

Before operations commence, the inspector, shore terminal, and vessel personnel should meet to discuss safety requirements and agree the procedures to be applied for cargo measurement and cargo quality assurance to ensure that:

- the cargo does not become contaminated and remains segregated;
- handling losses are minimized, and
- the operation proceeds with a minimum of delay.

6.2 INFORMATION TO BE DETERMINED BEFORE AN OPERATION COMMENCES

If the following checklist identifies any aspect of the operation that gives cause for concern, this shall be immediately communicated to the principal(s) prior to any cargo operations.

	Load		Discharge	
	Shore	**Ship**	**Shore**	**Ship**
1. The ship/shore/inspection company has agreed on the quantity of cargo to be transferred and specific contractual tolerances	✓	✓	✓	✓
2. The agreed quantity and quality is available	✓			✓
3. (a) The tanks involved have been identified, together with the approximate quantity to be transferred from/into each tank	✓	✓	✓	✓
(b) The capacity of the receiving tanks will be sufficient to contain the cargo		✓	✓	
(c) The proposed order that the tanks will be loaded/discharged has been agreed	✓	✓	✓	✓
4. (a) Any receiving tanks containing previous cargoes or residues have been identified and their contents confirmed as compatible with the cargo to be received		✓	✓	
(b) Verify adjacent tanks are temperature compatible with cargo to be received.		✓		
5. Any in-transit movement of cargo has been identified		✓		✓
6. Tank cargo history has been determined and noted:				
a) Previous five (vessel) cargoes if available, minimum of three		✓		
b) Last and current cargo (shore tank)	✓		✓	
7. The planned loading/discharge rate has been agreed	✓	✓	✓	✓

(Continued)	**Load**		**Discharge**	
	Shore	**Ship**	**Shore**	**Ship**
8. Tank and line preparation and cleaning procedures, if required, have been carried out and recorded	✓	✓	✓	✓
9. The materials used for any tank coating and its condition have been confirmed/assessed		✓	✓	
10. When the ship cargo tanks are subject to inert gas:				
a) Facilities for measurement and sampling of cargo tanks are available and calibrated, e.g., vapor lock valves, gas measurement devices		✓		✓
b) Inerting/depressurizing of separate tanks is feasible if required.		✓		✓
c) The quality of inert gas and its possible effect on the cargo quality has been assessed	✓		✓	✓
11. When carrying multi-grade cargoes, venting systems of the different grades can be positively separated		✓		✓
12. Any cargo tanks containing recovered washings (slops) which are to be discharged before, during or after the transfer of cargo have been identified and:				
(a) The nature and quantity of slops involved confirmed	✓	✓	✓	✓
(b) The shore terminal has agreed to accept the material	✓	✓	✓	✓
(c) Tank/line cleaning procedures to be applied after tank washings have been discharged are agreed	✓	✓	✓	✓
(d) Vessel should have effective segregation between cargo and slop systems		✓		✓
13. Where the shoreline cargo system to be used for the transfer connects with any other shoreline system, the status of the shoreline system has been confirmed (whether full or empty) and a method for verification is available	✓		✓	
14. Ship and shore lines to be used have been identified and:				
(a) The points where they may be checked are confirmed	✓	✓	✓	✓
(b) Transfer lines empty	✓	✓	✓	✓

c) The previous cargo through the line system has been confirmed and appropriate cleaning and/or pigging has been carried out	✓	✓	✓	✓

(Continued)	**LOAD**		**DISCHARGE**	
	Shore	**Ship**	**Shore**	**Ship**
15. In the case of multi-product cargo transfer it has been confirmed:				
(a) Whether a common line system will be used	✓	✓	✓	✓
(b) Whether blinds or two-valve separation are available for segregation	✓	✓	✓	✓
(c) What loading/discharge sequence will be used	✓	✓	✓	✓
(d) Whether simultaneous loading/discharge of two or more product cargoes will take place	✓	✓	✓	✓
16. All measurement and sampling points have been located	✓	✓	✓	✓
17. If Consignees' loading samples are on board, these are collected at discharge port				✓
18. Correction factors to be used for each product have been confirmed	✓	✓	✓	✓
19. Actual cargo temperature is confirmed	✓	✓	✓	✓
20. Cargo heating instructions are confirmed	✓	✓	✓	✓
21. When heating coils are fitted, materials are compatible with the cargo and the date when the coils were last tested; should be within 6 months		✓	✓	
22. Any chemical additives or inhibitors to be added are confirmed	✓	✓	✓	✓

7 INSPECTION, SAMPLING AND QUALITY CONTROL PROCEDURES

The following procedures provide a summary of chemical cargo loading and discharge operations that inspectors should follow.

Similar measurement and sampling procedures may be applied several times during the cargo loading-transportation-discharge cycle. To avoid repetition in these guidelines, these procedures are described in detail in this section only. Brief references to them are then made, as necessary, in the subsequent sections which detail the sequence of procedures to be applied at loading and discharge.

Under normal operating conditions, vessels will have prepared their tanks for loading during the preceding voyage and, where appropriate, will have followed specific recommendations given to the Master in their voyage instructions or made use of tank cleaning guidance manuals made available on board by the vessel's owners. Any such guidance manuals will also be considered by the Master in conjunction with any restrictions required by the tank coating manufacturers.

Vessels will present in what they consider to be a ready-to-load condition and inspectors at a load port will be required to either accept or reject the vessel's cargo tanks and associated pumps and lines.

Inspectors should be aware that they are not responsible for any cleaning or tank washing procedures aboard the vessel and they should not offer any advice or instruction to the Master in the event that their initial tank inspection/assessment results in a rejection requiring further cleaning.

NOTE There may be an exception to the foregoing where an inspection company might be asked by the vessel owner or charterer to provide a specialist tank cleaning expert to assist the Master. This is a specialized service, and no further reference will be made in these guidance notes to that activity.

7.1 LOAD PROCEDURES

7.1.1 Shore tanks

By mutual agreement between the parties concerned and subject to acceptance by the local Customs Authorities, automatic tank level gauging and temperature measurement systems may be used for custody transfer. Where this is the case, inspectors should satisfy themselves from the terminal's gauge proving records that the gauges are satisfactory, making an appropriate note in the general comments of their report. Notes should include the date of the last two checks made, any discrepancies found, and any adjustments made. Manual measurements should be taken wherever possible in order to check the automatic system. Where manual measurements are not possible, local tank readings should be taken for comparison with the automatic system.

The inspector should ascertain from the terminal operator if there are any calibration deficiencies such as tank listing, irregular bottom configuration etc.

The inspector should note the shore tank type and condition – fixed roof or floating roof, etc., together with details of the tank construction, position of the suction valves, previous cargo history, cleaning procedures, and coating.

If floating roof tanks are nominated, the tank roof should be checked to confirm that it is free of excessive quantities of water, snow, and debris. The floating roof position (floating, landed, or in the critical zone), should be determined before and after discharge or loading and any significant change in condition during operations should be noted. If at any time the roof is landed or within 6 in. (15 cm) of the critical zone this should be brought to the attention of the terminal for rectification. No Custody Transfer measurements shall be taken at any time the roof is within the critical zone shown on the calibration tables, and this should be brought to the attention of the terminal for rectification, and the principal should be notified. A letter of protest should be issued if the situation is not rectified, and custody transfer accuracy would be impaired. All floating roofs are considered confined spaces and shall not be accessed without a full risk assessment being completed including the means of extraction in place. (See Section 4.6)

The reference heights of the shore tanks as recorded in the tank calibration tables should be noted together with the date of the last calibration and any repairs. It should be noted that the calibration records may be hard copy or electronic.

If the cargo is protected by a nitrogen blanket under a positive pressure this should be noted, and permission should be sought to allow gauging and sampling in the conventional manner after depressurizing the tanks.

If the cargo is being heated the inspector should be aware of and should note the prescribed temperature range for the cargo and review the heating records.

Before taking the official opening measurements, the shore tank main discharge valve should be open unless a 'line empty before' to 'line empty after' procedure is being adopted by the terminal in which case the valves will remain closed. The procedure followed should be noted along with the position of filling valves when measurements were made. Any valve operation should be performed by terminal personnel.

The opening and closing measurements, temperatures, and water measurements for each nominated tank should be recorded.

7.1.1.1 Automatic gauging

Automatic tank gauging systems (ATGs), including radar systems with accuracy consistent with API *MPMS* Chapter 3.1B[2] may be used for custody transfer by mutual agreement between the principal(s).

In terminals where automatic gauges are used for Bill of Lading or Outturn purposes comparisons should be made by manual measurement (level and temperature) where permitted. If the difference between the automatic and manual readings on 'opening' and 'closing' are greater than operational tolerances then the manual measurement should be used.

If an automatic gauging system is used, and the readings cannot be verified by manual measurement, the principal(s) should be advised. The inspection report should note the last two times that ATG and manual measurements were compared, and record that only automatic gauging systems were used for quantity measurements.

7.1.1.2 Manual gauging

It is recommended that for sounding or ullaging, either a PEGD or a steel dip tape with an integral weight is used. These should have a performance traceable to a known standard.

When using manual gauging, reference heights should be checked and recorded before and after the cargo transfer. Any difference between the observed reference height and the reference height shown in the calibration tables should be noted and investigated (API *MPMS* Chapter 17.2[6]), see section 5.3 on potential measurement error.

Sounding (innage) or ullage (outage) measurements should be taken from the gauge reference points which correspond to the tank calibration tables. Reference height should be confirmed by direct manual measurement and if a stilling pipe is fitted it should be established whether the pipe is perforated. If the pipe is not perforated, then shore tank manual measurements for custody transfer shall not be used.

Manual gauging shall require either two consecutive gauge readings to be identical, or three consecutive readings within a range of 3 mm (1/8 in.). If the first two readings are identical, this reading shall be reported to the nearest 1 mm if metric tapes are used, or to the nearest 1/8 in., if US customary tapes are used. When three readings are taken, all three readings shall be within the 3 mm (1/8 in.) range and readings averaged to the nearest 1 mm for metric tapes and 1/8 in. for US customary tapes. For further details refer to API *MPMS* Chapter 3.1A[1] and EI HM 4 [16].

