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Contents

Contents

Introduction

For any given vessel, a ratio can be established between the quantity of liquid bulk cargoes measured on board the vessel and the corresponding measurement by a load or discharge facility. This ratio, called a Vessel Experience Factor (VEF) is a historical compilation of shore-to-vessel or vessel-to-shore cargo quantity differences and is used as a loss control tool to assess the validity of quantities derived from shore measurements. When agreed by interested parties, Bill of Lading or Outturn quantities may be determined based on vessel received or delivered quantities adjusted by the VEF, in cases where shore based measurements are not available, or are known to be inadequate for custody transfer. In the event of a dispute regarding the application of a VEF, resolution shall be made by the commercial parties involved.

Vessel capacity tables (Gauge Tables) are often calculated from the vessel's building plans, rather than based on accurate physical tank calibration measurements. There are usually differences between the quantity of a cargo measured in a calibrated shore tank or by a custody transfer meter, and the same cargo determined by vessel tank measurements. For a given vessel the use of quantity data from many voyages provides an indication of vessel measurement differences, as a numerical ratio. This ratio can also include other load and discharge factors. For each voyage a Vessel Load Ratio (VLR) and Vessel Discharge Ratio (VDR) can be calculated. The VLR or VDR is the quantity received or discharged as measured on the vessel (TCV – ROB or OBQ) divided by the Bill of Lading (shore delivered at loading) or Outturn Quantity (shore received at discharge) respectively. The mean of the qualifying VLRs or the VDRs over several voyages is called the VEF (VEFL and VEFD for load and discharge respectively.)

This standard provides a method for calculating VEF. The method uses an average of qualifying ratios, which fall within ±0.30 % of the mean. Certain voyages, including those considered to contain Gross Errors will be excluded from the mean calculation, as described in Section 8 of this standard. This method is preferred and should be used unless all parties specifically agree to an alternate method. See Annex D for an alternate method employing a statistical outlier rejection technique to discard unsatisfactory data.

A VEF cannot be calculated using voyages where load or discharge shore quantities are based on vessel measurement.

This document was developed by a joint American Petroleum Institute and Energy Institute Hydrocarbon Management Working Group.

Vessel Experience Factor (VEF)

1 Scope

This standard provides a recommended practice for the calculation and application of a VEF and provides guidelines for data compilation, data validation, and recommendations on the appropriate use of VEF during custody transfer involving marine tank vessels. It also provides clear guidance on maintenance of quantity data on board the vessel, calculation of VEFs and application of VEFs. The key aim is to provide a single unambiguous figure for VEFL or VEFD and to remove the possibility of any arbitrary inclusion or exclusion of data on the part of the individual(s) performing the final calculation. Close attention has been paid to the calculation method which has been tested using historical data. Bearing in mind the uncertainty which will attach to any individual measurement (including those being 'corrected' using the VEF figure) the calculation method will provide a stable and robust ratio.

The standard also provides instruction for parcel tankers, part cargoes, compartmental VEFs, and vessel-to-vessel transfers. The methods are applicable to liquid bulk cargoes including crude oil, petroleum products, chemicals, and LPGs.

2 Normative References

2.1 General

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

2.2 API/EI Documents

API *MPMS*, Chapter 17.5/EI HM 54, *Guidelines for Cargo Analysis and Reconciliation*

2.3 API Documents

API *MPMS*, Chapter 17.1, *Marine Measurement—Guidelines for Marine Cargo Inspection*

API *MPMS*, Chapter 17.2, *Measurement of Cargoes On Board Tank Vessels*

API *MPMS*, Chapter 17.4, *Method for the Quantification of Small Volume on Marine Vessels (OBQ/ROB)*

2.4 EI Documents

HM 28 [1], *Procedures for oil cargo measurements by cargo surveyors,* Section 1—*Crude oil*

HM 29, *Procedures for petroleum product cargo measurements by cargo inspectors*

HM 30, *Procedures for oil cargo measurements by cargo surveyors,* Section 3—*Liquefied petroleum gases*

2.5 Other Documents

ISO 8697 [2], *Crude petroleum and petroleum products—Transfer accountability—Assessment of on board quantity (OBQ) and quantity remaining on board (ROB)*

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1 Energy Institute, formerly the Institute of Petroleum, 61 New Cavendish Street, London W1G 7AR, UK, www.energyinst.org.uk.

2 International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.

3 Definitions

For the purposes of this document, the following definitions apply.

3.1
clingage
The liquid film that adheres to the inside surface of a container after it has been emptied.

3.2
compartmental VEF
A VEF based on ratios of only a specific vessel cargo compartment (tank) and corresponding shore quantities based on the standards as described for generating a valid VEF.

3.3
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

3.4
list correction
The correction applied to the volume or gauge observed in a vessel's tank when the vessel is listing, provided that liquid is in contact with all bulkheads in the tank.

List correction may be accomplished by referring to the list correction tables for each of the vessel's tanks or by mathematical calculation.

3.5
load on top
LOT
Defined both as a procedure and a practice as follows:

> *Procedure:* The shipboard procedure of collecting and settling water and oil mixtures, resulting from ballasting and tank cleaning operations (usually in a special slop tank or tanks), and subsequently loading cargo on top of and pumping the mixture ashore at the discharge port.
>
> *Practice:* The act of commingling onboard quantity with cargo being loaded.

3.6
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 emulsions, sludge, and sediment.

3.7
partial VEF
A VEF based on ratios of a specific set of compartments, or amount less than 75 % of a vessel capacity, with corresponding shore quantities based on the standards as described for generating a valid VEF.

3.8
remaining on board
ROB
Refers to material remaining in a vessel's cargo tanks, void spaces, and/or pipelines after the cargo is discharged. ROB includes any combination of water, oil, slops, oil residue, oil water emulsions, sludge, and sediment.

