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Guidelines for Voyage Analysis and Reconciliation of  
Cargo Quantities

3rd edition, April 2012



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Guidelines for Voyage Analysis and Reconciliation of Cargo  
Quantities

3rd Edition

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## Introduction

The shipment of petroleum or petroleum products by marine vessels may result in a difference between the load port and discharge port quantities. This difference, gain or loss, will be caused by one or more of the following:

- a) **Physical Loss/Gain** is an actual loss or gain of cargo (sometimes referred to as “Real Loss or Gain”).

Physical losses can be the result of evaporation, unmeasured ROB, line fill, cargo diversion, spillage or theft.

Evaporative loss may occur during load/discharge operations and during transit. Daily temperature variations and movement of the cargo during the voyage (sloshing) will increase evaporative losses. Cargos with higher vapor pressure are likely to suffer greater evaporative losses.

The ROB (quantity remaining on board) is the liquid and non liquid cargo left on board the vessel after discharge. The ROB measurement can only include cargo which remains on the tank floor and can be measured from available gauge points. Unmeasured ROB can occur when a vessel is out of trim and it is not possible to measure the cargo from the tank available gauge points. That cargo which remains as clingage on the tank sides or other internal structure is not included in the ROB measurement and will result in a real loss when the outturn is considered. The amount of clingage will be dependent upon cargo viscosity and temperature.

Line fill losses result from transfer lines which contain more cargo after the movement than before, leading to reduced quantities being measured in the receiving tanks. This can occur during loading or discharge.

Cargo diversion can occur inadvertently as a result of incorrectly set or leaking valves, operator error, or intentionally as theft.

While physical gains are not common, some cargos with the ability to absorb water or to blend with other components or additives may show physical gain. In addition, gains may be caused by physical operations and equipment errors or failures such as cargo diversion, Crude Oil Washing (COW) recovering clingage from previous cargo, etc.

- b) **Apparent Loss/Gain** is a difference in quantity which is not related to a physical loss. Apparent losses include errors which can possibly be corrected and also differences due to uncertainties in the measurement systems which generally cannot be removed. The majority of individual losses and gains are apparent rather than real and fall into the following categories.

Measurement error includes all the errors associated with measurement procedures, equipment and operator performance. These errors can be in liquid level or meter measurements, determining temperature, sampling, tank calibration, and laboratory testing methods.

Procedural error occurs when operations deviate from the industry measurement standards and good practice. An example would be the failure to ensure pipeline fullness at the start of the cargo transfer.

Calibration error relates to accuracy (calibration) of the measurement equipment. Only the base international standards are deemed to be exact. The possibility of introducing a fixed error or bias increases with every step in the calibration chain, moving from the base standard to the field device. Random error or uncertainty increases with each step.

Further, all measurement equipment is affected by use and handling, so regular field checks and calibrations are necessary to ensure that equipment continues to provide accurate measurements.

Paper Loss/Gain is a term frequently used to include all Apparent Losses/Gains. It is the result of calculation errors which may occur when converting basic measurement data into cargo quantities. Computer programmes and calculators have reduced the risk of mathematical errors but the cargo calculations should always be checked when a large discrepancy occurs.



# Guidelines for Voyage Analysis and Reconciliation of Cargo Quantities

## 1 Scope

This standard covers guidelines for the reconciliation of marine cargo quantities. These guidelines are intended to provide a basis for analyzing and reconciling the quantity differences (gains/losses) resulting from marine custody transfer movement(s) of petroleum and petroleum product cargoes. As such, the guidelines are complementary to, but do not replace, normal inspection procedures.

## 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.

The following documents may be referenced to supplement the information presented in this chapter:

### 2.2 API/EI Joint Documents

API MPMS Chapter 17.6/EI HM66, *Guidelines for Determining the Fullness of Pipelines between Vessels and Shore Tanks*

API MPMS Chapter 17.9/EI HM49, *Vessel Experience Factor*

API MPMS Chapter 17.11/EI HM52, *Measurement and Sampling of Cargoes On Board Tank Vessels Using Closed/Restricted Equipment*

### 2.3 API Documents

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

API MPMS Chapter 17.3, *Guidelines for Identification of the Source of Free Waters Associated with Marine Petroleum Cargo Movements*

### 2.4 EI Document

EI HM40 <sup>1</sup>, *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*

### 2.5 Other Documents

Marpol 73/78 <sup>2</sup>, *The International Convention for the Prevention of Pollution from Ships*

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<sup>1</sup> Energy Institute, formerly the Institute of Petroleum, 61 New Cavendish Street, London W1G 7AR, UK.

<sup>2</sup> International Maritime Organization (IMO) Publishing, 4 Albert Embankment, London SE1 7SR, United Kingdom, sales@imo.org.

### 3 Definitions

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

#### 3.1

##### **apparent loss**

A difference in quantity which is not related to a physical loss.

#### 3.2

##### **complex voyage**

Any voyage other than a single grade cargo movement from one load port to one discharge port.

#### 3.3

##### **physical loss or gain**

An actual loss/gain of cargo (sometimes referred to as “Real Loss/Gain”).

#### 3.4

##### **simple voyage**

A single grade cargo movement from one load port to one discharge port.

#### 3.5

##### **theoretical differences**

The theoretical shore quantity is the vessel quantity adjusted by the VEF at either the load or the discharge port. The theoretical shore quantity minus the actual measured shore quantity is the theoretical difference.

#### 3.6

##### **theoretical discharge port shore volume**

The vessel delivered volume (TCV – ROB) divided by the vessel’s experience factor (VEF).

#### 3.7

##### **theoretical load port shore volume**

The vessel received volume (TCV – OBQ) divided by vessel’s experience factor (VEF).

#### 3.8

##### **vessel experience factor**

##### **VEF**

A compilation of the history of the Total Calculated Quantity (TCV) vessel measurements, adjusted for On-Board Quantity (OBQ) or Remaining on Board (ROB), compared with the TCV shore measurements. The information used to calculate a VEF should be based on documents that follow accepted industry standards and practices, such as inspection company reports.

#### 3.9

##### **vessel-to-vessel transfer**

The movement of cargo from one vessel to one or more other vessels.

#### 3.10

##### **volume correction factor**

##### **VCF**

The ratio of the density of a liquid at a given temperature to its density at reference temperature (normally 60 °F or 15 °C). Multiplying a liquid’s volume by this value computes its volume at reference temperature (net standard volume). Also known as CTL (correction, temperature, liquid).

### 3.11

#### **voyage analysis report**

##### **VAR**

A report allowing for consistent organization and calculation of basic marine cargo data.

### 3.12

#### **voyage summary and reconciliation report**

##### **VSRR**

A report allowing for consistent summarizing of the various components affecting gains/losses of marine cargo transfers.

## **4 Cargo Reconciliation**

### **4.1 General**

If a marine petroleum shipment results in a unusual gain or loss a detailed cargo reconciliation should be made to determine, and if possible, to identify the reason(s) for volume differences.

The primary steps for marine cargo reconciliation are:

- a) collecting data;
- b) completing the Voyage Analysis Report (VAR); and, when required,
- c) completing a Voyage Summary and Reconciliation Report (VSRR);
- d) investigating the reason(s) for the loss or gain;
- e) taking action where appropriate.

### **4.2 Collecting Information and Data**

This first step consists of gathering all relevant vessel and shore measurement data. This will include the official custody transfer data together with reports and supporting documentation from the independent inspection company. These are the main sources for measurement and calculation data.

Typical marine transfer inspection reports include; shore gauging, metering, vessel gauging, time log, line fill verification, laboratory analysis, and Vessel Experience Factor (VEF). (See relevant API *MPMS* Ch. 17 sections for a complete list of information that should be included in inspection reports.)

Important information which could affect measurements may need to be collected from other sources. This can include but is not limited to; terminal ATG readings, remote temperature readings, product movement logs, vessel bunker reports, cargo stowage changes, and weather/sea conditions.