Water cuts should be obtained using either a steel dip tape with an integral weight with water-finding paste or a portable electronic gauging device (PEGD). It is recommended that two different types of water finding paste are used on steel tape/bob, paste should not be used on a PEGD Probe. The type of paste(s) or device used to establish the oil/water interface should be recorded. Where paste(s) is used, the inspector should record the level of 'clear cut' water reaction on the paste and the depth of any high intensity 'spotting' on the tape. Irrespective of the method used, sufficient time is required to allow the probe/paste to react with the water, this will depend upon the product being measured.

The corresponding measured volumes should be obtained from the calibration tables, confirming the correct terminal and tank number, reference height, and calibration date. Noting any additional corrections or amendments to the calibration tables.

7.1.1.3 Temperature measurement

It is recommended that a portable electronic gauging device (PEGD) or portable electronic thermometer (PET), with a performance traceable to a recognized national standard over a suitable temperature range, is used for all temperature measurements.

It is further recommended that its accuracy is checked before use, via a temperature verification with a device traceable to a recognized national standard. For depths of 3.0 m (10 ft) or greater, the minimum number of readings that shall be taken is three readings. These readings should be taken at the mid-point of the upper, middle, and lower levels. More readings could be necessary if temperature stratification has occurred. When depths are less than 3.0 m (10 ft), readings should be taken from only the middle level.

All PEGD or PET temperature readings should be recorded as indicated on the device or to the nearest 0.1 °C (0.1 °F) and averaged.

If temperature varies by more than 1.0 °C (2.0 °F), then a temperature profile should be obtained by taking temperatures at 1 m (3 ft) intervals or less and averaging the results. Heated cargoes are more easily susceptible to temperature stratification due to the uneven and non-uniform heating from the heating coils and could require temperature measurement at more levels. Care should be taken with measurements made below heating coil level.

If a portable electronic thermometer (PET) is not available, then a liquid-in-glass thermometer accurate to 0.1 °C (0.2 °F) may be used providing it has a performance traceable to a recognized national standard over a suitable temperature range. Additional care could have to be taken to ensure an accurate temperature measurement. The Inspection report should highlight this departure from the preferred measurement method.

7.1.2 Dynamic measurement (metering)

When the quantity of cargo to be loaded is to be established by dynamic measurement (metering), inspectors should, whenever possible:

- Record the type of meter, its size, and maximum rated flow rate.
- Record the position of the temperature probe in the line, i.e., center, bottom, top, etc.
- Record the intended flow rate, temperature, pressure, viscosity, and grade of cargo to be loaded.
- Where a temperature probe in the shore line is to be used to determine the temperature for correcting the metered quantity loaded, record in the inspection report the frequency of accuracy checks and the result of the last calibration check. If a second thermowell is available, additional verification of the probe should be made.
- Check temperature probes for consistency by comparing temperatures with those taken from ship and shore tanks.
- Verify that the meter(s) in service and the meter prover have valid calibration certificates.
- Ascertain the maximum and minimum flow rates at which the prescribed meter accuracy can be maintained.
- Determine and record the date of last meter calibration.

For more details on dynamic measurement refer to Annex B.

If the cargo is being delivered from static tanks, the shore tank measurement procedures detailed in 7.1.1 should also be followed, if possible, as these will provide a check on the quantity determined by metering.

7.1.3 Sampling

The objective of sampling is to obtain a small portion of material that represents the physical and chemical characteristics of the material being sampled.

The true representative nature of a sample cannot be determined when it is taken. There are many inherent limitations that shall be considered when sampling manually, any one of which can affect the representative nature of the sample. The most accurate practice available, which should be used for custody transfer purposes, is a flow proportional automatic pipeline sampling system operated in accordance with IP 476/ISO 3171 [19] or API *MPMS* Chapter 8.2[4]. Where automatic sampling is not available, then manual sampling becomes the best available practice.

The physical characteristics of the cargo, the storage facility, and the testing to be performed dictate the sampling procedures, sampling apparatus, sampling device, secondary container selection, the sample quantity required, and many of the sample handling requirements.

Samples taken from standpipes, vapor control valves (VCVs), and other fittings are subject to potential contamination from rust or other foreign matter that could be displaced from the top section of the standpipe into the sample. Standpipes, VCVs, and other fittings could also have been used for introducing additives to the tank either for the current or previous cargo and this can result in contaminated/unrepresentative samples. Condensation can build up in the standpipe allowing water to enter into the sample as it returns to the housing. This is a particular problem with heated cargoes. Samples shall not be drawn from unslotted standpipes for Custody Transfer purposes.

The inspector is responsible for ensuring that sufficient samples are drawn at all appropriate stages in the cargo movement for subsequent testing, compositing and/or retention. Samples not for immediate testing should be distributed as per the principal's instructions, and suitable retention times for the samples drawn should be agreed in advance with the principal(s).

Samples should be kept by the inspection company. It is important that all samples are stored under the appropriate conditions to ensure the integrity of the samples is not affected by the external environment. Samples, leaving the direct control of the inspection company, shall be sealed and records shall be kept of the respective seal numbers for future reference. Samples retained by the Inspection company may be sealed per the principal(s) instructions.

All samples should be clearly labelled in indelible ink with, as a minimum, the following information:

- the location at which the sample was drawn;
- the date and time the sample was drawn;
- the name of the inspector who drew the sample;
- a description of the cargo sampled;
- the type of sample (i.e., upper, middle, lower, dead bottom);
- the exact sampling location (i.e., shore tank number, terminal, vessel, etc.);
- appropriate hazard labelling.

When selecting the type and number of samples to be drawn, reference should be made to the principal(s) instructions and standard test methods specified for the cargo in question. If the test methods call for sample handling techniques which could alter the composition of the sample sufficiently to affect the results of other tests, or if special sample containers are required, then separate samples for these tests should be drawn. Care shall be taken to ensure that the correct type of sample container is used for the material to be sampled (for example, some materials are light sensitive and also some types of plastic containers will allow moisture to permeate through the walls).

7.1.4 Manual sampling of shore tanks

Before loading from a shore tank, samples should be drawn from each tank involved in the transfer operation, and when instructed to do so by the principal(s), should be tested against the relevant specification. For discharge operations, samples should be drawn from the shore tank before and after discharge.

Shore tank sampling should be carried out when the tank contents are at rest if sampling from the tank top. Whilst the principal(s) will specify the number and type of the samples to be drawn for immediate testing, it is recommended that upper, middle, and lower samples should be drawn based on liquid depth and tested to establish whether the contents of the tanks are homogeneous. If tank(s) are found to be non-homogeneous, principles shall be notified. Refer to IP 475/ISO 3170 for the range of homogeneity. Parameters used to assess homogeneity as well as variances allowed should be agreed with the principal(s). If for any reason representative samples cannot be drawn from the shore tanks, the principal should be informed immediately.

If sample point is on a tank circulation line or a designed sample circulation loop, tank should be in circulation, with consideration for static accumulator products.

Shore tank side sample points are not recommended for custody transfer purposes, unless this point is deemed to be suitable for obtaining a representative sample. However, in the event that this method has to be used, the principal(s) are to be informed immediately and the inspector should work with the terminal to ensure that lines are properly cleared.

If free water is detected in the shore tank, the inspector should report this to the principal(s) immediately and attempt to obtain a sample of the water.

7.1.5 Automatic sampling

Whilst it is not common to use automatic sampling for chemical cargoes, if it has been agreed that samples should be obtained from an automatic sampler, samples should be drawn in accordance with IP 476/ISO 3171 [19] or API *MPMS* Chapter 8.2 [4]. Whenever possible inspectors should:

Before transferring cargo

- Record the make of the sampler.
- Record type and operating mode of sampler, e.g., whether fast loop, in line, grab, flow, or time proportional.
- Record the site of the sampler and whether there are devices for mixing the cargo prior to its being sampled.
- Record sample frequency, e.g., grabs per unit of volume or per unit of time. Record also the size of the grabs.
- Check that the controls for sample size versus cargo size are set correctly. Record the sampler control setting.
- Record number, type, and size of sample receivers.
- Check that receivers are clean and dry.
- Seal receptacle and record seal number.

During cargo transfer

- Record the times that the sampling starts and stops. Sampling should begin immediately when the transfer starts and be stopped only when the transfer is completed or when flow stops.
- Check that the automatic sampler is working correctly by weighing the sample containers at regular intervals. Compare these weights with theoretical weights for the cargo

volume pumped or the time interval involved. Check that the ancillary equipment, e.g., insertion turbine meters, is working.

After cargo transfer

- Record the time the sampler was taken off line. If the sampler was taken off line before the transfer is completed and/or if the sample volume is less than the expected volume, a written letter of protest should be issued to the terminal.
- Ensure that the sample container contents are properly mixed before drawing sub-samples.
- Compare, where possible, all analytical results from the automatic sampler with the analytical results obtained from the representative samples taken from the shore tanks. Record the analytical test methods employed.
- Report any difficulties encountered with the automatic sampling procedures.
- From the sampler operator, collect all data necessary to calculate a sampler performance report and verify the performance is within the correct criteria. If it has not performed correctly the sample should be rejected and the principal(s) contacted immediately.

7.1.6 Pipelines

The nature and quantities of material in the shore lines and the total capacity of the lines to be used, from the vessel's flange to the shore tank(s) should be determined together and the method used should be noted. Refer to EI HM 70 / API *MPMS* Chapter 17.6[8].

Owing to the very large range of chemicals which are shipped, it is not possible to provide specific quality control loading procedures in this section for each cargo. The level of quality control is dictated by end use requirements and inspectors should be guided by the loading terminal and any special instructions from their principal(s). To ensure the cargo is transferred without contamination to the ship's tanks, it is recommended that samples are drawn from key points along the pipeline system and, in particular, at the end of shore line and at the point of custody transfer (normally ship's manifold).

Before start of loading operations, samples of the shore pipeline contents should be taken and retained. This should be repeated after line flushing, line packing, or line slopping operations.

The terminal should arrange for lines and valves to be set to prevent the cargo being contaminated or diverted through other lines and into tanks. The terminal should be requested to confirm that all relevant lines and valves are correctly set.

To ensure the product is received without contamination it is recommended that samples are drawn from key locations on the vessel such as lines, hoses, vessel manifold, and cargo tanks.

7.1.7 Vessel procedures before loading

Before starting operations, a key meeting should be held between the ship, shore, and inspection personnel. The details of the items which should be discussed at the key meeting are listed in section 6.