3.9
total calculated volume
TCV
The total volume of all petroleum liquids and sediment and water, corrected by the appropriate volume correction factor (Ctl) for the observed temperature and API gravity, relative density, or density to a standard temperature such as 60 °F or 15 °C and also corrected by the applicable pressure correction factor (Cpl) and meter factor, plus all free water measured at observed temperature and pressure (gross standard volume plus free water).

3.10
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.

3.11
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 tanks or by calculation.

3.12
vessel discharge ratio
DVR
The total calculated volume (TCV) by vessel measurement on arrival, less remaining on board (ROB), divided by the TCV by shore measurement at discharge [DVR = (TCV arrival volume – ROB)/TCV received on shore at discharge].

3.13
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.

3.14
vessel load ratio
LVR
The total calculated volume (TCV) by vessel measurement on sailing, less onboard quantity (OBQ), divided by the TCV by shore measurement at loading [LVR = (TCV sailing volume – OBQ)/TCV received from shore at loading].

4 VEF Considerations

4.1 General

All measurement data used must be based on current API/EI measurement standards for custody transfer purposes.

A vessel’s quantity can differ from shore quantity for a number of reasons, including:

— the inherent inaccuracies associated with measuring cargo found on board prior to loading (OBQ) or remaining on board after discharge (ROB), including undetected clingage;

— inaccuracies in the vessel’s engineering and/or architectural quantity calculations and measurement tables, including wedge calculations, trim, and list corrections;

— modifications, renewal, or additions to vessels tanks that may not be accounted for;

— measurement errors;

— volumetric shrinkage;

— partly full or empty vessel or shore lines;

— shore tank or meter calibration errors;

— evaporative losses;

— permanent or temporary tank deformation;

— permanent or temporary vessel deformation, i.e. hogging or sagging, which can affect trim;

— weather conditions affecting measurement.

The following are typical vessel transfer categories:

— Single Cargo Single Port;

— Multiple Cargoes Single Port;

— Single Cargo Multiple Ports;

— Multiple Cargoes Multiple Ports;

— Vessel to Vessel.

4.2 Reason for VEF

The VEF is primarily a loss control tool to help assess the validity of quantities calculated from shore side (tanks, meters, etc.), offshore or other vessel measurements. When agreed by interested parties VEFs may also be used to determine custody transfer quantities when shore-based measurements are not available, or are known to be inadequate for custody transfer.

A consistent vessel/shore ratio allows the calculation of a viable VEF. The VEF may then provide a reliable means for review of quantities loaded or discharged, provide meaningful cargo reconciliation and if credible shore measurement is not available, a means to determine Bill of Lading or Outturn quantities.

4.3 Marine Measurement Problems Resulting from Inaccurate Vessel Calibration Tables

Cargo tanks should be calibrated by physical measurement rather than computations made from design drawings in which the deadwood (internal frames, webs, longitudinal stiffeners, etc.) is often not accurately calculated. Any inaccuracy of the vessel calibration tables will be reflected in the VEF. In the case of new vessel or barge construction, cargo tanks should be calibrated at the shipyard by an independent third party, using industry standards. Accurate vessel calibration (capacity) tables will result in a VEF approaching unity.

It is essential to use current calibration tables based on the correct reference point for the measurement equipment used. Incorrect, outdated, or inconsistent use of calibration, wedge, trim or list tables will result in an erroneous VEF.

The methods used for vessel measurements, such as vessel automated tank gauging equipment versus manual gauging, or old calibration tables versus new calibration tables, has an effect on the accuracy of the VEF. The vessel

shall make every reasonable effort to consistently and accurately record data based on appropriate gauging techniques as prescribed in appropriate industry standards and to follow the calculation processes described in this document to minimize the variability of a VEF.

4.4 New Built, Dry Dock, and Vessel Modifications

Data from the vessel's maiden voyage and first voyage following dry dock shall not be used. Additionally, all data for voyages prior to dry dock shall be omitted, if verified that measurement equipment, tables, structural changes or other changes were made affecting vessel measurement.

If structural changes have been made that affect the measurement of a tank or tanks, those tanks should be recalibrated and prior voyages shall not be used.

NOTE Removal of any significant residue/sludge buildup will directly affect the VEF.

4.5 Load and Discharge Data Segregation

Theoretically, there should be no difference between a load and discharge VEF, as the VEF is meant to reflect inherent calibration inaccuracies. However, as a result of systematic differences between load and discharge operations, the load and discharge VEFs will not typically have the same values and therefore the load and discharge data should be maintained separately.

5 The Role of Vessel Operators

5.1 General

Vessel operators should provide, maintain, and ensure availability of the most current cargo tank calibration tables, that reflect accurate quantities, including certified and validated trim, list and wedge data tables.

Vessel operators should establish a system for efficient data storage, maintenance and retrieval to allow an accurate VEF determination for load and discharge.

5.2 Accurate Calibration Tables

Calibration (ullage/innage) tables for each compartment (tank) should reflect current configuration, capacity and gauge point locations. The tables should clearly identify and provide the following information:

— current vessel name;

— validated by classification society where applicable;

— tank/compartment number;

— gauge location;

— reference height;

— reference point;

— method of gauging (Open/Closed, Manual/Automatic, Ullage/Innage);

— trim and List corrections;

— wedge tables (or wedge data);

— vessels not requiring class certification (i.e. barges) should be physically calibrated based on current industry standards.

The vessel's tanks should be recalibrated if structural changes have been made that affect the measurement or if the VEF is not between 0.9950 and 1.0050.