Refer to Figure A.3 in Annex A for information on documentation that should be provided by the terminal, vessel or inspector.

### **4.3 The Voyage Analysis Report (VAR)**

#### **4.3.1 General**

The VAR provides a useful format for the organization of cargo data and also provides calculations recommended in this procedure. Any shore-to-shore variances are broken down according to Total Calculated Volume (TCV), Free Water (FW), Gross Standard Volumes (GSV), Sediment and Water (S&W), and Net Standard Volumes (NSV) during each stage of the voyage.

A blank example of the VAR form is provided in Annex A. (Examples of completed VARs can be found in Annex B.) It is recognized that other forms may be used for this purpose.

The remainder of Section 4 provides instructions for completing a VAR and, if it is found to be necessary, a VSRR.

If more than one port or cargo is involved, complete a separate VAR form for each parcel, for each movement, and for the total shore/vessel figures (including slops and all previously loaded parcels).

There are three types of VAR.

- 1) A simple voyage VAR is a single grade cargo movement from one load port to one discharge port.
- 2) A complex voyage VAR involves the shipment of one or more grades of cargo at one or more load or discharge ports.
- 3) Vessel-to-vessel Transfer VAR involves the movement of cargo from one vessel to one or more other vessels.

The VAR is divided into six sections.

- 1) Header—General Information (vessel and cargo identification, VCF tables used, etc.).
- 2) Section I—Comparison of Shore Quantities in Custody Transfer (Load vs Discharge Port).
- 3) Section II—Vessel/Shore Quantities at Load Port(s).
- 4) Section III—Vessel/Shore Quantities at Discharge Port(s).
- 5) Section IV—Vessel's Comparison of Loading and Discharge Port(s).
- 6) Footer—Comments and Signatures.

#### **4.3.2 Header General Information**

The header section of the VAR includes identifying information such as vessel name and related vessel information, cargo description and quantity units, port names and dates, and the source of Volume Correction Factors (VCFs) used to calculate shore and ship quantities at loading and discharge.

Compare the VCF sources used and, if they are not the same, recalculate volumes using the discharge port VCF throughout.

#### **4.3.3 Section I—Comparison of Shore Quantities in Custody Transfer**

Section 1 of the VAR records the loaded cargo quantity (Bill of Lading) and the discharged quantity (Outturn).

Compare the reported Outturn quantities from the discharge port(s) with the reported Bill of Lading quantities from the load port(s). Also compare the Bill of Lading API gravity or density against the Outturn API gravity or density.

Any volume difference is referred to as the shore-to-shore gain or loss for the shipment and is used as the primary indicator of whether a more in-depth analysis is required. The user's gain or loss experience with a particular cargo and/or trade route may determine if the particular shipment gain or loss is considered to be acceptable or excessive. A summary of the calculations for these shore-to-shore comparisons is shown in Table 1.

**Table 1—Bill of Lading to Outturn Comparison**

TCV	FW	GSV	S & W	NSV
Outturn TCV – Bill of Lading TCV	Outturn FW – Bill of Lading FW	Outturn GSV – Bill of Lading GSV	Outturn S & W – Bill of Lading S & W	Outturn NSV – Bill of Lading NSV
TCV Difference	FW Difference	GSV Difference	S & W Difference	NSV Difference
NOTE Differences should be noted in both volumes and percentages.				

**4.3.4 Section II—Vessel/Shore Quantities at Load Port(s)**

Section II records the vessel and shore quantities at the load port. This section will show any difference between vessel and shore quantities at the load port and will also allow the calculation of a theoretical load port shore volume.

Compare these values by subtracting the Bill of Lading quantities from the corresponding vessel quantities to obtain the difference in each as shown in Table 2. For this comparison, the vessel loaded volume is the volume gauged (TCV) on board after loading minus any OBQ measured on board before loading.

**Table 2—Shore to Vessel Comparison—Load Port(s)**

TCV	FW	GSV	TCV: VEF Adjusted
Vessel Loaded TCV – Bill of Lading TCV	Vessel Loaded FW – Bill of Lading FW	Vessel Loaded GSV – Bill of Lading GSV	Theoretical Shore TCV – Bill of Lading TCV
TCV Difference	FW Difference	GSV Difference	Theoretical Shore TCV Diff.
NOTE Differences should be recorded on the VAR form in volumes and percentages. It should be recognized that a total water comparison (FW + S&W) may be necessary to validate the FW difference. (See 5.4.1 and 5.4.2 of this document.)			

**4.3.5 Section III—Vessel/Shore Quantities at Discharge Port(s)**

Section III records vessel and shore quantities at the discharge port. This section will show any difference between vessel and shore quantities at the discharge port and will also allow the calculation of a theoretical discharge port shore volume.

Compare these values by subtracting the Outturn quantities from the corresponding vessel quantities to obtain the difference in each as shown in Table 3. For this comparison, the vessel discharge volume is the volume gauged (TCV) on board before discharge minus any ROB measured on board after discharge.

**Table 3—Vessel to Shore Comparison—Discharge Port(s)**

TCV	FW	GSV	TCV: VEF Adjusted
Vessel Discharged TCV – Outturn TCV	Vessel Discharged FW – Outturn FW	Vessel Discharged GSV – Outturn GSV	Theoretical Outturn TCV – Outturn TCV
TCV Difference	FW Difference	GSV Difference	Theoretical Shore TCV Diff.
NOTE Differences should be recorded on the VAR form in volumes and percentages. It should be recognized that a total water comparison (FW + S & W) may be necessary to validate the FW difference. (See 6.1.2 and 6.1.3 of this document.)			

#### 4.3.6 Section IV—Comparison of Vessel Quantities at Load and Discharge Port(s)

Section IV records the reported vessel's volume on departure at the load port and on arrival at the discharge port and will show any change in cargo volume during transit.

Calculate the vessel's transit quantity difference by subtracting vessel volumes at sailing port from arrival port volumes. Compare quantities as shown in Table 4 for each parcel and for the total vessel.

**Table 4—Vessel Transit Comparison**

TCV	FW	GSV
Vessel Arrival TCV – Vessel Sailing TCV	Vessel Arrival FW – Vessel Sailing FW	Vessel Arrival GSV – Vessel Sailing GSV
TCV Difference	FW Difference	GSV Difference
NOTE Differences should be noted in volumes and percentages. For this comparison, no adjustments are to be made to vessel volumes for OBQ or ROB.		

Calculate the OBQ and ROB difference, including totally segregated slops if applicable, by subtracting the components of the ROB from the components of the OBQ as shown in Table 5.

**Table 5—OBQ/ROB Comparison**

Total OBQ (Liquid + Non-liquid)	=	FW	+	GSV
Total ROB (Liquid + Non-liquid)	=	FW	+	GSV
Total Difference		Difference		Difference

#### 4.3.7 Footer: Comments and Preparer's Identification

In the footer, summarize any appropriate comments that pertain to the movement, especially Letters of Protest (LOP) or Notices of Apparent Discrepancy (NOAD). Enter the name, title, and company of the person preparing the VAR, and the date of preparation.

### 4.4 The Voyage Summary and Reconciliation Report (VSRR)

The VSRR is designed to consolidate the reported facts of the voyage, together with any relevant background information, in an effort to explain the reason(s) for the voyage gain or loss. An example of a completed voyage reconciliation can be found in Annex B, Figure B.7.

If a gain or loss is not satisfactorily explained from the voyage analysis process (VAR), proceed with the voyage summary and reconciliation process, in which specific relevant factors are reviewed to evaluate each gain or loss difference identified. Whenever possible, the differences should be quantified by volume. The total of the reconciliation volumes should approximately equal the total NSV gain or loss for the movement.

All quantity calculations, measurements, or testing methods used in this reconciliation that are not based on recognized standards should be fully explained, referenced, or documented.

The VSRR is divided into five general areas.