Details of the tank coatings and the previous five cargoes if available, minimum of three, carried should be obtained and verified for suitability. It should be confirmed that the tank, pump, and line cleaning procedures carried out meet the requirements for the cargo(es) to be loaded. The cleaning and preparation of the ship's tanks and lines is the responsibility of the master of the vessel. Where tanks are not considered suitable, the principal(s) should be notified immediately and loading shall only proceed after receipt of written responsibility for loaded quality from the ship's master, confirmed by the principal(s).

Vessels should present cargo tanks in a ready-to-load condition and inspectors at a load port will be required to issue a tank inspection report stating whether or not they found the tanks in a suitable condition of cleanliness to load the nominated cargo. The report should state the limits of the inspection (i.e., visual from deck level or tank entry, sounding, wall wash etc.). The report should also include an assessment of the vessel's lines to be used for loading and note if these are included within the calibration tables.

Vessel Dry Tank Certificates should not be signed by inspectors. Refer to specific instructions issued by the principal(s) concerning third party documents.

Gauging and sampling are often performed through closed and restricted systems; therefore, these should be cleaned/prepared along with the tanks, pumps, and lines and methods used should be confirmed. For further information refer to EI HM 52/API *MPMS* Chapter 17.11 [10].

7.1.7.1 Tank acceptance

In general, petrochemicals are pure substances and tolerance levels for contamination are extremely low.

It is the master's responsibility to present the vessel in suitable condition to load the nominated cargo. It is the inspector's responsibility to assess, so far as is possible, that the vessel is ready to load without risk of contamination.

Potential sources of contamination can include:

- cargo lines from the loading manifold to the tank bottom including drop lines and stripping lines;
- prior cargoes;
- cleaning material residues;
- pump suctions including deep well pump cofferdams;
- vent and inert gas lines;
- unbroken blisters in coated tanks;
- flaking or broken blisters of the tank coating;
- discoloration of tank coating;
- tank coating suitability;
- seawater residues;
- polymerized materials;
- cargo heating systems, and
- closed and restricted sampling points including standpipes.

This list is not exhaustive and, in particular, epoxy coated tanks can absorb cargo during a loaded passage. Depending on the subsequent cargoes, absorbed product can be extracted quickly by a subsequent solvent cargo or desorption can take weeks or months and the potential for contamination could remain.

As examples, both styrene monomer and ethylene dichloride are known to be slow to be desorbed from epoxy coated tanks. This phenomenon has been well documented during recent years and avoidance of risk depends on proper cargo sequencing and is outside the remit of the inspector. It is commented on in this section for information only.

7.1.7.2 Tank cleaning information

Inspectors are not responsible for the preparation and cleaning of cargo tanks prior to loading. This is entirely the responsibility of the vessel. Inspectors should not offer advice in the event that cargo tanks are not ready to load, other than to give reasons why the tank has been rejected.

Chemical cargoes have a low tolerance to contamination, and it is common for various tank cleaning chemicals/detergents to be used during tank washing. Chemicals and cleaning agents can have an effect on the cargo to be loaded.

The inspector should record the tank cleaning method declared by the vessel along with other actions taken to reduce the risk of contamination but should not sign any document which implies confirmation that the method was appropriate or was actually used. If the inspector is in doubt as to whether or not the method stated by the vessel is appropriate, then they should refer this to the principal(s).

7.1.7.3 Tank cleaning operations

As for many other bulk liquids, the most common tank washing material is seawater. Depending on the previous cargo, the water could have to be applied at elevated temperatures. The vessel will take note of any restrictions recommended by the tank coating manufacturers and, in some cases, notably volatile water miscible chemicals, water washing cannot be started until the tank has been ventilated to a visible dry state to avoid the formation of acidic compounds.

Some chemicals cannot tolerate the presence of chlorides; therefore all salt water washing should be followed by a fresh water wash. As part of the cleaning process a range of chemical additives, dependent on the previous cargo, may be used.

Inspectors are advised that most tank cleaning chemicals will cause cargo tanks to be unsafe for entry. Inspectors **shall not** conduct tank entry unless tanks have been gas freed and certified safe for entry (see confined space guidance, in 4.6).

It is common for chemical tankers to be equipped with deep well pumps and it is normal practice for the cofferdams around the pump suctions to be purged with air or inert gas immediately prior to loading.

7.1.7.4 Internal inspection of tank surfaces

Chemical tankers will clean the cargo tanks and associated manifolds and pipeline systems before arrival at the load berth.

Inspectors are responsible for inspecting cargo tanks for visual cleanliness and for chemical cleanliness in cases where final acceptance is subject to wall wash testing. These guidance notes can therefore assist the inspector in forming a judgement.

Special attention should be paid to the condition of the tank coating in the case of epoxy coated tanks and, in particular, to the presence of blisters and flaking of the coating. Unbroken blisters may contain residues from an earlier cargo as will loose or flaking coating. Depending on the charterer or shipper requirements, the inspector could be asked to estimate the percentage of coating missing or damaged.

Attention should also be paid to the internal cargo tank structure, pipes, drop lines, pump casings, suction wells, heating coils, gauging and sampling standpipes.

Inspectors cannot visually inspect the internal condition of pipelines and the inspection report should clearly state these and any other limitations. Vent and inert gas lines are usually visible at the tank entry point and could contain prior cargoes, polymerized material, or washing residues that, if present, could contribute to contamination. Deck lines can have drain points and these should be opened in case residues from tank washing operations or prior cargoes are present.

7.1.7.5 Wall wash sampling and testing – see Annex E

Due to the sensitive nature of certain chemical cargoes, visual inspection of the tank surfaces could not be sufficient to eliminate the risk of contamination and acceptance procedures could require testing of wall wash samples.

Wall wash techniques require random washing of tank surfaces over small areas (usually about 1 square meter), either with a sample of the cargo to be loaded or with a laboratory grade methanol.

The purpose of 'washing' small, but representative, areas of the tank walls is to identify by chemical analysis, trace amounts of materials that can be detrimental to the cargo. Such contaminants, if any, could have originated from the tank cleaning materials or previous cargo or could have survived through additional intermediate cargoes. Refer to API *MPMS* Chapter 17.8 [9] and ASTM E2664 [12] for various wall washing methods.

Inspectors should be aware that wall wash sampling procedures can cause a previously gas free tank to develop an unsafe atmosphere. (See confined space guidance, in 4.6).

7.1.7.6 Cargo tank coating suitability

The following notes are provided to assist inspectors in understanding potential contamination problems that can arise with chemical cargoes:

- The cargo resistance of coatings of the same generic type can vary between manufacturers and the manufacturers' resistance lists, usually available aboard the vessel, should be consulted when there are any doubts as to the suitability of any particular cargo.
- Zinc silicate, phenolic epoxies, and pure epoxies are the most commonly used generic coating systems in cargo tanks for the carriage of chemicals. The principal limitation in the use of zinc silicates is that they are only suitable in a narrow pH range of approximately 5.0 to 9.0. Phenolic epoxies are generally able to carry a wider range of low molecular weight cargoes and have a higher free fatty acid resistance.
- Some coatings are temperature sensitive. Cargo carriage requirements could require heating, and temperature control should match the coating operability range.
- Organic epoxy coatings can absorb cargoes during a voyage. The contamination potential to a subsequent cargo is therefore considerable as:
  - The amount of absorbed material retained over different time periods cannot be determined.
  - Variable absorption/desorption characteristics are found between different coating types.
  - Variable absorption/desorption characteristics are found within the same generic

coating types from different manufacturers.

- Different rates of absorption/desorption are found between different cargoes

- Factors such as coating thickness, temperature and tank cleaning also have an influence on absorption and desorption.
- With some chemical cargoes, absorbed material can survive intermediate cargoes and extensive tank cleaning operations.

7.1.7.7 Vessel measurements

The vessel's draught should be determined, ideally by reading the draught marks, and recorded along with the sea conditions. A comparison should be made with the vessel's declared readings and any differences resolved. Trim and list to be determined. Inspector to request list to be corrected prior to cargo measurement.

Vessel lines should all be drained before measurements begin.

Where vapor lock valves have been retrofitted, reference should be made to the documentation issued by a competent authority confirming that no physical differences exist between documented and actual reference heights. Where supplementary tables have been issued following retrofitting, these should be used. If any discrepancies are identified, then these should be taken into consideration when making calculations.

Tank reference heights should be checked and compared with the corresponding values quoted in the tank calibration tables. Any differences should be investigated and reported.

The amount and nature of any OBQ (previous cargo residues) in all cargo tank(s) to be loaded should be determined. OBQ should only be referred to as Liquid, Non-Liquid, or Free Water. When there is sufficient liquid available, level, temperature, and water measurements should be obtained, and a sample taken for retention.

All cargo tanks, including those containing part or previously loaded cargoes, should be measured and quantities recorded. Comparison should be made with quantities measured at the previous port.

If the liquid is not in contact with all tank bulkheads, the wedge formula as described in Annex C should be used. Vessel compiled wedge tables can be used provided they are based on the formula in Annex C.

Where applicable, and in the presence of the vessel's personnel, sea valves and overboard discharge valves should be confirmed as closed and sealed before loading begins. Seal numbers should be recorded.

The quantities and types of material in all non-designated cargo spaces such as slops tank, void spaces, and ballast tanks should be determined and recorded. Samples could be needed.

Where it is not possible to conduct manual measurements to determine the OBQ, the principal(s) shall be advised, and a letter of protest issued.

Where any form of vessel's automated tank gauging is used, a means should be sought to verify the accuracy of these readings. This should include review and consideration of the vessel's calibration records. If displacer type automatic level gauges are used, actual stowed readings should be checked against the documented figures. Any differences found or reported by vessel personnel should be noted. If there are no differences in stowed automatic level gauge readings, then automatic gauges may be used for ullages.

Where vapor lock valves are fitted, a portable electronic gauging device (PEGD) should be used for all manual liquid measurements, ensuring the correct safety procedures in accordance with

ISGOTT are employed. If vapor lock valves are not available, then a steel tape should be used.

Whatever methods are used for the ullage and temperature measurements, please refer to 7.1.1 and 7.1.2 for the required accuracy.