5.3 Accurate Voyage Data and Logs

The log record identified in Section 7 should have supporting load and discharge documentation for each voyage, based on current API/EI custody transfer measurement standards, preferably supported by a Voyage Analysis Report. The vessel should maintain load and discharge data separately.

5.4 Consistent Equipment and Gauge Referenced Points

Properly calibrated equipment should be utilized for all gauging. The same gauging location(s) should be used for each compartment as identified on the calibration tables, i.e. gauged from the same location at load and discharge port. The type of gauging equipment and reference point should consistently be used, i.e. Open/Closed, Manual/Automatic, Ullage/Innage. The reference location (i.e. lip of valve, hatch flange or edge of flame screen rest) should be clearly identified at each gauging point.

6 Factors Affecting VEF and VEF Data

6.1 General

Reliable VEFs are derived from accurate data. Particular attention should be given to obtaining the current information, and in ensuring that the gauge locations, equipment, calibration tables and procedures are consistently used on board the vessel. Every reasonable effort should be made to mitigate the factors listed in this Section to obtain a reliable VEF. The various factors mentioned are not seen as reasons to exclude particular data, but rather are mentioned as potential causes which may lead to the variability that the calculation method addresses.

6.2 Data Source

The voyage data used to compile a VEF may have to be based on information supplied by the vessel, the accuracy of which cannot be verified. Data supplied should be checked against the Chief Officer's Cargo Log Book for remarks, comments, comparison against the quantity per draft readings, etc. that may affect the reliability of the reported figures.

6.3 Potential Biases To Data

6.3.1 Facility Bias

VEFs based on data from a given facility may reflect bias inherent in that facility, including but not limited to, tank calibrations, meter inaccuracies, gauging errors and inconsistencies, line fill issues, calculations, etc. However, unless a known bias is determined, and agreed by parties involved, VEFs calculated using data from these facilities are valid if no other data is available and the data adheres to the requirements in Section 8. A load VEF or discharge VEF based on only one terminal may or may not be reliable.

6.3.2 Sea Conditions

TCV vessel quantities may be overstated or understated at locations where the vessel is gauged during periods of rolling seas or heavy swells, as is often the case at offshore facilities and during ship to ship transfers.

6.3.3 Clingage—Undetected ROB

Clingage, or undetected ROB, may vary depending on the physical characteristics of the cargo, the ambient air and sea temperature, the type and capabilities of the vessel, the number of tanks, the cargo temperature throughout the voyage and during discharge, and the conditions under which the discharge is performed. The vessel discharge amount is likely to be understated by an amount of undetected cargo remaining on board (ROB). This results in the measured ROB in almost every case being less than the cargo on board quantity (OBQ) measured at the subsequent load port, assuming consistent measurement processes.

6.3.4 Light (unheated) vs. Heavy Products (heated)

It is possible that if a vessel changes service between heavy products and light products, the VEF will be affected.The VEF of a clean product vessel will be influenced much less by undetected ROB than would a black/heavy oil vessel.

6.3.5 Temperature

For black/heavy oils, or those whose flow characteristics are poor at ambient temperatures, it is likely that the vessel will retain a larger amount of undetected clingage of ROB during winter months, than in the summer months (or warmer climate). This could also be the case if discharge cargo temperature was significantly lower than loadport cargo temperature.

6.4 General Calculation

6.4.1 VEFs compiled from a differing number of voyages may result in different factors. Therefore, this standard states the number of voyages to be used.

6.4.2 Cargo calculations and factors, such as volume correction factors (Ctl), ROB/OBQ determinations, wedge calculations, and trim/list corrections, should be consistent.

6.5 Partial Cargoes

Vessel capacity tables are often calculated from building plans rather than actual physical measurement. Deadwood may have been deducted on a linear basis inconsistent with its actual placement inside the tank. This may result in gauging inaccuracies that depend on the level of product in the tank. For example, the lower parts of the tank may overstate quantities while the upper parts may understate quantities. When compartments are not used or are partially loaded, a partial cargo VEF or compartmental VEF can be established following the same guidelines for determining a VEF.

6.6 Outdated Data and Tank Deformation

A lack of recent consecutive (voyage) data may result in failure to reflect changes to tank capacity from causes such as build up of residue within the tank, structural changes or hull deformation (perhaps from grounding or collisions), changes in gauging equipment or procedures or tank calibration table modifications. If a suitable comment does not exist on the vessel log, an investigation and subsequent report should be made explaining the reason for a vessel not having recent consecutive voyage data.

6.7 Data Basis and Accuracy

Inconsistent measurement procedures and practices will increase data variability and lead to a less consistent VEF. The following should be avoided.

— Imprecise and/or varying gauge reference points.

— Use of different types of gauging equipment (i.e. closed system equipment or automated tank gauging equipment versus manual equipment).

— Outdated, incorrect or inconsistent gauge, calibration or correction tables.

— Vessels computerized calibration tables (unless independently verified against certified calibration tables).

7 Documentation and Data Gathering

7.1 General

These guidelines provide for collecting data in a uniform manner. It is required that the data is collected and recorded by the vessel for every voyage, as soon as available, in a permanent record. The data thus gathered should be in a clear, understandable format, as illustrated in the sample logs presented in Annex A (Sequential Load Log) and Annex B (Sequential Discharge Log) of this chapter. The records should normally be maintained on the vessel [however, for unmanned barges the records should be maintained by the barge operator (see 7.5.2)] . If subsequent corrections are made to quantities by the independent inspection company that would differ from those in the field documents left on board the vessel, the corrected documents should be made available to the vessel to supersede the field documents. The final VEF report should be prepared utilizing the appropriate sequential log data, and should be signed by the vessel personnel and the independent inspector.