- 1) General Information (vessel and cargo identification, port names, dates, etc.).
- 2) Comparison of NSV Quantities in Custody Transfer (load vs discharge port).
- 3) A Summary of Reported Differences (based on researching the possible causes of differences).
- 4) Vessel Quantities, (1) reported and (2) adjusted for VEFs at load and discharge ports.
- 5) Comments and Signatures.

**Caution—VEFs must be calculated as per API MPMS Chapter 17.9.**

NOTE 1 VEFs should not be calculated using volumes from vessel-to-vessel transfers.

NOTE 2 Confirm and record the Vessel Experience Factor Load (VEFL). Determine the theoretical shore volume by dividing the vessel loaded volume by the VEFL and compare it to the Bill of Lading TCV. (See VEF, API MPMS Ch. 17.9.) Differences should be noted in both volumes and percentages.

NOTE 3 Confirm and record the Vessel Experience Factor Discharge (VEFD). Determine the theoretical shore volume by dividing the vessel delivered volume by the VEFD and compare it to the Shore Receipt TCV. (See VEF, API MPMS Ch. 17.9.) Differences should be noted in volumes and percentages.

## 5 Possible Causes of Losses or Gains

### 5.1 General

The factors which may contribute to cargo measurement differences during a marine custody transfer movement are discussed below. When any of these factors are used and/or quantified in performing a voyage analysis, reasons for doing so should be supported. Their impact on the entire movement should be considered.

NOTE Marine transportation product loss/gain is defined as the difference between the net cargo quantity measured at the loading terminal and the net cargo quantity measured at the receiving terminal. This can be in volume or in weight. A loss will have a negative sign:

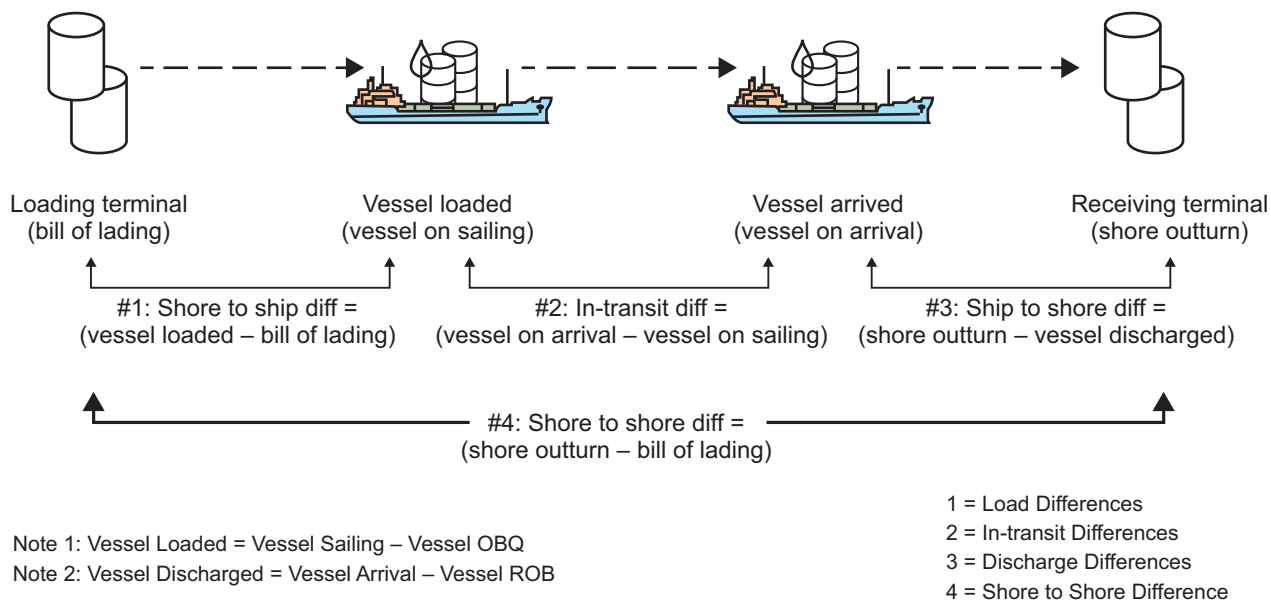
$$\text{Net Loss/Gain (\%)} = \frac{(\text{Net received quantity}) - (\text{Net loaded Quantity})}{(\text{Net loaded Quantity})} \times 100$$

Due to measurement uncertainties and other practical limitations discussed below there will be differences between the quantity loaded and the quantity received. The task of loss control is to determine if a particular difference is unusual or simply to be expected under the circumstances which apply and then, when an unusual difference is identified, to determine where any loss has occurred.

### 5.2 Cargo Transfer Measurement Points

In a typical marine movement there are four points at which the cargo is measured. One of these points will normally be defined in the contract as the point where the custody transfer measurement will be made. Figure 1 shows the differences that occur at each stage of the movement.

When a loss/gain has occurred a comparison of these four measurements points will often show a discrepancy at one point, which will indicate where to begin further investigation.



**Figure 1—Four Point Reconciliation**

A simple example might be as follows:

- 1) Shore Tanks at Load (BOL), 1,000,000 Bbls (net).
- 2) Vessel at Load (adjusted by VEFL) 1,000,050 Bbls (net).
- 3) Vessel at disport (adjusted by VEFD) 995,000 Bbls (net).
- 4) Shore Tanks at Disport (Outturn) 994,950 Bbls (net).

Overall loss is 5050 Bbls (0.51 %) and the loss appears to have occurred during the voyage. However, it is not possible to assume that this is the case and all points of measurement must be investigated. In this case, although the loss appears to be on board, there could be a number of reasons/causes as to why and where the loss occurred e.g. the vessel quantity could have been mis-measured at load. This would indicate that the bill of lading was overstated, leading in turn to further investigation of the shore measurements. The following sections address items which should be considered as part of an investigation.

## 5.3 Shore Measurements

### 5.3.1 Meters

Custody transfer measurement may be carried out using meters. Some knowledge of how the various meter types operate, potential errors and the generation of final figures will allow pertinent questions to be asked when investigating a gain or loss.



Meters may be incorrectly installed, maintained, operated or have errors due to wear and tear of components. Points for consideration include the following.

- a) Meter proving frequency (this should be in accordance with manufacturer's recommendations, company, or national legislation).
- b) Maintenance records.
- c) Control charts.
- d) Meter factor or K factor on the custody transfer document compared to the most recent prover report.
- e) Prover calibration records.
- f) Possible application of incorrect (out of limit or out of date) meter factors.

The terminal should be able to provide meter factor control charts and the last prover calibration report with traceability to national/international standards. If possible metered volumes should be compared with shore tank volumes.

NOTE Custody transfer meters should be properly proven, certified and operated to a recognized industry standard. If any of the meter data cannot be obtained, the metered volume may be questionable.

### **5.3.2 Shore Tank Measurements**

#### **5.3.2.1 General**

Tank calibration tables should comply with recognized industry standards. The date of the most recent calibration should be noted and confirmed. This information should be requested from the facility but also may be available through the independent inspector.

When addressing suspected problems with shore tank measurements the following issues should be considered.

- a) Differences between manual and automatic tank gauge (ATG) measurements.
- b) Tanks may move and deform over time causing reference points to distort and capacity tables to become less accurate.
- c) Inadequate settling time before gauging may result in inaccurate liquid measurements, particularly with regard to water determination.
- d) Tank bottom flexing may affect measurements especially if tank level has changed considerably during the movement.
- e) Temperature or density (degrees API gravity/kg/m<sup>3</sup>) stratification may have an effect on floating roof correction calculation.
- f) Valve leakage.
- g) Product density (degrees API gravity/kg/m<sup>3</sup>) may be incorrect. A comparison should be made with density (degrees API gravity/kg/m<sup>3</sup>) at other measurement points.