7.1.8 Vessel procedures at start of loading

7.1.8.1 Sampling

A sample should be taken for a visual check at the start of loading from a convenient sample point as near as possible to the vessel's manifold. This is principally to ensure the cargo is visually acceptable as per cargo specification. All samples should be kept by the inspector and sealed as per principal(s) instructions. Sampling and testing requirements are generally specified by the principal(s).

In the event of any sample not meeting the specification, the principal(s) shall be contacted immediately.

7.1.8.2 Line fullness verification

Line fullness verification should be performed at the start, and where possible on completion, of loading to ensure the fullness of the shore lines. Refer to EI HM 70 /API *MPMS* Chapter 17.6[8] for the methods available.

Subject to wall wash tests (where applicable) and receiving laboratory clearance, the vessel will then be able to start loading.

7.1.8.3 First foot sampling

There are limitations to the extent to which inspectors can visually inspect all parts of the loading system, vessel, and shore. Loading/discharge manifolds, vents, and inert gas lines can only be inspected where visually accessible. Extensive areas of the pump and piping systems can only be assessed for cleanliness on the basis of information obtained from the vessel in respect to tank cleaning operations and previous cargoes. First foot samples could therefore be required to determine whether any contaminants remain within the shore/vessel's loading systems which could have a detrimental effect on the cargo to be loaded.

The samples should be drawn in clean, clear glass bottles and visually examined for appearance. Any visual contamination should be immediately reported. An additional sample for testing/retention can be required in an amber bottle for cargoes which are light sensitive.

Sampling and testing requirements are generally specified by the principal(s). Samples should be labelled, sealed, and distributed as per principal's instructions and as described in 7.1.3 of this document. Any deviation in the quality should be advised to the principal(s).

7.1.9 Vessel procedures after loading

7.1.9.1 Vessel measurements

The vessel's draught should be determined, ideally by reading the draught marks, and recorded along with the sea conditions. A comparison should be made with the vessel's declared readings and any differences resolved. Trim and list to be determined from the draughts recorded. Inspector to request list to be corrected prior to cargo measurement.

Loading arms and vessel lines should all be drained before measurements begin.

Where vapor lock valves have been retrofitted, reference should be made to the documentation issued by a competent authority confirming that no physical differences exist between documented and actual reference heights. Where supplementary tables have been issued following retrofitting, these should be used. If any discrepancies are identified, then these should be taken into consideration when making calculations.

Tank reference heights should be checked and compared with the corresponding values quoted in the tank calibration tables. Any differences should be investigated and reported.

All cargo tanks, including those containing part or previously loaded cargoes, should be measured and quantities recorded. Comparison should be made with measurement made prior to loading.

Where applicable, it should be confirmed, in the presence of the vessel's personnel, that sea valves and overboard discharge valves remain in the closed position and seals are intact.

The quantities and types of material in all non-designated cargo spaces such as void spaces and ballast tanks should be determined and recorded.

Where it is not possible to conduct manual measurements to determine the loaded quantity, the principal(s) shall be contacted, and a letter of protest issued.

Where any form of vessel's automated tank gauging is used, a means should be sought to verify the accuracy of these readings. This should include review and consideration of the vessel's calibration records. If displacer type automatic level gauges are used, actual stowed readings should be checked against the documented figures. Any differences found or reported by vessel personnel should be noted. If there are no differences in stowed automatic level gauge readings, then automatic gauges may be used for ullage measurements.

Where vapor lock valves are fitted, a portable electronic gauging device (PEGD) should be used for all manual liquid measurements, ensuring the correct safety procedures in accordance with ISGOTT are followed. If vapor lock valves are not available, then a steel tape should be used.

Water cuts should be obtained from all vessel cargo tanks using either a steel dip tape with an integral weight with water-finding paste or a portable electronic gauging device (PEGD). Water finding paste should not be used on a PEGD probe. It is recommended that two different types of paste are used. The type of paste(s) or device used to establish the oil/water interface should be recorded. Where paste(s) is used, the inspector should record the level of 'clear cut' water reaction on the paste and the depth of any high intensity 'spotting' on the tape. Irrespective of the method used, sufficient time is required to allow the probe/paste to react with the water.

Where a cargo/water interface detector is used to determine free water by ullage, the depth of free water is the observed reference height at the measurement point, minus the measured ullage of the detected interface at that point. According to the vessel's trim, it could be necessary to calculate free water volumes using the wedge formula.

If present, free water should be sampled using a bottom sampler, and samples should be retained.

The corresponding measured volumes should be obtained from the calibration tables, confirming the correct vessel name and tank number, reference height and calibration date. Noting any additional corrections or amendments to the calibration tables including the correction for the Vapor Control Valve if retrofitted. Any shell correction factor presented for the vessel should not be applied.

7.1.9.2 Sampling

Sampling and testing requirements are generally specified by principal(s). In the absence of specific instructions, samples from each of the vessel tanks shall be drawn and retained separately. If required, a volumetric composite sample of the cargo shall be prepared under controlled conditions for testing.

Under certain circumstances a more comprehensive sampling procedure will be required, such as when onboard blending has taken place or where a non-homogenous cargo is suspected.

Where vessels are loading under a restricted or closed loading system, inspectors should reference HM 52/API *MPMS* Chapter 17.11 [10].

Specific manual sampling details can be found in 7.1.3.

7.1.10 Calculations

Calculate the quantities in each vessel's tank according to section 8.

7.1.11 Vessel experience factor

Vessel's experience factor shall be calculated in accordance with the recommendations in EI HM 49 / API *MPMS* Chapter 17.9.

7.1.12 Reconciliation of measured quantities

Comparisons should be made between the quantities delivered and received. In the event that there is an apparent discrepancy between shore-to-vessel quantities that is equal to or greater than 0.3 % (after application of the VEF if applicable), the inspector, terminal, and vessel's representative shall investigate and confirm that all measurements and figures are correct. If the discrepancy is still greater than 0.3 % after investigation, the inspector should inform their principal(s) as soon as possible, preferably prior to the vessel sailing. Letters of protest should be issued. It should be noted that principal(s) can have different measurement tolerance levels.

7.2 DISCHARGE PROCEDURES

The procedures described in the previous sections for the load port will, to a large extent, be mirrored at the discharge port and are therefore only summarized here. The contents of all shore tanks and associated pipelines nominated to receive the cargo should be sampled and may be tested in accordance with the principal(s) requirements.

Line fullness verification should be performed at the start, and where possible on completion of discharge to ensure the fullness of the shore lines. Refer to EI HM 70 / API *MPMS* Chapter 17.6[8].

7.2.1 Vessel measurements before discharge

At the key meeting it should be confirmed if any cargo has been transferred during the voyage. Reasons why cargo was transferred should be noted and it should be confirmed that all vessel's lines are drained back and in a similar condition to completion of loading. 7.1.9.1 can be referred to for gauging and measurement procedures.

7.2.2 In-transit difference

On completion of the measurements and calculations, comparisons should be made between the Bill of Lading, load port figures, and arrival figures. Any in-transit difference greater than 0.1 % should be investigated and letters of protest issued accordingly. It should be noted that principal(s) could have different measurement tolerance levels.

Weather and sea conditions, at load and/or discharge port, can affect the validity of vessel measurements and these conditions should be noted in the report.

7.2.3 Sampling

Where instructed, samples carried on board from the load port should be collected and retained by the inspector. Details of load port samples should be recorded by the inspector including the location where they are stored. If such samples are not available for collection, a note of protest should be issued to the vessel.

Sampling and testing requirements are generally specified by principals. In the absence of specific instructions, samples from each of the vessel tanks shall be drawn and retained separately. If required, a volumetric composite sample of the cargo shall be prepared under controlled conditions for pre-discharge testing.

Where vessels are discharging under a restricted or closed system, inspectors should reference HM 52 / API *MPMS* Chapter 17.11 [10].

Specific manual sampling details can be found in 7.1.3.

7.2.4 Tank stripping operations/ROB

Vessel lines should all be drained before measurements begin.

The vessel's draught marks should be determined, ideally by reading the draught marks, and recorded along with the sea conditions. A comparison should be made with the vessel's declared readings and any differences resolved. Trim and list to be determined by the draughts recorded. Inspector to request list to be corrected prior to cargo measurement

Tank reference heights should be checked and compared with the corresponding values quoted in the tank calibration tables. Any differences should be investigated and reported.

The amount and nature of any ROB in all cargo tank(s) discharged should be determined and recorded. ROB should only be referred to as Liquid, Non-Liquid, or Free Water. When there is sufficient liquid available, level, temperature, and water measurement should be obtained, and a sample drawn for retention and principal(s) advised prior to vessel departure.

If the liquid is not in contact with all tank bulkheads, the wedge formula as described in Annex C should be used. Vessel compiled wedge tables can be used provided they are based on the formula in Annex C.

It is good practice to compare ROB with the OBQ quantities and investigate any differences.

All cargo tanks, including those containing part or previously loaded cargoes, should be measured and quantities recorded. Comparison should be made to measurements taken prior to discharge.

Where applicable, it should be confirmed, in the presence of the vessel's personnel, that the sea valves and overboard discharge valves remain sealed after discharge.

The quantities and types of material in all non-designated cargo spaces such as slops tank, void spaces, and ballast tanks should be determined and recorded.

7.2.5 Shore tank gauging and sampling

The shore tanks should be measured and sampled before and after discharge. Refer to 7.1.1, 7.1.2, 7.1.3, and 7.1.4 for procedures.

7.2.6 Reconciliation of measured quantities

Comparisons should be made between the quantities received ashore and the corresponding Bill of Lading quantities.

If the shore quantities differ from the corresponding Bill of Lading quantities by an amount greater than that set by the principal(s), or in the absence of any specific tolerances 0.3 %, this difference should be investigated.

With reference to Figure 2, the investigation should include a voyage analysis including:

- Bill of Lading to Outturn (1 – 4).
- Shore to vessel comparison at load port (1 – 2).
- In-transit difference (2 – 3).
- Vessel to shore comparison at discharge port (3 – 4).
- OBQ to ROB difference.

NOTE 1 The initial investigation could involve the use of provisional outturn figures.
NOTE 2 Vessel's figures should have the VEF applied, provided a valid VEF can be established.
NOTE 3 Further details can be found in EI HM 64 / API *MPMS* Chapter 17.5[7].