7.2 Sequential Logs

7.2.1 General

A sequential log should be maintained separately by the vessel for load and discharge data. When Sequential Logs are unavailable or incomplete, data may have to be compiled from multiple sources such as databases maintained by inspection companies or other independent sources. These logs should contain the following information.

7.2.2 Sequential Load Log (Annex A)

Vessel Name or appropriate identification:

1) Load Date (Bill of Lading).

2) Vessel’s Voyage Number.

3) Load Terminal—Port.

4) Cargo Description.

5) Method of Gauging—Manual (M) or Automatic (A).

6) Total Calculated Volume (TCV) on board.

7) On Board Quantity (OBQ).

8) Total Calculated Volume (TCV) loaded (6 – 7).

9) % quantity loaded of 100 % vessel cargo capacity.

10) Load Total Calculated Volume (B/L).

11) Basis of Load TCV determination—shore (S), vessel with VEF (VVEF), vessel without VEF (V).

12) Record whether the same VCF tables have been used for both shore and vessel. Yes or No.

13) Record why the voyage should be excluded from VEF calculation and other pertinent information.

14) Signed by responsible vessel's officer.

15) Name of inspection company.

7.2.3 Sequential Discharge Log (Annex B)

Vessel Name or appropriate identification:

1) Discharge Date.

2) Vessel's Voyage Number.

3) Discharge Terminal—Port.

4) Cargo Description.

5) Method of Gauging—Manual (M) or Automatic (A).

6) Total Calculated Volume (TCV) on board.

7) Remaining On Board (ROB).

8) Total Calculated Volume (TCV) discharged (6 – 7).

9) % quantity loaded of 100 % vessel cargo capacity.

10) Outturn Total Calculated Volume (TCV).

11) Basis of Outturn TCV determination—shore (S), vessel with VEF (VVEF), vessel without VEF (V).

12) Record whether the same VCF tables have been used for both shore and vessel. Yes or No.

13) Record why the voyage should be excluded from VEF calculation and other pertinent information.

14) Signed by responsible vessel's officer.

15) Name of Inspection Company.

7.2.4 Gauge Locations/Equipment

For each voyage, the Sequential Logs should indicate the measurement equipment used, (i.e., vessel remote automated equipment or manually gauged).

7.2.5 Comments

Record any comments about previous vessel/shore comparisons contained in the vessel's records. Any dry docking voyage data should be entered on the sequential log and an entry made in the comments Section to include information on de-slopping and/or de-sludging, any structural modification or tank re-calibration.

7.2.6 Independent Inspection

The log record should have supporting documentation provided by the inspection company for each load or discharge.

7.2.7 Volume Correction Factors (Ctl)

If different Ctl tables have been used for shore and vessel quantity calculations, the shore should be recalculated to match the vessel Ctl table used before being entered into the log. The vessel should maintain these records and make them readily accessible to interested parties. Alternatively, the ship can be recalculated using shore Ctl tables, again for purposes of the VLR or VDR log only.

7.2.8 Absence of Accurate Vessel Measurements

If vessel figures after loading are known to be inaccurate, the data to be used for that voyage should be based on the vessel arrival figures (less OBQ), and a comment shall be made on the Sequential Load Log. For offshore loadings where independent third parties are not present, vessel on arrival figures at the discharge port less previous ROB should be used to generate a VLR and the log marked accordingly.

7.3 Partial VEFs

Depending on the trading patterns of the vessel, it may be regularly loaded in a particular condition. Under these cirucmstances, data to allow calculation of partial VEFs may be available. Collation of such data may prove sufficient and satisfactory to allow for the calculation of a valid Partial VEF, provided that the basic rules for qualification are followed.

7.4 Compartmental VEFs

On Chemical, Multi-grade, or specialized vessels, data to allow calculation of individual Compartmental VEFs is usually available. This data may be useful, if applicable to the compartment(s) in use for the specific cargo in question. Collation of data on these compartments may prove sufficient and satisfactory to allow for the calculation of a valid Compartmental VEF, provided that the basic rules for qualification are followed.

7.5 Barge VEFs

7.5.1 General

The basis and validity of the VEF for barges is similar to ships. However, unlike most ships, current voyage data required to calculate the most current VEF is often not readily available, and may require additional effort or special arrangements to obtain the data in a timely manner.

7.5.2 Manned/Crewed Barges

As with ships, it is recommended that barge personnel maintain vessel and shore transfer data on board, and make such data available to interested parties for the purpose of determining a current VEF, as described in this standard. The barge crew should take reasonable steps to ensure gauging is always performed from the correct location, and to ensure that correct tables, including trim and list corrections, are used for that specific gauge point location.

7.5.3 Unmanned Barges

Of all types of vessels, unmanned barges often allow for the most significant degree of inconsistency and error. It is recommended that barge operators maintain vessel and shore transfer data, and make such data available to

interested parties, for the sole purpose of determining a current VEF as described in this standard. The barge operator, and the party employed to gauge, should take extra precautions to ensure the gauging is always performed from the correct consistent location, and that the correct and most current tables, including trim and list corrections, are used for that specific gauge point location. When sequential logs are unavailable or incomplete, data may have to be compiled from multiple data sources, such as databases maintained by inspection or oil companies.

7.5.4 Multiple Barges in Tow

Multiple barges may be loaded with the shore tank only gauged at the beginning of the first barge and closed after the last barge is loaded. A “Combination Tow VEF” may be calculated for this combination tow, provided sufficient data is available from prior transfers using the same combination tow and the basic rules for qualification are followed.

8 Data Qualification and Rejection Criteria

8.1 General

The most recent TWENTY voyages should be used, or as many as are available up to a maximum of twenty. A valid VEF is one that results from at least FIVE qualifying voyages. Information from all load or discharge terminals should be used to calculate the respective VEF.