- h) The observed reference height should have been measured and may not be the same as stated on the tank capacity table (or information plate). However, the difference between the two measurements should be minimal. Any significant differences should be investigated and may be due to distortion or a build up of sediment.
- i) The datum plate height above the tank bottom may not allow for identification and quantification of material below the datum plate.
- j) Unslotted standpipes may have been used for measurements.
- k) Sediment build up in the tank or stand pipe may affect free water determination, measurement accuracy, and /or tank critical zone positions (see 5.3.2.2). Also the presence of sediment on the tank bottom may complicate free water determination as the horizontal water/oil interface may not extend across the whole tank.
- l) Tank shell thermal expansion corrections may not have been correctly applied.
- m) Measurements taken within the coned bottom critical zone of a tank should be avoided.

Terminal balances and stock records may be needed to investigate any potential cargo diversions.

### 5.3.2.2 Floating Roof Tanks

If the shore tanks have floating roofs it is important to verify that the roofs were not in the critical zone at the start or finish of the movement. Measurements taken in the critical zone should be avoided. It is essential that opening and closing measurements should be taken with the roof floating freely or with the roof resting on it's legs (refer API MPMS Ch. 3). Sediment build up can change the critical zone. Tank capacity tables should show the levels at which the roof is fully grounded or floating, verify that any changes in these levels have been recorded. In some locations tanks may be calibrated for both high and low leg positions. Verify that correct capacity tables were used to obtain volumes.

Issues with gauging a floating roof tank could be as follows.

- a) When a measurement is made and the roof is thought to be floating but is not then an incorrect quantity will be measured.
- b) In older tanks sediment build up can extend the critical zone.
- c) Movement of the floating roof or gauging tape due to wind.
- d) Change in tank roof orientation, i.e. tilting or canting, sinking etc.
- e) A change in the weight of the floating roof, i.e. water, snow load, product on roof.
- f) Absence of a fixed reference height (i.e. gauging on the floating roof).
- g) Roof leg positions at the time measurements were taken should have been verified by the inspector.

### 5.3.3 Line Verification

The fill condition of shore lines before and after loading and discharge should be correctly determined and documented. Slack lines can result in a discrepancy in the bill of lading or the outturn quantities. The fill condition of vessel lines after loading and discharge should also be documented to verify that there is no unmeasured cargo on the vessel. The effect of any reported differences in line fill can usually be calculated. Refer to API MPMS Ch. 17.6, *Guidelines for Determining the Fullness of Pipelines Between Vessels and Shore Tanks*, for more detailed information regarding the procedure.

In the event of a discrepancy then shoreline configuration should be verified to ensure that pipelines were correctly aligned.

## **5.4 Vessel Measurements**

### **5.4.1 General**

Vessel measurements are a vital part of the transport chain and need to be reviewed as part of any loss or gain investigation. A difference between shore quantity and vessel quantity, adjusted by the VEF, can indicate an inaccurate shore or vessel measurement.

Automatic gauging equipment may drift (or partly fail) over time and regular manual checks need to be made using calibrated equipment, particularly as closed and restricted operations are leading to increased reliance on automatic systems.

Where there is a concern that specific tank readings appear to be incorrect, records of regular verification of vessel automatic gauges against manual readings can be requested from vessel owners or operators.

When addressing suspected problems with vessel measurements the following issues should be considered.

- a) Use of non-calibrated measurement equipment.
- b) Weather and sea conditions.
- c) Capacity tables may have been incorrect (i.e. for a different gauge point).
- d) Differences between manual and automatic tank gauge (ATG) measurements.
- e) Trim, list, and wedge corrections may not have been correctly applied.
- f) Gauge height adjustments to allow for retrofitted equipment such as vapor control valves and closed system fittings may not have been correctly applied.
- g) Different gauge points may have been used at load and discharge.
- h) Unslotted standpipes may have been used for measurements.
- i) Vessel line fill condition may have been different at load and discharge port.
- j) Clingage, sludge, sediment, and unmeasured ROB and OBQ may have been present.
- k) Vessel line capacities may not have been correctly accounted for.
- l) Insufficient numbers of temperature reading may have been taken for stratified or heated cargo tanks.

### **5.4.2 Vessel Tank Capacity Tables**

Vessel capacity tables should be specific to the vessel/tank and carry the date together with notes and corrections for any structural changes, particularly modifications to stand pipes and vapor control valve fittings.

Calculations should be checked to verify that trim and list corrections have been applied correctly, as this can have a significant impact on the measured quantities. Ideally a vessel should complete loading as close to even keel and upright as possible to reduce errors in gauging.

### 5.4.3 Vessel Experience Factor

Where a VEF has been applied to the vessel's figures, refer to API MPMS Ch17.9/EI HM49.

### 5.4.4 Transit Differences

Transit differences are normal to most marine movements and result from either a physical gain or loss during the voyage or discrepancies in measurement. Measurement differences may be due to the use of different measurement equipment used at load(s) and/or discharge port(s). This can include Inspector equipment, Vessel equipment, and Vessel ATGs.

A comparison of the vessel's departure TCV and its arrival TCV will give an indication of transit cargo variation. The measurements which make up the TCV (GSV and FW) should be reviewed individually.

A transit gain may be due to:

- a) Material pumped from engine room bilges into slop tanks.
- b) Heating coils leaking into cargo tanks.
- c) Displacement into cargo tanks of other materials, which were received/discharged between the time when cargo load and discharge measurements are made, e.g., bunkers, slops, and other parcels.
- d) Introduction of water to cargo tanks
- e) Measurement inaccuracy due to vessel motion and/or equipment limitations.

If a vessel shows more cargo on arrival at the discharge port than was reported on departure from the load port, the cargo volumes and measurements should be carefully reviewed and analyzed. If the departure quantity is considered to have been understated, this apparent transit gain may be entered on the VSRR form under "Transit Difference."

A transit loss may be due to:

- a) Vapor losses.
- b) Leaks:
  - 1) External: cargo that escapes from vessel tanks to the sea.
  - 2) Internal: cargo that escapes to other cargo tanks or into voids, cofferdams, slop tanks, ballast tanks, or other non-designated areas but is not discovered.
- c) Unreported cargo diversion, or cargo burned as fuel.
- d) Transfer or decanting of free water from slop or dirty ballast tanks during voyage.

Caution should be exercised when recording transit variations since such variances may or may not have any bearing on the overall gain or loss.

Examples:

- a) A large transit loss, with no corresponding difference between VEF-adjusted vessel volume versus outturn at discharge, might indicate a physical loss during the voyage.

b) A large transit gain, with a large vessel/shore difference at the load port and minimal differences noted at discharge, might indicate vessel measurement errors caused by gauging in rolling seas, the use of different calibration tables at each port, or a change in the reference gauge point.

c) Evaporative losses.

#### **5.4.5 Change in Cargo Stowage**

Stowage refers to the arrangement of cargo in the vessel. Changes in stowage should be investigated. Some examples are:

a) Request from Charterers for blending of cargo en-route or heating and/or circulation of cargoes between two or more tanks.

b) Need to alter the vessel's trim for stability/performance or to facilitate load/discharge.

#### **5.4.6 Cargo Diversion**

Any unauthorized diversion of cargo must be fully investigated and reported.

Bunker survey reports and receipts should be obtained where appropriate.

#### **5.4.7 OBQ and ROB**

A difference in OBQ and ROB quantities may be expected as a result of unmeasured ROB or clingage which may later settle to the bottom of the tanks and then become measurable as OBQ for the next voyage. ROB clingage which does not settle can result in shore to ship cargo gains at next loadport. The practice of loading on top of retained oily residues (slops) and the implementation of enhanced cargo recovery techniques, such as crude oil washing (COW), have a marked effect on the differences in these volumes.

Typical ROB quantities have been considerably reduced since the introduction of double hulled vessels. Large quantities of cargo remaining in the tanks may suggest poor procedures or problems with vessel's equipment.

Liquid calculations should be checked to ensure that the wedge formula has been applied correctly where appropriate.

While measured ROB does not represent a measurement loss it may be a real loss to the receiving terminal. High ROB (measured and unmeasured) can be due to inadequate heating on the vessel, possibly coupled with low temperatures at discharge.