If differences remain unresolved, all principal(s) should be advised without delay. A letter of protest should be issued to terminal and vessel as soon as the difference is noted. The letter of protest to the vessel could need to be issued via the vessel's agent if the vessel has sailed.

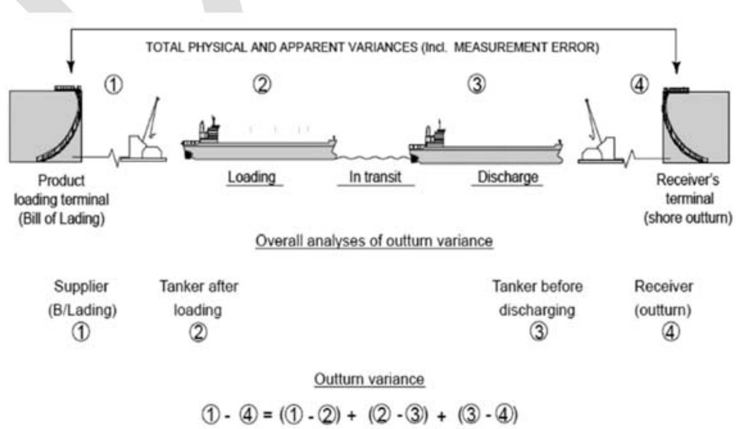


Figure 2: Marine transfer measurement points

Shore to shore difference, (4-1) = (2-1) + (3-2) + (4-3)
NOTE By convention, losses have a negative sign

8 CALCULATION OF QUANTITIES

8.1 GENERAL

This section refers only to the calculation of liquid chemical quantities, and not the calculation of quantities of chemical gases, animal or vegetable oil or molasses.

8.2 CALCULATION METHODS

Two broadly similar methods are used:

(a) Correct the density/specific gravity at standard temperature with the thermal expansion coefficient to the observed temperature and multiply this by the volume at observed temperature to obtain mass/weight. (Density/specific gravity refers to vacuum/air – mass/weight.)

(b) Correct the volume at the observed temperature to the volume at the standard temperature by applying a VCF after which the weight/mass is obtained by multiplying the standard volume with the density at standardtemperature.

It is sometimes the case that the quantity of cargo loaded (or discharged) is obtained by other methods, such as weighbridges. The inspector's report should include full details of the gross and tare weights of all individual units.

There are variations within the two methods, a) and b), including, but not limited to:

Correction to the density at standard temperature using either.

(a) product-specific tables of density at various temperatures, or

(b) a density correction factor, per degree difference in observed temperature.

Correction of observed volume using a VCF obtained from either:

(a) API-ASTM-EI *Petroleum measurement tables* (b, c or d)

(b) ASTM D1555 [13] and ASTM1555M [14] (metric edition), which tabulates VCFs for various aromatics.

(c) A VCF, per degree difference in observed temperature, obtained from a recognized source, supplied by principal or specifically determined and agreed by the commercial parties before vessel arrival.

(d) Product-specific tables of VCF, showing the VCF at observed temperatures, which shall be applied to obtain the volume at standard temperature.

As a result of the various methods used, reports should clearly state:

(a) the origin of the density used in the calculation;

(b) the origin of the VCF used in the calculation;

(c) the standard temperature used. (Standard temperatures are 15 °C, 20 °C or 60 °F; however, other temperatures may be used if mutually agreed), and

(d) the unit in which the final quantity is expressed; mass (weight in *vacuo*) or weight (weight in air).

Unless there are local requirements stating that quantities should be expressed as a mass (i.e., in *vacuo*), then it is preferable that they are expressed as a weight (i.e. in air).

8.3 EXAMPLES OF SHORE TANK AND MARINE TANK CALCULATIONS

Volumetric calculation

Example 1 – What is the volume at 60 °F and weight of a cargo of p-xylene using ASTM D1555 [13]

Measured volume	9 280 gallons
Measured temperature	88,7 °F
VCF by D1555[13]	0,98414
Volume at 60 °F	9 280 x 0,98414 = 9 132,8 gallons
Density at 60 °F	7,2086 lbs/gal
Weight	9 132,8 * 7,2086 = 6 5834,7 lb (air)

Example 2 – What is the volume at 15 °C and weight of a cargo of p-xylene using ASTM D1555M [14]

Measured volume	1 289 561 liters
Measured temperature	22,3 °C
VCF by D1555M [14]	0,99278
Volume at 15 °C	1 289 561 x 0,99278 = 1 280 250
Density at 15 C kg/l (air)	0,8643 kg/l
Weight	1 280 250 liters * 0,8643 kg/l= 1 106 520 kg

Example 3 – What is the volume at 15 °C of a cargo of MTBE using ASTM D1250 [15] C

Measured volume	1 289 561 liters	
Measured temperature	22,5 °C	
Coefficient of thermal expansion	0,0014202 alpha 15 per °C	
VCF by D1250 [15] table 54C	0,99360	
Volume at 15 °C	1 281 308 liters	
Density at 15 °C	0,7440 kg/l (vac)	0,7429 kg/l (air)
Mass	953 293 kg, 953,293 tonnes (vac)	
Weight	951 884 kg, 951,884 tonnes (air)	

8.3.1 Weight calculations

Example 4 – What is the weight of a cargo of Benzene using density correction coefficients?

The density at standard temperature is converted to density at measured temperature. Density at measured temperature is applied to measured volume to give weight.

$$p_t = p_s + (\Delta_t Cs)$$

Where:

p_t = density at measured temperature

p_s = density at standard temperature
Δ_t = difference in temperature (standard – measured)
Cs = density correction coefficient

Measured volume	1 289 561 liters
Measured temperature	22,5 ºC
Density coefficient	0,00100 kg/l per ºC
Density at 15 ºC	0,8831 kg/l (air)
Density at 22,5 ºC	0,8756 kg/l (air)
Weight	0,8756 kg/l * 1 289 561 l = 1 129 140 kg
Liters at 15 ºC	weight/density at 15 ºC (air)
	1 129 140 liters /0,8831 = 1 278 609 liters at 15 ºC

9 FINAL REPORT

On completion of a cargo inspection, a final report should be compiled. The format of this report depends upon any agreement reached between the principal(s). Although it could not be required for the final report, it is recommended that a copy of all documentation completed and retrieved during the inspection be retained on file for further reference. For the sake of consistency in reporting, it is suggested that a final report should contain the following information:

- cover letter highlighting any special operational problems that may have been observed, either aboard the vessel or ashore
- summary report: including Bill of Lading quantity, outturn difference, ship/shore differences (including adjustments by VEF), in-transit variation, change in OBQ/ROB, FW, etc.;
- time log;
- quantity report;
- analysis report;
- vessel's ullage report;
- vessel's OBQ/ROB report;
- vessel experience factor report;
- slops report;
- tank cleaning report;
- void space report;
- sample report;
- shore tank measurement and calculation reports;
- meter quantities and proving report;
- auto sampler performance report;
- line fullness verification;
- Letters of protest and notices of apparent discrepancy, and
- Copies of any other relevant supplementary documentation

9.1 INSPECTION DATA

When compiling an inspection report, all raw data from which the report is derived should be recorded in the inspector's notebook(s) and stored with the report.

ANNEX A (Informative) GUIDELINES FOR VERIFYING THE ACCURACY OF MANUAL GAUGING EQUIPMENT

A.1 INTRODUCTION

Static measurement procedures before, during and after the loading and discharging of cargoes, require the accurate determination of levels, temperatures, density, and free water. The accuracy of all apparatus used for these determinations should, therefore, be verified against standard equipment traceable to recognized national standards. Electronic ullage, temperature and water interface detectors may require frequent maintenance and should always be subject to accurate checking or calibration. More details on calibration are contained within HM4 – *Manual level measurement for hydrocarbon liquids* and API *MPMS* Chapter 3.1A[1] – *Standard practice for the Manual Gauging of Petroleum and Petroleum Products.*

A.2 LIQUID-IN-GLASS THERMOMETERS

A.2.1 Laboratory inspection

Before initial use and at least once a year thereafter, each thermometer should be checked in the laboratory against a certified thermometer at three or more temperatures across the operating range.

A.2.2 Field inspection

Before using a thermometer, a visual check on the integrity of the thermometer should be made to ensure it is not broken or that the bulb and visual thread does not contain air bubbles.

A.3 PORTABLE ELECTRONIC GAUGING DEVICES (PEGD)

Equipment may be single function device or may be part of a multi-functional device (ullage, temperature and oil/water interface). In either case, accuracy should be checked before use in accordance with the manufacturer's instructions. Equipment should operate within maximum permissible tolerances specified in ISO 4512 [24] and ISO 4268 [26]. PEGD should be calibrated against a recognized national standard at least annually. A copy of the calibration certificate for the PEGD should be available on request.

Electronic thermometers whether single function device or as part of a multi-functional device, should be checked for accuracy using a constant temperature bath on a monthly basis at two or more temperatures across the operating range.

Prior to use, PEGD should be checked against reference thermometers at one or more temperatures near to the expected operating temperature range.

A.4 MANUAL GAUGING TAPES

Manual gauging tapes should conform to HM 4 [16], ISO 4512 [24], API *MPMS* Chapter 3.1A[1] or equivalent national specifications.

Manual gauging tapes should be examined prior to use; any tapes which are illegible, kinked or damaged, worn or unreadable scale, should not be used for Custody Transfer measurements.

A.5 DENSITY DETERMINATION

A.5.1 Hydrometers

The accuracy of a hydrometer should be verified annually against a recognized national traceable standard hydrometer that has been calibrated or verified, or both, in accordance with EI IP 160 [20] / EI IP 235 [21] / ASTM E126 [11].

Each hydrometer is manufactured with a thin line etched about the top of its stem corresponding exactly to a line on the paper scale inside the stem. The coincidence of these two lines should be checked before every measurement to ensure that the paper scale has not moved. There may be other types of hydrometers where the etched line is replaced with, for example, a colored band.

A.5.2 Laboratory Densitometers

The accuracy of a densitometer should be verified prior to use in line with the laboratory Statistical Quality Control (SQC) or verified regularly against a traceable standard.

Care should be taken to ensure that no air is present in the glass measuring tube.

ANNEX B (Informative)
MONITORING METERING SYSTEM PERFORMANCE

B.1 INTRODUCTION

To maintain the highest level of accuracy at all flow rates during the loading of a cargo, it is essential that both the performance of the meter and proving systems are monitored.