The available data on occasions may be in error and will result in non-typical VLRs or VDRs, or essential information may be missing. The VEF calculation process employs criteria to validate and qualify a particular VLR or VDR before inclusion in the VEF calculation.

8.2 Data Qualification and Gross Error

The VEF calculation process is supported by two numerical qualifications, specifically the elimination of “gross errors,” considered to be in excess of 2 %, and secondly the omission of vessel to shore ratios which exceed 0.30 % from the mean of the voyages remaining after elimination of gross errors. Elimination of gross errors ensures that bad data will not skew the mean. Vessel calibration tables have been known to misrepresent quantities by as much as 2 %. Beyond 2 % is uncommon and probably result from mismeasurement or a random error, however in the event such large variances are consistent the voyages may be used.

8.3 Voyage Criteria

Data to be used in the final mean calculation should exclude:

— Voyages where only vessel measurements were available (i.e. vessel to vessel transfers).

— Maiden voyage for the vessel, voyage following dry dock should not be used.

— Voyages prior to the vessel’s last dry dock shall be omitted, if verified that significant sludge was removed, measurement equipment, tables, or procedural changes were made affecting vessel measurement.

— Voyages where the VLR or VDR is less than 0.98000 or great than 1.02000. Ratios outside these limits are likely to be attributable to gross error. See 5.2.

— Voyages when the VLR or VDR differs by more than 0.30 % of the mean (not including gross error voyages) of the data considered. As an example, if the average of all voyages listed is 1.00105, all voyages within the range from 0.99805 through 1.00405 would qualify.

— Voyages where vessel or shore figures are known to be inaccurate.

All voyages should be listed, but only voyages that qualify shall be used in the calculation of a VEF. A reason, as listed above, shall be provided for any voyage data excluded. No voyages shall be excluded beyond the reasons given above, unless specifically agreed by all interested parties.

9 Calculation of the Vessel Experience Factor (VEF)

9.1 General

Using the Sequential Log, the VEF Calculation Form is to be completed. See Form Example in Annex C.

— List last voyage first and voyage numbers are to be listed sequentially.

— Units must be consistent, i.e. Bbls, M^3, M.tons, L.tons, etc. Units cannot be mixed.

— Cross out either “load” or “discharge” and other inapplicable title information.

— The average TCV ratio is equal to total vessel loaded TCV divided by total shore (off-shore) delivered TCV.

— Calculate the ratios to 5 decimal places and report the final VEF to 4 decimal places.

— Quantities should be combined for multiple grades on the same voyage, unless a valid compartmental or partial VEF is available.

9.2 Procedure VEFL

The following steps need to be followed to calculate the VEFL.

Step (a) Considering criteria in Section 8 of this standard, list the voyage data for as many as available, up to a maximum of twenty voyages.

Step (b) Calculate individual VLRs for each voyage, rounding to five decimal places.

Step (c) Disqualify vessel shore gross error difference in excess of 2 %, in other words all voyages with ratios outside the range of 0.98000 and 1.02000.

Step (d) Of the remaining voyages; calculate the Average Vessel/Shore Ratio from the total quantities.

Step (e) Check whether VLRs qualify—Y/N. (VLRs outside ±0.30 % from Average Vessel/Shore Ratio determined in step (d) do not qualify.)

Step (f) Use only remaining qualifying voyages to calculate VEF if at least five qualifying voyages remain. If less than five qualifying voyages remain, a valid VEF cannot be calculated.

Step (g) Calculate total vessel and shore quantity.

Step (h) Divide total vessel quantity by total shore quantity.

Step (i) Calculate to five decimal places and round to four decimal places the VEF = VEFL established in Step (h).

NOTE Voyages where data is missing in the Sequential Log (Annex A) should be excluded from the VEF calculation form (Annex C).

9.3 Procedure VEFD

The following steps need to be followed to calculate the VEFD.

Step (a) Considering criteria in Section 8 of this standard, list the voyage data for as many as available, up to a maximum of twenty voyages.

Step (b) Calculate individual VDRs for each voyage, rounding to five decimal places.

Step (c) Disqualify vessel shore gross error difference in excess of 2 %, in other words all voyages with ratios outside the range of 0.98000 and 1.02000.

Step (d) Of the remaining voyages; calculate the Average Vessel/Shore Ratio from the total quantities.

Step (e) Check whether VDRs qualify—Y/N. (VDRs outside ±0.30 % from Average Vessel/Shore Ratio determined in step (d) do not qualify.)

Step (f) Use only remaining qualifying voyages to calculate VEF if at least five qualifying voyages remain. If less than five qualifying voyages remain, a valid VEF cannot be calculated.

Step (g) Calculate total vessel and shore quantity.

Step (h) Divide total vessel quantity by total shore quantity.

Step (i) Calculate to five decimal places and round to four decimal places the VEF = VEFD established in Step (h).

NOTE Voyages where data is missing in the Sequential Log (Annex A) should be excluded from the VEF calculation form (Annex C).

10 Application of the Vessel Experience Factor (VEF)

10.1 General

The VEF is meant to compensate for vessel measurement inaccuracies. It may be derived from data from multiple loading and discharge terminals with varying degrees of accuracy. This data in turn is compared to vessel figures that may be affected by weather, trim, list, rolling seas, and the type and size of cargo relative to the compartment and vessel capacity. Generally, the closer a vessel's cargo is to its maximum capacity, the more applicable the VEF, particularly in the absence of partial or compartmental VEFs. The VEF is commonly applied to vessel and barge quantities as a matter of procedure for both loss control and reconciliation purposes, and sometimes for Bill of Lading and Outturn custody transfer purposes. The VEF is recognized as a valid and valuable measurement monitoring tool by inspection companies, oil companies, trading companies as well as regulatory and government bodies.