If cargo heating has been specified and a problem is suspected, heating records should be obtained from the vessel. These should indicate whether charter party requirements have been followed.

If the cargo has not been correctly heated wax may be deposited on the tank floor and sides, increasing measured and unmeasured ROB. Heated cargos can suffer from high ROB if the cargo has not been discharged quickly once below the level of heating coils.

Excess ROB in one tank may indicate that stripping was too slow or that stoppages have occurred, allowing heavy cargo to begin to solidify. Time logs and any Letters of Protest should be reviewed.

The physical characteristics of the product and the ability of the vessel to pump it are also factors affecting ROB. Problems can result from cargo vaporizing in the pumps (air lock) and loss of suction during final stripping. Trim and/or list may prevent the free flow of product to the suction point.

### 5.4.8 Undetected ROB

Undetected ROB is the result of cargo that remains clinging to the bulk head (clingage) or in unmeasurable areas of vessel compartments.

Clingage varies depending on the physical characteristics of the cargo and the conditions under which the discharge is performed. It also can vary depending upon the type of vessel, the number of tanks, and tank construction. Any quantification of loss due to clingage can only be a subjective determination, but it is an identifiable reason for cargo loss.

While clingage cannot be measured for the voyage in question, it may be estimated for similar cargo type and voyage conditions by using one of two methods:

- a) ROB versus subsequent voyage OBQ (excluding water introduced in cargo/slop tanks for tank washing on ballast voyage).
- b) Load On Top Monitoring Record Calculation (see API MPMS Ch. 17.1).

NOTE Clingage may be recoverable through COW or tank cleaning on a subsequent voyage.

### 5.4.9 Crude Oil Washing

Crude oil washing (COW) operations can reduce the cargo volumes retained on board after discharge (ROB). Although COW is a useful technique to improve cargo discharge, its effectiveness is dependent on many factors including the nature of the cargo, the efficiency of equipment, the number of tanks being washed, and the ambient air and sea temperatures during discharge.

A thorough COW may reduce ROB to less than the OBQ. However, COW may cause additional cargo losses with volatile cargoes due to the vapor generated. In cold weather, use of high pour or viscous cargoes for COW may increase rather than decrease clingage.

A flushing medium may be employed to COW a vessel's tanks or to displace a previously discharged cargo in the shore line. The medium, typically a light oil, is loaded aboard the vessel and stowed in a suitable tank for the intended purpose.

The vessel should be gauged before and after the flushing medium is transferred to the vessel. The quantity received by the vessel (TCV) should be compared to the volume from the shore tank or meter and must be correctly accounted for to properly reconcile cargo quantities. Any flushing medium remaining on the vessel after discharge should be accounted for as ROB.

NOTE Refer to Marpol 73/78 (the International Convention for the Prevention of Pollution from Ships) and HM40, *Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being transported by sea*.

### 5.4.10 Slops

Slops are a readily identifiable source of gain/losses in cargo outturns when compared with Bill of Lading volumes and should be taken into consideration in the reconciliation. Slops discharged with the cargo may have been either commingled with the cargo (loaded on top) or segregated from the cargo in a separate tank.

## 5.5 Water Determination

### 5.5.1 Free Water

Sales are based on GSV or NSV and therefore accurate water measurements are critical.

When investigating possible losses, a water balance should be carried out between each measurement point. In cases where large amounts of water are found, analysis may determine the source of the water (Estuary, formation water, sea water, etc.). Care should be taken that all aspects are checked as there is often confusion between fresh ballast water and formation water. Now that segregated ballast is almost universal, ballast water should not normally be found in cargo tanks.

If additional water is reflected in a larger gross measurement on the vessel after loading and then at discharge there may not have been any apparent net product loss.

Differences in the free water (FW) quantity could be due to the following.

- a) Introduction of water into the cargo from vessel pipelines, inert gas system, cargo heating system, loading/discharge lines (particularly under sea lines or floating hoses), or shore lines during the loading or discharge operations. Water in the shore line between an automatic sampler and the vessel on loading may not have been accounted for.
- b) Mixing of FW with cargo as it is pumped. This will reduce the FW volume while increasing the S&W volume. However, total water should remain the same.
- c) Settling out of S&W which will increase the FW content at the discharge port, compared to the load port.
- d) Insufficient time allowed for water to settle.
- e) Different measurement methods, e.g. separate S&W and FW measurements versus total S&W of homogenized samples from an in-line sampler.
- f) Different methods of detecting FW, e.g. water paste versus electronic interface detector, especially for crude oils containing emulsified water. Use of different or improper water paste.
- g) FW volumes on the vessel not properly corrected for wedge or trim conditions.
- h) Different sea conditions when measuring the FW on the vessel at the load port and discharge port, e.g. rough seas versus calm seas.
- i) Changes in trim and/or list from loading port to discharge port. Depending on gauge point locations a wedge of FW may not be detected under certain conditions.
- j) Tank bottom deformation or sediment in tanks affecting FW measurement.
- k) The datum plate height above the tank bottom preventing measurement of water below the datum plate. This is a particular problem with cone bottom tanks where gauging points are typically offset to one side of the tank.
- l) Shut down or malfunction of the automatic sampler during a part of the loading or discharge or improper cleaning and operation.
- m) Ballast water entering the vessel's cargo tanks or lines.

Refer to API *MPMS Ch. 17.3, Guidelines for Identification of the Source of Free Waters Associated with Marine Petroleum Cargo Movements*, for a possible explanation of the origin of excessive FW.

### 5.5.2 Sediment and Water (S&W)

A difference between reported S&W at load port and discharge port will give a shore-to-shore NSV gain or loss, unless this is associated with a similar change in FW.

Inconsistent S&W results can occur for any of the following reasons.

- a) The non-homogeneity of product may result in samples that contain more or less water than the whole cargo.
- b) Different methods of sampling, e.g. manual sampling versus automatic inline sampling.
- c) The use of incorrect sampling method or procedure.
- d) Inability to obtain representative samples with closed or restricted equipment (see *MPMS* Chapter 17.11).
- e) Different methods of laboratory analysis, e.g. Karl Fischer titration, water by distillation, centrifuge, etc.
- f) Settling of S&W can decrease the entrained S&W content of the vessel composite at a discharge port as compared to a load port. Likewise, mixing resulting from turbulence during pumping may increase S&W as FW becomes entrained and thus part of S&W.
- g) Failure to follow standard test methods, e.g. use of non-standard or exhausted reagents.
- h) Improper sample handling and/or mixing.

Auto sampler records may be available so that performance throughout the movement can be verified against relevant standards (API *MPMS* Ch. 8.2 or ISO 3171). Manual samples obtained from shore tanks and vessel may be used for reference comparison purposes.

An automatic flow proportional sampler is the preferred method for collecting a representative sample from a cargo at loading and discharge. Manual samples, especially when taken through restricted or closed gauging systems, are less likely to be representative.

Various types of auto sampler are in use (portable, fixed inline probe, fast loop, fast loop with pumped mixer). Where an automatic sampler has been used it should be confirmed that the sampler and sample probe are installed in a suitable position and that flow proportional mode of sampling was utilized.

Verify if the product was susceptible to layering (vertical separation of lighter/heavier components or settling of water in layers, or even horizontal stratification in very viscous products) when the spot or zone samples were taken.

Density (degrees API/kg/m<sup>3</sup>) and water content measurements on the individual zone or spot samples may confirm layering such that running samples or upper/middle lower samples may not be sufficient to determining correct parameters to apply to the full cargo.

### 5.5.3 Water Balance

Typically, an increase in free water volumes on the vessel during a voyage may indicate that water has settled out. However this could indicate incorrect measurement, sampling or the possible introduction of water into the cargo.

Free water may be from internal or external sources such as shore tanks, pipelines, sea water, steam lines or vessel compartments. Analysis of samples, if available, will help to determine its source. Free water quantities in the first vessel tanks loaded may indicate the presence of water in either the shore or vessel lines.