It should be recognized that monitoring the functioning of the equipment and instrumentation is a complex task which when required will need to be carried out by a specialist.

There are, nevertheless, some checks which a cargo inspector should perform in order to ensure that the measurements taken and quantity shown on the Bill of Lading are correct. These checks are described in this Annex.

For details of proving procedures and corrections for the effects of temperature and pressure, reference should be made to EI HM 12 [18] *and/or* ISO 7278 parts 1 [28] and 2 [29], or API *MPMS* Chapter 4.5[3]. ISO 4267-2:1988 [25], Petroleum and liquid petroleum products — Calculation of oil quantities — Part 2: Dynamic measurement for the calculations and EI HM 10 [17] and ISO 7278-1 [28] and 2 [29] for procedures.

B.2 METER AND PROVING CALCULATIONS

B.2.1 Meter factor

A meter factor is used to convert a meter reading to the volume of oil (GOV) that has passed through the meter. There are two meter factors in common use. K-factor relates the collected pulses to the measured volume. Meter Factor is the multiplier to the meter indicted volume to give the 'true' volume. If a K-factor based on a nominal value is to be used a meter factor may be derived from proving to correct the 'nominal volume to a 'true' value. Definitions of these are given in Section 2. In modern metering stations both K-factor and a meter factor to correct a nominal K-factor are most commonly used.

To derive the factor required, the meter is proved by passing an accurate volume of liquid through the meter and noting the meter output. The K-factor can be calculated directly as can the meter factor if the output is either mass or volume units. K-factor may also be derived from pulsed output meters from the pulses, prover volume and nominal K-factor. In describing or demonstrating the performance of the meter, inspectors may also be shown the performance expressed as (Relative) error expressed as a percentage. This is conventionally defined as:

$$E = \frac{Qi - Q}{Q} 100\% \qquad \text{(Equation B.1)}$$

Where:

Q is quantity (mass or volume) as measured by the reference prover
Qi is quantity (mass or volume) indicated by the meter

B.2.2 Meter factor

In large metering stations a pipe prover, or a small volume prover which can be regarded as a special case of a pipe prover, is used to determine the accurate (or 'true') volume passed through the meter during proving.

A pipe prover will have been calibrated and its volume between switches (base volume) will be expressed as the volume at standard conditions of temperature and pressure. These are normally 15 °C and 101.325 k Pa or 60 °F and 14.7 psi. This volume should be adjusted to the proving conditions by applying correction factors for the effect of temperature and pressure on the steel used in the construction of the prover. If the volume of the prover at the standard conditions is denoted by V_b, and the corrected volume of the prover at the proving conditions by V_c, then:

$$V_c = V_b \times C_{tsp} \times C_{psp} \qquad \text{(Equation B.2)}$$

where:

C_{tsp} is the correction factor for temperature on the steel of the prover
C_{psp} is the correction factor for pressure on the steel of the prover

The meter factor (F) and K-factor (K) are given by:

$$F = V_c/V_i \qquad \text{(Equation B.3i)}$$

$$K = n/V_c \text{ pulses/m}^3 \qquad \text{(Equation B.3ii)}$$

where:

n is the number of pulses generated by the meter whilst proving
V_i is the volume indicated by the meter or calculated from nominal K-factor.

When the meter and prover are close coupled, and preferably lagged, the meter and prover operate at the same conditions of temperature and pressure and the equations above apply. However, frequently this is not the case and the meter and prover operate at slightly different temperatures and pressures and this should be taken into consideration. If the temperature and pressure between the meter and prover are greater than 0,1 ºC and 50 kPa (0.5 bar) theK-Factor determined at proving should be calculated.

This may be achieved in two ways:

Todetermine the result at the meter conditions differences in volume are allowed for by applying the correction factors C_{tl} and C_{tlp} determined for the temperature and pressure difference between the prover and the meter.

More commonly however this is carried out by bringing the liquid in the meter and prover to the same conditions, which for convenience are the standard conditions of 15 ºC and 101.325 kPa (in some transactions 60 °F may be the standard used).

$$K = \frac{n \times C_{tlm}}{V_c \times C_{tlp}} \times \frac{C_{plm}}{C_{plp}} \qquad \text{(Equation B.4)}$$

where:

C_{tlm} is the correction factor for temperature on the liquid in the meter
C_{plm} is the correction factor for pressure on the liquid in the meter
C_{tlp} is the correction factor for temperature on the liquid in the prover
C_{plp} is the correction factor for pressure on the liquid in the prover

Frequently, equation (B.4) is given in terms of the prover base volume V_b by substituting equation (B.2).

C_{tlm} and C_{tlp} are obtained directly from the equations used to generate the Petroleum Measurement Tables and for tank measurements are termed VCFs. C_{plm} and C_{plp} are obtained from petroleum measurement equations also.

The current version of the petroleum measurement table – API *MPMS* Chapter 11.1[5] are computer implementations and combine pressure and temperature correction factors into a single correction.

In some systems the K-factor in use is changed after each proving, in others the result is used to verify the K-factor is within a tolerance from a predetermined value, and if so, no adjustment is made.

Frequently, a new K-Factor is derived for every transfer. This may involve proving prior to the transaction, taken from a previous transaction, or during the transaction.

In some installations where the meter is proved during the transaction, a new K-factor would not be available until after the full delivery and then an alternative method is used.

This nominal value may be the value specified by the meter manufacturer or a nominal value defined from historical calibrations. A nominal GOV, and hence a nominal GSV, are derived using K_n and then corrected to derive the 'true' GOV and the GSV of the cargo transferred through the meter.

GOV and GSV can then be corrected for any variation in the measured K-factor (or meter factor) from the nominal value at the end of the transaction.

$$\text{GOV (true)} = \text{Nominal GOV} \times K_n/K_p$$
$$\text{Nominal GOV} = N/K_n \qquad \text{(Equation B.5)}$$
$$\text{GOV (True)} = N/K_p = \text{Nominal GOV} \times K_n/K_p$$

K_p = K-factor obtained when proving.

It is not possible to manually check a metering station; all that can reasonably be done is to determine if the final metered GSV is substantially correct by taking the metered GOV and applying average corrections for pressure and temperature. If a nominal GOV is printed out an average meter factor should be applied.

NOTE Some metering systems continually compensate mechanically for temperature during the transfer. This is particularly true of positive displacement metering systems.

B.2.3 Linearity

As flow meters have a specified linear range of flow rates, the performance of the meter across a specified flow rate range is normally determined by proving. This determination may be carried out for each transaction by proving each meter at a number of different flow rates, with a K-factor, meter factor or error determined at each flow rate. Alternatively, this exercise is carried out at specified intervals with an assumption linearity is unchanged if the K-factor at a fixed (duty) point is unchanged within specified limits. More advanced flow computers will allow the input of K-factor at a number of flow rates and hence non-linearity errors are reduced significantly.

B.3 MONITORING PROCEDURES

The following procedures are recommended for monitoring the measurement data obtained during the transfer:

- If used, the value of the nominal meter K-factor (K_n) should be verified from records and confirmed as having been correctly entered or set into the electronic totalizer or flow computer. It should be noted if linearity based on multiple flow rates is being applied.
- Proving of each meter should be witnessed during transfer to check that:
  - The meter factor K-factor was obtained at approximately the average flow rate of the transaction under stable operating conditions.
  - The repeatability of the proving results at any one flow rate is within specification in ISO 2714 [22], ISO 2715 [23] and HM 10 [17] / ISO 7278 [27]. (Older standards such as ISO 7278 [27] and EI HM 12 [18] suggest the range of consecutive meter or K-factors is within 0,05% in a sequence of five proving runs. Newer standards (API *MPMS* Chapter 4.5[3]) have allowed the use of more or fewer proving values with acceptance based on a standard deviation of the results. This will be a method employed more often when proving ultrasonic meters or when using small volume provers.
  - The temperature difference between meter and prover for each proving run is less than 0,2 °C.
  - The prover base volume used in the computation is valid.
  - The meter factor is within ±0,2 % of the previous meter factor at equivalent operating conditions.

NOTE Most flow meters will have a meter factor or K-factor dependent on the temperature and viscosity of the liquid. Comparisons therefore have to be made with similar viscosity, temperature, and flow rate. Additionally, check the tranfer itself is carried out within the linear range of the meter.

If there are any discrepancies, then the cargo inspector should immediately advise all principals concerned and issue a letter of protest.

ANNEX C (Informative**)**
WEDGE FORMULA CALCULATION

The original wedge formula was based on a rectangular section tank with no corrections for the difference in volume resulting from the vessel hull curvature.

Subsequently this formula has been adapted to take these curves into account. This has been achieved by calculating the theoretical width of the tank.

Use consistent units throughout the calculation.

C.1 CALCULATION OF THE TRIM FACTOR

In all wedge calculations the common angle is the trim angle of the ship.

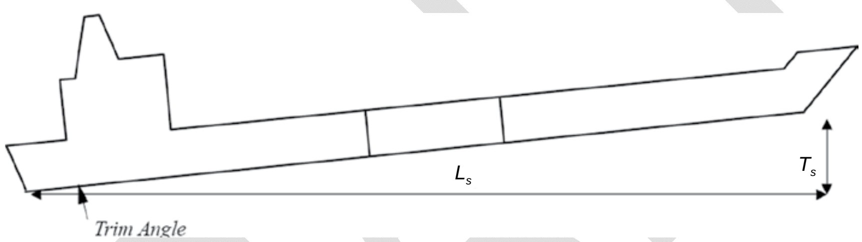


Figure C.1: Schematic showing the trim angle of a ship

The tangent of this angle is T_s/L_s. In formula:

$$F = \frac{T_S}{L_S} \quad \text{(Equation C.1)}$$

in which:

F	is the trim factor
T_s	is the trim of the vessel
L_s	is the length between perpendiculars

C.2 CALCULATION OF THE LENGTH OF THE WEDGE

The calculation of the length of the wedge is necessary in order to check whether the wedge formula can be applied.