The current VEF, as described in this standard, may be applied for loss control and custody transfer purposes. The number of qualifying voyages should be provided, and the user of the VEF should have all available supporting data and documentation for regulatory and audit purposes.

10.2 Load/Discharge

10.2.1 Loading

The VEFL is used to compare the shore's TCV delivered with the vessel's VEF Corrected TCV loaded.

10.2.2 Discharging

The VEFD is used to compare the shore's TCV received with the vessel's VEF Corrected TCV delivered.

10.2.3 Insufficient Data

If sufficient data is not available to allow calculation of a VEFL or VEFD in accordance with this standard, then the commercial parties shall agree on the ratio to be used as a VEF for the transfer in question based on the information that is available.

10.3 Vessel To Vessel Transfers

Respective VEFs may be applied to the transferred quantities of each vessel. However, in general, TCV transfer quantities should be based on the full shuttle (daughter) vessel quantity divided by its VEF, unless otherwise agreed by all parties.

10.4 Compartmental and Compartmental Grouping VEFs

This standard recognizes the use and application of compartmental VEFs, provided sufficient compartment specific data exists to allow a qualifying VEF to be determined as described in this standard. If data to determine a compartmental VEF is not available it is recommended to apply a full cargo VEF to individual compartments alone, without consideration of the remainder of the cargoes or locations as described below.

10.5 Partial Cargo VEFs

10.5.1 Partial Cargo VEF Available

This standard recognizes the use and application of partial cargo VEFs, provided sufficient specific data exists reflecting similar partial cargo conditions, and resultant ratios, where a valid VEF may be determined as described in this standard.

10.5.2 Partial Cargo VEF Unavailable

If data to determine a partial cargo VEF is not available it is recommended to apply the full cargo VEF to each partial cargo.

10.5.3 Operations at Multiple Ports or Berths

It is recommended when loading or discharging at multiple facilities, one of which has active shore tanks, the quantity at the active tank facility may be determined by subtracting the total of the quantities from the static shore tank facilities from the VEF adjusted full vessel quantity.

10.5.4 Multiple Grade Operations at Single Facility

The same procedure as described in 10.5.3 can also be applied to multiple grade operations at a single facility when one of the grades is being loaded or discharged from active tanks and appropriate compartmental VEFs are not available.

10.6 Multiple Barges In Tow VEFs

It is recommended that a Combination Tow VEF be applied if available. If a Combination Tow VEF is not available individual VEFs should be applied to each individual barge.

Annex A
(normative)

Sequential Load Log

Vessel: M/T Consensus														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Vessel Data—BBLS / M3 / MT					Shore Data					
Date	Voyage Number	Terminal -Port	Cargo Description	Method of Gauging	Vessel Sailing TCV	OBQ	Vessel Loaded TCV	% Vessel Capacity Loaded	Load TCV (B/L)	Load (B/L) Basis	Same VCF Tables used	Comments	Signed for vessel	Signed for Inspection Co./ Shore Rep
23-Jan-05	001/05	Alba	Alba	M	600,739	20	600,719	96	600,825	S	Yes			

1) Load Date (Bill of Lading).
2) Vessel's Voyage Number.
3) Load Terminal - Port.
4) Cargo Description.
5) Method of Gauging - Manual (M) or Automatic (A)
6) % quantity loaded of 100 % vessel cargo capacity.
7) Total Calculated Volume (TCV) on board.
8) On Board Quantity (OBQ)
9) Total Calculated Volume (TCV) loaded.
10) Load Total Calculated Volume (B/L)
11) Basis of Load (B/L) determination - shore (S), vessel with VEF (VVEF), vessel without VEF (V).
12) Record whether the same volume correction factor (VCF) tables have been used for calculation of both vessel and shore. Yes or No.
13) Record reasons why the voyage should be excluded from the VEF calculation, and other pertinent information.
14) Signed by responsible vessel's officer.
15) Signed by Independent Inspector and company, or shore representative if no inspector is appointed.

Annex B
(normative)

Sequential Discharge Log

Vessel:		M/T Nonsuch												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
				Vessel Data - BBLS / M3 / MT					Shore Data					
Date	Voyage Number	Terminal - Port	Cargo Description	Method of Gauging	Vessel Arrival TCV	ROB	Vessel Discharged TCV	% Vessel Capacity Loaded	Outturn TCV	Outturn Basis	Same VCF Tables used	Comments	Signed for vessel	Signed for Inspection Co./ Shore Rep
13-Jan-05	001/05	Rotterdam	Ekofisk	M	775,028	20	775,008	96	774,876	S	Yes			

1) Discharge Date.
2) Vessel's Voyage Number.
3) Discharge Terminal - Port.
4) Cargo Description.
5) Method of Gauging - Manual (M) or Automatic (A).
6) Total Calculated Volume (TCV) on board.
7) Remaining On Board (ROB).
8) Total Calculated Volume (TCV) discharged.
9) % quantity loaded of 100 % vessel cargo capacity.
10) Outturn Total Calculated Volume (TCV).
11) Basis of Outturn determination - shore (S), vessel with VEF (VVEF), vessel without VEF (V).
12) Record whether the same volume correction factor (VCF) tables have been used for calculation of both vessel and shore. Yes or No.
13) Record reasons why the voyage should be excluded from the VEF calculation, and other pertinent information.
14) Signed by responsible vessel's officer.
15) Signed by Independent Inspector and company, or shore representative if no inspector is appointed.