## 5.6 Additional Factors

### 5.6.1 Temperature

Temperature measurements are critical in standard volume calculations and a careful review of temperature measurements is recommended as part of any reconciliation.



Temperature changes in a short period of time may indicate a measurement problem unless the oil is being aggressively heated. Temperatures can be examined volumetrically and the resulting theoretical values compared to the actual temperatures reported (see the example below for the volumetric calculation). Small differences in temperatures can result in significant volume changes.

Sensitivity varies and is greater with lighter products but can be of the order of 0.15 % by volume for a 1 °C temperature change or 0.08 % by volume for a 1 °F temperature change.

**EXAMPLE** Volumetric theoretical temperature calculation vessel discharge

Shore Volume	50,000	
Shore Temperature	70	
Shore Volume x Temperature	3,500,000	Ratio
Vessel Volume	100,000	
Vessel Temperature	100	
Vessel Volume x Temperature	10,000,000	Ratio
Shore VT ratio + Vessel VT ratio	13,500,000	
Shore Volume + Vessel Volume	150,000	
Shore VT + Vessel VT / Shore V + Vessel V	90	Theoretical Temperature

### 5.6.2 Evaporation Losses

Evaporation is the loss of the relatively low boiling point hydrocarbon components (“light ends”) of cargoes to the atmosphere and occurs during loading, in transit and at discharge. The extent of this loss is influenced by the volatility of the cargo, the temperature of the cargo, and agitation of the cargo, COW, the condition of the vessel, and the design and operation of the vessel inert gas system and pressure/vacuum relief (P/V) valves.

Vapor pressure can be used as an indication of the relative volatility of the cargo at a given temperature. The evaporation portion of a loss is difficult to measure.

Factors that can contribute to evaporation loss include the following.

- a) High vapor pressure of the cargo.
- b) Increase in temperature of the cargo caused by ambient conditions or heating of the cargo.
- c) The improper operation of the vessel’s inert gas system and the incorrect setting of P/V on the vessel.
- d) Gauge hatches left open.
- e) Excessive agitation of cargo during loading or passage, e.g. heavy weather conditions.
- f) Poor integrity of the cargo compartment—worn packing on tank lids.
- g) COW operation at discharge.
- h) The amount of free surface area of the cargo.

### 5.6.3 Density (degrees API/kg/m<sup>3</sup>)

A significant difference between shore and vessel density (degrees API/kg/m<sup>3</sup>) measurements may lead to a quantity difference. For example in the case of long shore lines a large proportion of the loaded quantity may not have been sampled. Although losses due to density (degrees API/kg/m<sup>3</sup>) differences are quite small when considering standard volume, many product cargoes are traded in weight and in these situations density (degrees API/kg/m<sup>3</sup>) differences can lead to more significant losses.

Density (degrees API/kg/m<sup>3</sup>) stratification may occur with some products. This can result in composite shore tank samples showing differences from the product loaded if only part of a tank is drawn from and may also lead to problems in determining a density (degrees API/kg/m<sup>3</sup>) for the cargo when blending on-board.

### 5.6.4 Volume Correction Factors (VCF)

VCF tables should be consistent at all measurement points throughout the voyage. If the loaded quantities were calculated using VCF tables other than the VCF tables used at the discharge port, then the loaded quantities should be recalculated based on the VCF tables used at the discharge port, for the purposes of comparison. Any quantity difference resulting from the use of different VCF tables should be recorded on the VSRR in the "Table Difference—Reported Quantity."

When investigating measurement differences the VCF Table difference should be reviewed to confirm that it is within parameters for the tables involved and the cargo temperature.

**NOTE** Not all countries apply current ISO or API/EI/ASTM standards, some continue to use the 1952 ASTM tables and many Former Soviet Union (FSU) countries use GOST tables which calculate cargo quantities as weight in vacuum.

### 5.6.5 Volumetric Shrinkage

Volumetric shrinkage can occur when mixing two hydrocarbons with different molecular structures. The amount of shrinkage depends on the density (degrees API/kg/m<sup>3</sup>) difference and percentage of the components. The shrinkage is greatest when the percentage of light or heavy component increases towards a 50/50 mixture. For additional details and the calculation procedures, see API MPMS Ch. 12.3, *Calculation of Volumetric Shrinkage Resulting from Blending Light Hydrocarbons with Crude Oil*.

### 5.6.6 Letter of Protest—Notice of Apparent Discrepancy

Any unusual event which occurred during a loading or discharge should have been reflected in the terminal or vessel time log and possibly in a Letter of Protest or Notice of Apparent Discrepancy. This documentation should be reviewed as part of any loss investigation.

### 5.6.7 Lightering

When cargo is transferred in a lightering operation, the quantity transferred may be better quantified by using the shuttle receipt quantity, adjusted by the VEF, than the quantity based on the delivering vessel. If weather or sea conditions during lightering were not conducive to accurate measurement, or measurements could not be obtained, the transferred quantity may be better quantified using the shuttle vessel's arrival quantity (minus OBQ) at the discharge port, adjusted by the VEF.

## 5.7 Measurement Uncertainties and Errors

Examples of possible errors that are not specific to vessel or shore tank include the following.

- a) Failure to follow proper operating practices.

- b) The use of defective or non-standard measurement equipment.
- c) The environment at the time the measurements are taken.
- d) Observed tank height differences between opening and closing measurements.
- e) The use of incorrect tank tables or the improper use of tank capacity tables.
- f) The use of incorrect quantity correction factors (i.e. VCF or WCF).
- g) Temperature and density (degrees API/kg/m<sup>3</sup>) stratification (may also have an effect on floating roof correction calculations).
- h) The use of incorrect conversion factors when converting between systems of measurement.
- i) Random errors in measurement.
- j) Failure to use properly calibrated equipment.
- k) Failure to perform cargo measurement operations in accordance with API standards.
- l) Use of multiple shore tanks.

## **Annex A** (informative)

### **Instructions for Completion of Voyage Analysis Forms**

#### **A.1 Voyage Analysis Forms**

##### **A.1.1 List of Forms**

- 1) Voyage Analysis Report (VAR) (see Figure A.1)
- 2) Summary of Vessel-to-vessel Transfers (see Figure A.2)
- 3) Field Facts (see Figure A.2)
- 4) Voyage Summary and Reconciliation Report (VSRR) (see Figure A.4)

**NOTE** The forms in this Annex may be copied for use by anyone, however they are included only as examples. When all parties agree, other forms may be used.

##### **A.1.2 The Voyage Analysis Report (VAR)**

The VAR form is where the essential information regarding any marine custody transfer is recorded. A separate VAR form should be completed for each shore-to-shore or Vessel-to-vessel Transfer. On complex voyages and lightering, a Summary VAR should also be completed. Refer to 4.2 for complete instructions regarding entries on the VAR form.

All volumes on VARs must be based on consistent Volume Correction Factors (VCFs). If the VCFs used at the load port are different from the discharge port VCFs, Section I of the VAR form provides a box on line 5 to enter the recalculated load port quantity based on the discharge port VCF.

The four possible applications of the VAR form are listed below. A single VAR form may cover more than one application, and each application is indicated by checking one (or more) of the blocks at the top left corner of the form:

a) A *Load VAR* where the following are filled in:

- 1) the top section (vessel name, cargo, port, etc.) records general information about the cargo transfer;
- 2) Line 1 of Section I (Bill of Lading quantity);
- 3) all of Section II (lines A – J).

b) A *Discharge VAR* where the following are filled in:

- 1) Since the discharge port is where shore-to-shore quantity discrepancies would be found, the entire VAR form should be completed.

c) A *Vessel-to-vessel Transfer VAR* where the following are filled in:

- 1) the top section (vessel name, cargo, port, etc.) records general information about the cargo transfer;
- 2) Section II (Lines A – J).

d) A *Summary VAR* where the entire form is filled in (as applicable).