Figure C.2: Schematic to calculate the wedge length

The tangent of the trim angle equals D_a / L_w. This implies that L_w can be expressed as

$$L_w = \frac{D_a}{T_s} \times L_s \qquad \text{(Equation C.2)}$$

in which:

L_w is the length of the wedge
D_a is the height of the wedge against the aft bulkhead
T_s is the trim of the vessel
L_s is the length between perpendiculars

If the length of the wedge is greater than that of the tank then, in fact, no wedge exists as liquid is in contact with all tank bulkheads. Volume is therefore determined using vessel trim corrections and tank calibration tables.

C.3 CALCULATION OF D_a

The diagram below shows the sounding (dip) being taken from a position on deck, at a distance of *U* from the aft bulkhead.

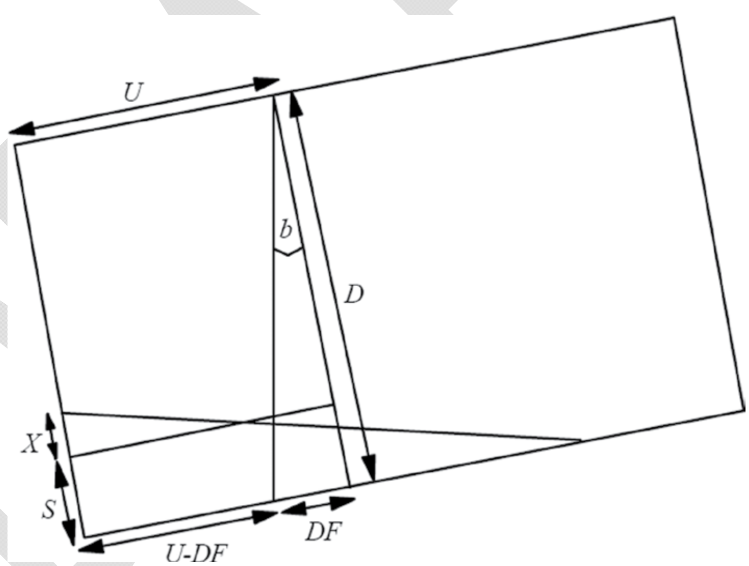


Figure C.3: Schematic of the sounding (dip) from a position on deck at a distance of U from the bulkhead

The corrected sounding against the aft bulkhead (D_a) is the original sounding (*S*) plus a correction (*X*). *X* can be calculated via the equation:

$$X = F \times (U - DF) \qquad \text{(Equation C.3)}$$

As angle *b* has the same value as the trim angle, *DF* can be obtained by multiplying the total (reference) height by the trim factor as determined in C.1.

The full equation for the calculation of the height of the wedge against the aft bulkhead:

$$D_a = S + (F \times (U - DF)) \qquad \text{(Equation C.4)}$$

in which:

D_a is the height of the wedge against the aft bulkhead
S is the original sounding
F is the trim factor (T_s/L_s)
U is the distance from gauge point to aft bulkhead
D is the reference height of the tank at gauge point

C.4 WEDGE FORMULA BASED ON THE TANK WIDTH

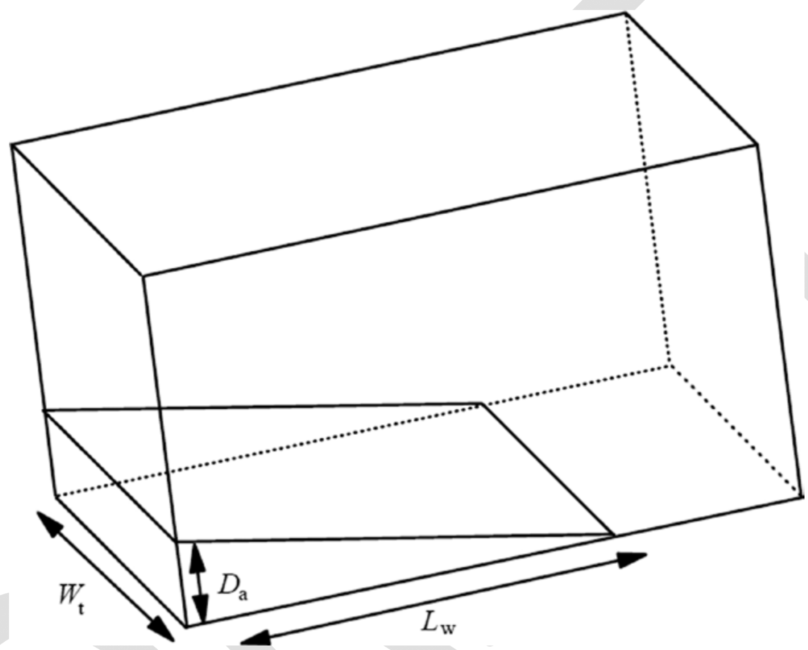


Figure C.4: Schematic to calculate the wedge formula based on tank width

The content of the wedge (V_w) is:

$$V_w = \frac{L_w \times D_a \times W_t}{2} \qquad \text{(Equation C.5)}$$

in which:

L_w is the length of the wedge
D_a is the height of the wedge against the aft bulkhead
W_t is the width of the tank

D_a and L_w should be calculated. W_t can be extracted from the vessel's general arrangement and/or capacity plans.

Combination of equations C.2 and C.5 will give as volume of the wedge:

$$V_w = \frac{D_a^2 \times L_s \times W_t}{2 \times T_s} \qquad \text{(Equation C.6)}$$

However, due to the fact that this equation does not take account of deadwood, curves in the bilge strake of the wing tanks and possible sumps and wells in tanks fitted with a double bottom, the method described in the next paragraph is preferred.

C.5 WEDGE FORMULA BASED ON THEORETICAL TANK WIDTH

The principal difference between this formula and the conventional wedge formula, is the calculation of the theoretical tank width (W_{th}).

The need for this theoretical tank width is based on the fact that wing tanks do not maintain their deck-width as progress is made toward the bottom of the tank.

Therefore, the width of the wedge is considerably smaller in those tanks since ROB/OBQ is typically at the tank bottom.

The theoretical tank width is calculated by dividing the volume taken from the tank table at an even keel, by product innage x tank length. The result should then be the actual width of the tank at that mean product-level.

The procedure is as follows:

- First calculate the liquid height at the aft bulkhead of the tank, see equation C.3.
- Then determine whether the product is in a wedge via the length of the wedge, see equation C.2.
- Calculate the theoretical tank width.

This is done via the mean adjusted sounding ($D_a/2$). Next look in the ship's calibration tables in the even keel section and find the table volume related to a sounding of $D_a/2$. (T_v).

The theoretical width of the tank can now be found with the following equation:

$$W_{th} = \frac{T_v \times 2}{L_t \times D_a} \qquad \text{(Equation C.7)}$$

Substitution of the theoretical tank width in equation C.6 will lead to the final wedge formula:

$$V_w = \frac{D_a \times L_s \times T_v}{T_s \times L_t} \qquad \text{(Equation C.8)}$$

in which:

V_w is the volume of the wedge
D_a is the height of the wedge against the aft bulkhead
L_s is the length between perpendiculars
T_v is the table volume at $D_a/2$
T_s is the trim of the ship
L_t is the length of the tank

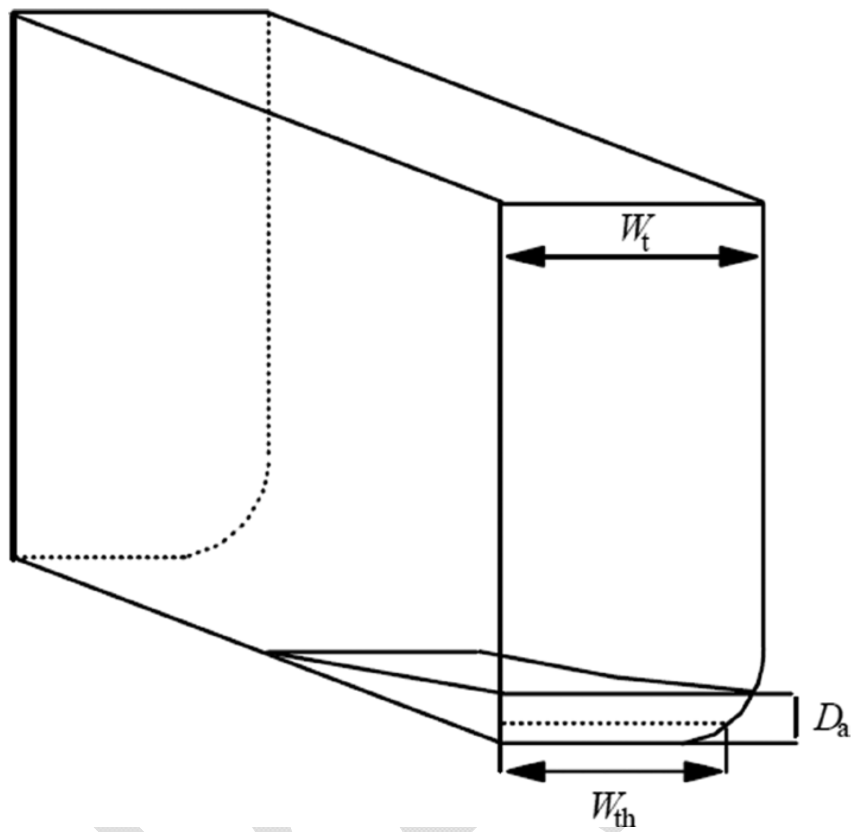


Figure C.5: Schematic representing the theoretical tank width

ANNEX D (Informative**)**
OFFSHORE AND SHIP-TO-SHIP TRANSFER OPERATIONS

D.1 GENERAL

This annex provides additional guidance on the measurement and reconciliation at offshore facilities and ship-to-ship (STS) transfer operations of cargoes between vessels which can take place offshore or at a berth.

D.2 SAFETY – PERSONNEL TRANSFERS

Access to vessels at sea is considered a high risk activity and is covered under section 4.7.

D.3 INSPECTION

All measurements and sampling should be performed in accordance with section 7. However, where vessels are offshore consideration should also be given to the following points;

During offshore or STS operations, or when the vessel is at an exposed berth, cargo may be in motion within the vessel's tanks. When cargo levels are in motion, please follow the procedures indicated in API *MPMS* Chapter 3.1A[1]. In the event that three gauges cannot be taken within a range of 3 mm (or 1/8 in.) because the cargo is moving, at least five readings should be obtained in minimal time, recorded, and then averaged. The ullage/outage gauges are to be taken as quickly as is practical and the immersion time of the bob/tape should be as brief as possible. Adverse conditions such as these should be recorded.