Annex C
(normative)

VEF Calculation Form Example

Vessel Experience Factor—Calculation

Vessel: M/T CONSENSUS
Load or ~~Discharge~~
Date: December 1, 2004

1	2	3	4	5	6	7	8	9	11	10	12	13	14
	List all voyages				BBLS / ~~M^3 / MT~~ (Use same units for all entries)					Step 1	Step 2	Qualifying Voyages	
Cargo	Voyage Number	Cargo Description	Terminal - Port	Date	Vessel Sailing/ ~~Arrival~~ TCV	OBQ ~~ROB~~	Load/ ~~Discharge~~ TCV	B/L ~~or Outturn~~ TCV	Vessel Load/ ~~Discharge~~ Ratio	Gross Error > 2 %?	Qual. Voy. (>0.30 %) Y/N?	Load or ~~Discharge~~ TCV	B/L or ~~Outturn~~ TCV
Last	35	Arab Med	Ras Tanura	30-Oct-11	849,442	840	848,602	845,100	1.00414		N		
2nd	34	Merey	Puerto La Cruz	10-Sep-11	496,330	150	496,180	495,200	1.00198		Y	496,180	495,200
3rd	33	Cusiana	Covenas	20-Aug-11	~~325,289~~	~~196~~	~~325,003~~	~~310,494~~	~~1.04702~~	~~Y~~	~~N~~		
4th	32	Schiehallion	Sullom Voe	26-Jul-11	903,214	310	902,904	901,350	1.00172		Y	902,904	901,350
5th	31	Gullfaks	Mongstad	21-May-11	877,236	246	876,990	877,473	0.99945		Y	876,990	877,473
6th	30	El Sharara	Zawia	28-Mar-11	853,115	121	852,994	851,625	1.00161		Y	852,994	851,625
7th	29	Xikomba	Xikomba	15-Jan-11	605,052	232	604,820	606,981	0.99644		N		
8th	28	Forties	Hound Point	11-Dec-10	705,878	115	705,763	705,692	1.00010		Y	705,763	705,692
9th	27	Rabi Light	Cap Lopez	30-Sep-10	855,504	294	855,210	852,941	1.00266		Y	855,210	852,941
10th	26	Doba	Kome Kribi 1	28-Jul-10	881,892	392	881,500	880,427	1.00122		Y	881,500	880,427
11th	25	Belanak	Belanak	15-May-10	688,938	217	688,721	689,314	0.99914		Y	688,721	689,314
12th	24	Oriente	Esmeraldos	1-Apr-10	652,238	146	652,092	650,748	1.00207		Y	652,092	650,748
13th	23	Cabinda	Malongo	26-Feb-10	872,491	338	872,153	871,387	1.00088		Y	872,153	871,837
14th													
15th	Note: Vessel in dry dock Jan 1-28, 2010 for below deck piping changes												
16th													
17th													
18th													
19th													
20th													
						Totals:	9,237,929	9,228,238			Totals:	7,784,507	7,776,157

Notes:
- List last voyage first
- Do not include load and discharge information on the same form
- Cross out either "load" or "discharge" and other inapplicable title information
- The average TCV ratio is the total vessel loaded TCV divided by total shore TCV

Average TCV Ratio: 1.00105 : [ ]

TCV VESSEL / TCV SHORE : 1.00107

Qualifying Range (excluding Gross Errors)

L: 0.99805 H: 1.00405

Vessel Experience Factor: 1.0011

ANNEX C1—VEF CALCULATION FORM BLANK

Vessel Experience Factor—Calculation
Load or Discharge

Vessel: _____
Date:

1	2	3	4	5	6	7	8	9	11	10	12	13	14
	List all voyages				**BBLS / M^3 / MT (Use same units for all entries)**					**Step 1**	**Step 2**	**Qualifying Voyages**	
Cargo	**Voyage Number**	**Cargo Description**	**Terminal - Port**	**Date**	**Vessel Sailing/ Arrival TCV**	**OBQ ROB**	**Load/ Discharge TCV**	**B/L or Outturn TCV**	**Vessel Load/ Discharge Ratio**	**Gross Error > 2 %?**	**Qual. Voy. (>0.30 %) Y/N?**	**Load or Discharge TCV**	**B/L or Outturn TCV**
Last													
2nd													
3rd													
4th													
5th													
6th													
7th													
8th													
9th													
10th													
11th													
12th													
13th													
14th													
15th													
16th													
17th													
18th													
19th													
20th													
						Totals:					Totals:		

Notes:
- List last voyage first. Do not include load and discharge information on the same form.
- Cross out either "load" or "discharge" and other inapplicable title information. The average TCV ratio is the total vessel loaded TCV divided by total shore TCV.

Average TCV Ratio: _____ : _____

TCV VESSEL / TCV SHORE

Qualifying Range (excluding Gross Errors)

L: _____ H: _____

Vessel Experience Factor:

Annex D
(normative)

Alternate Calculation Method

D.1 Statistical Basis and Significance

Employs a statistical method for establishing the reliability of individual load (or discharge) ratios and for estimating the confidence limits (probability = 95 %) for the range of acceptable values.

D.2 Voyage Criteria

Data from a minimum of TEN qualified voyages is needed to calculate a VEF with the greatest accuracy.

D.3 Calculation

D.3.1 General

In this method, only Vessel Load Ratios or Vessel Discharge Ratios, which are statistically significant at the 95 % probability level, are included in the calculation of the VEF.

— List last voyage first.

— Data from different voyages do not need to be consistent and can be mixed, i.e., some voyages in barrels, and some in tons. However, vessel and shore data for each individual voyage must be consistent and cannot be mixed.

— The average TCV ratio is equal to total vessel transferred TCV divided by total shore TCV.

— It is not recommended to include both load and discharge information on the same sequential voyage log and calculation.

— Calculate the ratios to 5 decimal places and report the final VEF to 4 decimal places.