**NOTE** The *Summary VAR* should not be confused with the *Summary of Vessel-to-vessel Transfers* form.

### A.1.3 The Summary of Vessel-to-vessel Transfers Form

The *Summary of Vessel-to-vessel Transfers* form is designed to capture all quantities transferred during a lightering operation:

- 1) the top section is for general information (mother vessel name, number of transfers, lightering position, etc.);
- 2) a *Summary of Transfers* section to indicate the total quantity of cargo discharged from the mother vessel and the total received by all shuttle vessels during a lightering operation;
- 3) a *Detail of Transfers* section to indicate the name of each shuttle vessel, the quantity lightered based on mother vessel gauging, and the quantity lightered based on shuttle vessel gauging.

### A.1.4 Field Facts Form

The Field Facts form is designed to verify that specific operational items were either performed or checked as recommended by the appropriate standards. Items that cannot be verified may warrant later consideration as measurement or operational uncertainties. To be most effective, the form should include facts from both the loading port(s) and discharge port(s).

### A.1.5 The Voyage Summary and Reconciliation Report Form (VSSR)

The VSSR information is divided into four vertical groupings:

- 1) the heading, showing the vessel's name, load and discharge ports, dates of arrival and sailing, etc.;
- 2) a listing and reconciliation of the quantity differences taken from the VAR report (Transit difference, OBQ/ROB difference, etc.);
- 3) a calculation of the difference between the vessel loaded volume (VAR, line C) adjusted first by the VEFD and then by the VEFL;
- 4) comments that apply to the reconciliation.

## A.2 Simple Voyages

A *simple voyage* is a single grade cargo movement from one load port to one discharge port.

For a simple voyage, only one VAR form is needed and it will cover the loading, the discharge, and a summary of the voyage. Therefore, the *Loading*, *Discharge* and *Summary* boxes at the top left corner of the form should all be marked.

If the reason for any gain or loss cannot be readily detected from the VAR form alone, completing the VSSR form should be considered.

## A.3 Complex Voyages

A *complex voyage* involves the shipment of one or more grades of cargo at one or more load and/or discharge ports. Complex voyages may require the use of all three analysis forms. Following is an example of the forms that would be used for a typical complex cargo analysis. See A.1 for instructions to complete each style of VAR mentioned below.

**Table A.1—Recommended Forms for Complex Voyage Analysis**

Cargo	Load Port	Discharge Port	VAR Application (Mark Box on Form)	VSRR
X	A	D	Loading, Discharge, Summary	If needed
Y	B	E	Loading, Discharge	If needed
Z	B	D	Loading, Discharge	If needed
Z	B	E	Loading, Discharge	If needed
Z	B	D, E	Summary	If needed

**Complex Cargo Example:**

One vessel loads and discharges *three cargoes* and a VAR form should be completed for each loading, discharge and summary (five VARs as in Table A.1).

**A.4 Vessel-to-vessel Transfer (Lighterings)**

A Vessel-to-vessel transfer occurs when a cargo is moved from one vessel to another. Typically, this is ship-to-ship or ship-to-barge. The most common lighterings involve cargoes of crude oil where a large tanker discharges parcels of the crude oil to smaller tankers that can meet draft restrictions at the intended discharge terminal.

**Vessel-to-vessel Transfer Example:**

Supertanker “C” loads

200,000 tons of Crude Oil at Load port “A”

Supertanker “C” discharges

60,000 tons to Shuttle Vessel “A”

70,000 tons to Shuttle Vessel “B”

70,000 tons to Shore Terminal “C”

Forms needed:

- Loading VAR for Supertanker “C” at Load port “A”
- *Vessel-to-vessel Transfer VAR* for Shuttle “A”
- *Vessel-to-vessel Transfer VAR* for Shuttle “B”
- *Summary of Vessel-to-vessel Transfers* to recap the two shuttles from Supertanker “C”
- *Discharge VAR* for Supertanker “C” (for the discharge at Shore Terminal “C”)
- *Summary VAR* summarizing:
  - 1) the loading of Supertanker “C;”
  - 2) the quantities discharged to shore from the two shuttles;
  - 3) the balance from Supertanker “C” discharged directly to shore.

VSRR form may be required to research variances indicated on each VAR above.

<input type="checkbox"/> Loading <input type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input type="checkbox"/> Summary				Reference No.	Voyage/Trip No.	C/P Date (M/D/Y)	Page No. ____ Of ____
Vessel				Cargo		Type of Voyage	
Loading Port/Terminal/Berth		Arrived (M/D/Y)	Sailed (M/D/Y)	Discharge Port/Terminal/Berth		Arrived (M/D/Y)	Sailed (M/D/Y)
Quantity Unit <input type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier	Receiver	VCF Table Used			
				Shore Load	Shore Disc	Vessel Load	Vessel Disc
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.							-1
Outturn 2.							-2
Diff. 3.							(3) = (2) - (1)
Diff. % 4.		%		%		%	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)	Recalculate if B/L and O/T use different tables					(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at ( ) Load Port(s)</b>							
Vessel Sailing A.				LIQUID	NON-LIQUID		(A)
OBQ (All) B.							(B)
Loaded C.							(C)=(A) - (B)
Difference D.							(D)=(C)-[(1) or (5)]
Difference % E.		%		%			(E)=(D)/[(1)or(5)]×100
Load Vessel Ratio F.							(F)=(C)/[(1) or (5)]
Load VEF G.							(G)
Theoretical Shore H.							(H)=(C) / (G)
Theoretical Shore Diff. I.							(I)=(H) - [(1) or (5)]
Theoretical Shore Diff. % J.		%					(J)=(I)/[(1) or (5)]×100
<b>III. Vessel/Shore Quantities at ( ) Discharge Port(s)</b>							
Vessel Arrival K.				LIQUID	NON-LIQUID		(K)
ROB (All) L.							(L)
Discharged M.							(M) = (K) - (L)
Difference N.							(N) = (M) - (2)
Difference % O.		%		%			(O) = (N) / (2) × 100
Discharge Vessel Ratio P.							(P) = (M) / (2)
Discharge VEF Q.							(Q)
Theoretical Shore R.							(R) = (M) / (Q)
Theoretical Shore Diff. S.							(S) = (2) - (R)
Theoretical Shore Diff. % T.		%					(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s) VCF Table Must Be Consistent</b>							
Transit Difference U.							(U) = (K) - (A)
Difference V.		%		LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.							(W) = (B) - (L)
TCV Difference (3) - OBQ (B) + ROB (L)				[S&W(1) / GSV(1)] × 100		[S&W(2) / GSV (2)] × 100	
ADJ TCV DIFF _____ (Quantity)/ _____ %				S&W at Load Port _____ %		S&W at Discharge Port _____ %	
Comments:							
Prepared by		Title		Company		Date Completed (M/D/Y)	

Figure A.1—Voyage Analysis Report (VAR)