Whenever possible, hoses being used for the transfer of cargoes should be inspected for cleanliness and information requested with regard to previous use to ensure suitability for the transfer in question.

Consideration should be given to the sampling requirements due to the logistics of moving samples and equipment to and from the vessel. The number and type of samples required should be agreed with principal(s) prior to departure to the vessel.

D.4 RECONCILIATION OF FIGURES

Calculate the quantities in each vessel's tank according to section 8.

When STS operations are undertaken the Bill of Lading figures can be calculated in a number of ways. Prior to attendance the inspection company should seek clarification from their principal(s) as to how the Bill of Lading is to be calculated. Some examples are listed as follows:

Examples;

1. The average of the delivered and received figures.
2. Delivered figures.
3. Received figures.
4. Transfer of original Bill of Lading to receiving vessel.

Application of VEF is a commercial decision and may be applied to examples 1, 2 and 3 as instructed by principal(s).

The method for Bill of Lading calculation should be consistent throughout the STS operation.

D.5 REPORTING AND FINAL REPORT

All reporting should be performed in accordance with the main document; however, due to the offshore location of the transfer area it is possible that this will be outside of most mobile phone network's coverage and principal(s) should be advised accordingly as this will delay the issuing of information.

ANNEX E (Informative)
WALL WASH GUIDELINES

Chemical tankers frequently load and discharge multiple different high purity cargoes which have no tolerance to contamination from earlier (prior) cargoes.

Due to the sensitive nature of certain chemical cargoes, the standard visual inspection of the tank surfaces may not be sufficient to eliminate the risk of contamination and acceptance procedures may require testing of wall wash samples. Conducting a wall wash operation will involve entry into confined spaces (please refer to section 4.6)

A) Traditional Wall Wash

The purpose of 'washing' small, but representative, areas of the tank walls is to identify by chemical analysis, trace amounts of materials that may be detrimental to the cargo. Such contaminants, if any, may have originated from the tank cleaning materials or previous cargo or may have survived through additional intermediate cargoes. Refer to API *MPMS* Chapter 17.8 [9] and ASTM E2664 [12] for various wall washing methods.

The most common method of taking a sample is to choose an area(s) of the tank wallabout 1 meter wide and about 2 meters from the bottom of each tank. A sample of laboratory grade methanol or, in some cases, of the cargo to be loaded is cascaded over the surface of the tank either directly from a bottle or from a spray bottle where it is allowed to run down the surface. The run-down is then collected in a bottle held at about 1 meter below by use of a flat sided funnel. An alternative method is to allow the cascaded liquid to run over and be absorbed by filter papers. The filter papers are then transferred to a bottle before being tested. Wall wash sampling is easier if there are two inspectors available. The wash material should be of an equal or better quality than the cargo being loaded to avoid erroneous results.

Recommendations for wall washing are as follows:

- Tank surfaces should be dry.
- Type of tank coating should be checked to be compatible with product to be loaded
- Discolored or broken coating sections on tank walls should be sampled as follows:
  a) Where such areas are less than 20 % of total surface area (excluding deckheads), the washings should be included with those of the rest of the tank.
  b) Larger areas should be sampled and tested separately.
- Samples should be tested under laboratory conditions.
- The minimum number of areas to wall wash depends on the tank capacity:

Tank capacity	Minimum No. of areas to wash
less than 500 M3 (3000 bbls)	5
500-1000 M3 (3000-6300 bbls)	7
Greater than 1000M3 (>6300 bbls)	9

Inspectors should be aware that wall wash sampling procedures may cause a previously gas free tank to develop an unsafe atmosphere. (See confined space guidance in 4.6).

B) **Tank condition assessment using spectroscopic assessment of wash water**

A more modern approach, consistent with

1. Improved Health and Safety practice, as no tank entry is required
2. A more complete assessment of the cargo handling equipment to be used, as the wash water is taken from all surfaces of the tank, rather than a small area, and from the associated lines and pumps.

is to assess the level of cleaning achieved by passing wash water samples through a small, on board spectroscope and, using established calibration graphs, continue cleaning operations until as defined residual concentration is measured in the wash water.

Each previous cargo is assessed using calibration charts supplied either by the equipment manufacturer, or by another authority, such as the charterer.

The usual procedure is that tank cleaning operations are carried out before the vessel reaches port, and the spectroscopic evidence provided to Inspectors by the ship's crew either electronically before arrival or possibly on arrival as a physical copy. The inspection company staff have to review the data presented, compare it with the supplied reference data, and then note if the supplied data conforms or does not conform to the criteria specified by the stakeholder(s).

The spectroscopic assessment procedure is applicable for products and chemicals that are sufficiently water soluble for detection to be effective. Thus, for certain chemicals the traditional wall washes will be required.

It should be noted that, at the present time, this process, whilst both an improvement over the existing wall wash practices, is not yet universally accepted, nor is it established in claim situations to the same degree that wall wash processes have been for decades, with responsibilities not defined.

ANNEX F (Informative)
PIGGING OPERATION

Typical Procedure for Pigging Method

1. Refer to the product Safety Data Sheet before pigging any product, and safety precautions including Personal Protective Equipment (PPE) should be observed.

2. The correct propellant for the pigging operation should be selected, appropriate to the product

3. Before opening the pig launcher, the Operator will ensure the main line isolation valve is closed and the launcher's vent/drain valve is open.

4. While standing to one side of the line to be pigged, open end closure.

5. Insert the suitably sized pig and position it in the pig trap/launcher (utilizing the metal launcher cage if necessary).

6. Check the gasket is in good condition, (new gasket should be used every time) and correctly aligned. Close the end closure and seal using a "full head of bolts".

7. Ensure all vent and drain lines are closed.

8. Connect air/nitrogen hose (as appropriate for product to pigged) to the launcher.

9. All pigging operations should be undertaken with both ends of the pipeline to be pigged attended by Operators liaising directly by phone or radio.

10. Only one pigging operation should be completed at once, this helps to confirm the routing of the pipeline

11. The Duty Operator at the launching end should ensure the receiving end is ready to receive the pig and get the Receivers authority to launch prior to firing the pig.

12. The Operator launching the pig should announce which line the pig is being sent down, the receiving Operator should also state which line he is expecting to receive the pig into and his location on the site.

13. The Duty Operator at the receipt end of the line will, before giving permission for the pig to be launched, confirm that all valves are correctly set. In particular they will check and confirm the following:

    a. The drain valve is closed
    b. The main line valve is open (inlet)
    c. The tank side valve is open (outlet)
    d. The end closure is tight and secure (full head of bolts)

14. After receiving clearance, the Duty Operator at the launching end of the pipework will now proceed as follows:

a. Slowly open the air/nitrogen supply to the launcher.
b. Check the pipework for leaks.
c. If there are no leaks vent pressure from the launcher via the vent/drain valve.
d. Close the vent/drain valve and slowly open the main pipework line valve.
e. Slowly open the air/nitrogen supply to the launcher.
f. Advise the receiving Operator "pig launched".

15. The receiving Operator will confirm that this message has been received. If confirmation is not forthcoming the operation will be shut down immediately.

16. Control of the pig's speed will be the responsibility of the receiving Operator. They should monitor the pressure on the pipeline by listening to the speed of the liquid being released through the gagged valve on the outlet of the pig receiver. Adjustments should be made if required by opening or closing the outlet valve on the pig receiver.

17. When the pig is received the receiving Operator will advise the launching Operator to close the air/nitrogen supply.

18. On receipt of advice that the pig has been received the launching Operator will close the air/nitrogen valve and the main line isolation valve. They will then inform the receiver that this action has been carried out.

19. On confirmation that the air/nitrogen supply has been isolated and the main line valve is closed, the receiving Operator will allow as much pressure through the line into the receiving tank as possible (when pigging liquid into the tank) and then close the pig receiver valve.

20. The receiving operator should isolate all valves to the pig receiver and check the pressure gauge within the pig receiver. All pressure should be released to a safe area before attempting to remove the pig receiver door.

21. Once the pig is removed it should be washed out and squeezed dry before being placed in the appropriate pig skip.

22. The Duty Operators will then agree who will be releasing the remaining pressure in the line. The line will still contain residues of the product so an assessment should be made to ensure the pressure is released into a safe area away from the Operators place of work.

23. Having decided how the excess line pressure will be handled, it will be done so in a controlled manner. Any drain points or vent lines used will be closed and capped after use.

Operational Notes:

Given the wide variety of line size, complexity, materials and even product sequences, each procedure should be reviewed by a knowledgeable person in its own context.

There are a variety of types of pig in use, ranging from multi cup hard pigs through speedball type to foam pigs. The type of pig being used will have a significant influence of how effective the pigging operation, particularly an individual transit with a foam pig, is at clearing the line completely. It may be necessary to pig a line multiple times with a foam pig, particularly if the line in question is long, has many bends, or has contained a viscous product, to achieve a similar clearance that a single transit multi cup hard pig might on a short straight line. The choice of pig, the operations associated with pigging, and the maintenance and control of the equipment and operation are a matter for the facility operator, not the inspector.

The assessment of a pig trap and pig after transit alone, whist useful, is not a full assessment of a line and any residues. Subsequent line flush operations and the analysis of flushed product is a better guide to the effectiveness of any line clearance operation, be it line blowing, pigging or other. The assessment of the pig and pig trap shouldn't be relied upon as a definitive assessment of the whole line condition.

Any line clearance operation should be subject itself to an assessment, including the documentation of key paraments such as line size, length, complexity, including hose exchanges etc., the product characteristics of both previous contents and product intended to pass through the line.

The attending Inspector has to rely on the information provided by the terminal in relation to prior cargo(es) and any washing/cleaning performed on the shore line prior to pigging.

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This publication has been produced as a result of standards development work within the Committee on Petroleum Measurement (COPM) of the American Petroleum Institute and the Hydrocarbon Management Committee (HMC) of the Energy Institute. COPM and HMC develop and maintain state of the art hydrocarbon measurement standards used around the world.

AMERICAN PETROLEUM INSTITUTE
1220 L Street Northwest
Washington, DC 20005-4070
USA

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Energy Institute
61 New Cavendish Street
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e: pubs@energyinst.org

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ISBN:978 0 85293 737 2

9780852937372