— Quantities should be combined for multiple grades on the same voyage, unless a compartmental or Partial VEF is being calculated.

D.3.2 Process

The calculation routine is as follows:

Step (a) Let there be n admissible VLRs. List these in ascending order and label r_1 to r_n.

Step (b) Establish whether or not r_1 or r_n are statistically significant at the 95 % probability level. To do this:

(i) Calculate the terms R_L and R_H, according to the following formula:

For n = 3 to 7 inclusive:

$$R_L = \frac{r_2 - r_1}{r_n - r_1} \quad \text{and} \quad R_H = \frac{r_n - r_{n-1}}{r_n - r_1}$$

For n = 8 to 10 inclusive:

$$R_L = \frac{r_2 - r_1}{r_{n-1} - r_1} \quad \text{and} \quad R_H = \frac{r_n - r_{n-1}}{r_n - r_2}$$

For n = 11 to 13 inclusive:

$$R_L = \frac{r_2 - r_1}{r_{n-1} - r_1} \quad \text{and} \quad R_H = \frac{r_n - r_{n-1}}{r_n - r_2}$$

For n = 14 to 20 inclusive:

$$R_L = \frac{r_3 - r_1}{r_{n-2} - r_1} \quad \text{and} \quad R_H = \frac{r_n - r_{n-2}}{r_n - r_3}$$

(ii) Compare values of R_L and R_H with the critical value corresponding to the value of n shown in Table D-1.

(iii) Delete r_1 if the value of R_L is greater than the critical value as determined in (ii).

(iv) Delete r_n if the value of R_H is greater than the critical value as determined in (ii).

Step (c) If as a result of Step (b) any VLRs have been deleted, re-label the remaining VLRs as r_1 to r_n.

Repeat Step (b) until no more VLRs are deleted.

Step (d) Calculate the average (mean), r, to five decimal places, using the sum of remaining ratios divided by the number of ratios.

Step (e) Round the average, r, to four decimal places and record it.

NOTE The Sequential Voyage Log and Calculations Form can also be used for recording purposes.

The VLRs obtained and recorded can then be used to commence this calculation at Step (a). If desired, this form can be used to identify the ascending order numbering of VLRs, r_1 to r_n.

D.3.3 Example of Calculation

Step (a) List VLRs in ascending order and label r_1 to r_{10}:

Voyage Number	VLR	Label
9	0.99755	r_1
10	0.99858	r_2
8	0.99906	r_3
1	0.99986	r_4
7	1.00086	r_5
3	1.00105	r_6
5	1.00225	r_7
4	1.00278	r_8
6	1.00548	r_9
2	1.01207	r_{10}

Step (b)

(i) Since the number of VLRs is 10, calculate R_L and R_H for n = 10.

$$R_L = \frac{r_2 - r_1}{r_9 - r_1} = \frac{0.99858 - 0.99755}{1.00548 - 0.99755} = \frac{0.00103}{0.00793} = 0.130$$

$$R_H = \frac{r_{10} - r_9}{r_{10} - r_2} = \frac{1.01207 - 1.00548}{1.01207 - 0.99858} = \frac{0.00659}{0.01349} = 0.489$$

(ii) Compare R_L = 0.130 and R_H = 0.489 with the critical value at the 95 % probability level corresponding to n = 10 shown in Table D.1, i.e., 0.477.

(iii) As R_L = 0.130 is less than the critical value of 0.477, do not delete r_1.

(iv) As R_H = 0.489 is greater than the critical value of 0.477, delete r_{10}.

Step (c) Re-label the remaining ratios r_1 to r_9. Repeat Step (b) and confirm that in this example, no more VLRs have been deleted.

Step (d) Calculate the mean, r, of the 9 remaining ratios to four decimal places, and report as the vessel experience factor: r = 1.0008

Table D.1—Critical Values at the 95 % Probability Level

n	Critical Value
3	0.941
4	0.765
5	0.642
6	0.560
7	0.507
8	0.554
9	0.512
10	0.477
11	0.576
12	0.546
13	0.521
14	0.546
15	0.525
16	0.507
17	0.490
18	0.475
19	0.462
20	0.450

Bibliography

[1] API *MPMS*, Chapter 1, *Vocabulary*

[2] API *MPMS*, Chapter 2, *Tank Calibration* (all sections)

[3] API *MPMS*, Chapter 3, *Tank Gauging* (all sections)

[4] API *MPMS*, Chapter 5, *Metering* (all sections)

[5] API *MPMS*, Chapter 12.1, *Calculation of Static Petroleum Quantities*

[6] API *MPMS*, Chapter 12.2, *Calculation of Liquid Petroleum Quantities Measured by Turbine or Displacement Meters*

[7] HM 1, *Calculation of oil quantities*

[8] HM 4, *Manual measurement of level in tanks,* Section 1—*Non-electrical methods*

[9] HM 26, *Metering systems,* Section 1—*Guide to liquid metering systems*

[10] HM 27, *Metering systems,* Section 2—*Guide to gas metering systems*

[11] HM 68, *Procedures for bulk liquid fatty acid methyl esters (FAME) and blended biodiesel cargo inspections.*

[12] IP Standard 475 [1], *Manual sampling* (ISO 3170)

[13] IP Standard 476, *Automatic pipeline sampling* (ISO 3171)

[14] ISO Standard 4266, *Petroleum and liquid petroleum products—Measurement of level and temperature in storage tanks by automatic methods*.

[15] ISO Standard 4266, Part 2, *Measurement of level in marine vessel*s

[16] ISO Standard 4266, Part 5, *Measurement of temperature in marine vessels*

[17] ISO 4268, *Petroleum and liquid petroleum products—Temperature measurements—Manual methods*

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