Mother Vessel		No. of Transfers	Reference No.	Voyage/Trip No.	C/P Date (M/D/Y)	Page No. Of
Quantity Unit <input type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier	Receiver	VCF Table Used		Finished(M/D/Y)
				Shore Load	Shore Disch.	Vessel Disch.
Note: Volume Data and Line Reference Can Be Taken From Voyage Analysis Report(s) (VAR)						
SUMMARY OF TRANSFERS						
	TCV	FW	GSV	Calculation REF		
Total Discharged				Total R (5 + 9 +13 +17 + 21 + 25)		
1. Mother Vessel						
Total Receipts				Total H (6 +10 +14 +18 + 22 +26)		
2. Shuttle Vessels						
3. Difference from Mother Vessel				H – R		
4. Difference %		%		% (H – R) / R × 100		
DETAIL OF TRANSFERS						
First Transfer - Line (R)	Page Number					
5. From Mother Vessel	_____ of _____					R
Shuttle Receipt Ref #	Page Number					
6. Vessel Name	_____ of _____					H
7. Difference from Mother Vessel						H -R
8. Difference %		%				% (H -R) / R × 100
Second Transfer - Line (R)						
9. From Mother Vessel	Page Number					R
Shuttle Receipt Ref #	Page Number					
10. Vessel Name	_____ of _____					H
11. Difference from Mother Vessel						H -R
12. Difference %		%				% (H -R) / R × 100
Third Transfer -Line (R)						
13. From Mother Vessel	Page Number					R
Shuttle Receipt Ref #	Page Number					
14. Vessel Name	_____ of _____					H
15. Difference from Mother Vessel						H -R
16. Difference %		%				% (H -R) / R × 100
Fourth Transfer -Line (R)						
17. From Mother Vessel	Page Number					R
Shuttle Receipt Ref #	Page Number					
18. Vessel Name	_____ of _____					H
19. Difference from Mother Vessel						H -R
20. Difference %		%				% (H -R) / R × 100
Fifth Transfer - Line (R)						
21. From Mother Vessel	Page Number					R
Shuttle Receipt Ref #	Page Number					
22. Vessel Name	_____ of _____					H
23. Difference from Mother Vessel						H -R
24. Difference %		%				% (H -R) / R × 100
Sixth Transfer - Line (R)						
25. From Mother Vessel	Page Number					R
Shuttle Receipt Ref #	Page Number					
26. Vessel Name	_____ of _____					H
27. Difference from Mother Vessel						H -R
28. Difference %		%				% (H -R) / R × 100

Figure A.2—Summary of Vessel-to-Vessel Transfers



Vessel		Cargo		Reference No.	Voyage/Trip No.	Page No.
Loading Port/Terminal/ Berth	Arrived (M/D/Y)	Sailed (M/D/Y)	Discharge Port/Terminal/Berth		Arrived (M/D/Y)	Sailed (M/D/Y)
Identify the following and state the methods or equipments used at load port and discharge port. Indicate either name of equipment used, or if applicable check, (X).						
			Loading (Used/Checked)		Discharge (Used/Checked)	
<b>1. Measurements Used in Custody Transfer</b> (State Shore or Vessel)						
<b>2. Shore Operations</b>						
2.1 Measurements						
2.1.1 Manual Tank Gauges						
2.1.2 ATG (Tank/Remote/Both)						
2.1.3 Meters						
2.1.4 Temperatures						
2.1.4.1 Portable Electronic Thermometer						
2.1.4.2 Cup Case Thermometer						
2.1.4.3 Remote Temperature Device						
2.1.4.4 Other						
2.2 Sampling						
2.2.1 In-Line Sampler						
2.2.2 Manual Shore Tanks						
2.2.3 Spot Line						
2.3 Sample Testing						
2.3.1 Gravity Standard Test Method						
2.3.2 S&W Standard Test Method(s)						
2.4 Shore Pipeline(s)						
2.4.1 Identification (Name/No. of Pipeline)						
2.4.2 Total Capacity (Bbls)						
2.4.3 Method of Line Condition Verification						
<b>3. Vessel's Operations</b>						
3.1 Measurements						
3.1.1 Hand Gauges						
3.1.2 Closed Systems						
3.1.3.1 Hand Held Electronic Gauge (State Type)						
3.1.3.2 ATG						
3.1.4 Temperatures						
3.1.4.1 Portable Electronic Thermometer						
3.1.4.2 Cup Case Thermometer						
3.1.4.3 Remote Temperature Device						
3.2 Sampling						
3.2.1 On Board Ship In-Line Sampler						
3.2.2 Vessel's Tanks Samples (Composite)						
3.2.3 Vessel's Manifold Spot Samples						
3.3 Sample Testing						
3.3.1 Gravity Standard Test Method						
3.3.2 S&W Standard Test Method(s)						
3.4 Vessel's Pipeline(s)						
3.4.1 Identification (Name/No. of Pipeline)						
3.4.2 Total Capacity (Bbls)						
3.4.3 Method of Line Condition Verification						
<b>4. Calculation and Paperwork</b>						
4.1 Letter of Protest Issued						
4.2 Notice of Apparent Discrepancies Issued						
4.3.1 Volume Correction Factor Tables Used on Ship						
4.3.2 Volume Correction Factor Tables Used on Shore						
4.4.1 Vessel Arrival Draft						
4.4.2 Vessel Sailing Draft						

Figure A.3—Field Facts

Vessel		Cargo		Type of Voyage		Reference Number		Voyage/Trip No.		Page Number	
Loading Port/Terminal/Berth				Arrived (M/D/Y)		Discharge Port/Terminal/Berth		Arrived (M/D/Y)		Sailed (M/D/Y)	
Information may be taken for a completed Voyage Analysis Report (VAR).											
NSV Shore-to-Shore Difference		Reported QTY		Quantity Units		Quantity Units		<input type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Adjusted Qty	
Bill of Lading		1								1	
Outturn		2								2	
Difference		3								3	
Difference %		4								4	
Reconciliation											
Summary of Reported Differences		Reported Quantity		Evaporation Loss		Shipboard Loss		Volumetric Shrinkage		Undetected ROB	
Transit Difference										Line Fill Discrepancy	
OBQ/ROB Difference										Measurement Errors	
Shore FW Difference										Adjusted Quantity	
Shore S&W Difference											
Table Difference*											
Load Port Theoretical Difference											
Discharge Port Theoretical Difference											
Load/Discharge VEF Difference**											
Total All Differences											

\*Table difference is the difference between the bill or lading figure and the recalculated quantity based on applicable VCF table (e.g. 6A).

\*\*Load/discharge VEF Difference is A - B = C.

Reported

Adjusted

A) \_\_\_\_\_

B) \_\_\_\_\_

C) \_\_\_\_\_

Vessel Loaded Volume Divided by the VEFD

Vessel Loaded Volume Divided by the VELF

Load/Discharge VEF Difference

Comments:

Prepared By

Title

Company

Date Completed

Figure A.4—Voyage Summary and Reconciliation Report (VSRR)

## Annex B (informative)

### Examples of Cargo Analysis and Reconciliation

#### B.1 Example of a Complex Voyage Analysis and Reconciliation

In this example (Figure B.1, Figure B.2, Figure B.3, Figure B.4, and Figure B.5), a vessel is loaded with fuel oil. The vessel first ties up to an anchorage near Boston where part of its cargo is lightered to a barge. The barge subsequently discharges at one shore terminal, and the vessel then transports and discharges the balance of the cargo ashore at another shore terminal.

The completed forms at the back of this Annex (Figure B.1, Figure B.2, Figure B.3, Figure B.4, and Figure B.5) are intended to illustrate how to analyze and reconcile a complex voyage that includes a lightering operation to a barge. This process allows the voyage to be broken down into components where each element of the loading, lightering and discharge can be analyzed.

##### B.1.1 Cargo Transfers Used in the Example

- 1) Vessel "A" loads 211,863 barrels of fuel oil at Venezuela.
- 2) Vessel "A" transports the cargo to Boston anchorage and lighters 35,918 barrels of fuel oil to a Barge "B."
- 3) Barge "B" transports its cargo to Braintree, MA.
- 4) Vessel "A" transports the balance of the fuel oil to Boston Terminal.

##### B.1.2 Explanation of the Example Forms (Figure B.1, Figure B.2, Figure B.3, Figure B.4, and Figure B.5)

- 1) Figure B.1 is the VAR Summary for the entire 211,863 barrels of fuel oil.
- 2) Figure B.2 details the lightering of the 35,918 barrels of fuel oil to Barge "B."
- 3) Figure B.3 details the discharge of the remaining fuel oil from Vessel "A" to Boston Terminal.
- 4) Figure B.4 details the loading of Barge "B" (at anchorage) and its discharge ashore (at Braintree, MA).
- 5) Figure B.5 is the summary of the lightered quantities based on gauging both Vessel "A" and Barge "B" at anchorage.

##### B.1.3 Analyzing the Voyage

###### B.1.3.1 Figure B.1: The VAR Summary

The VAR Summary form (see Figure B.1) accounts for the entire cargo at loading, lightering at anchorage, and discharging both the barge and the balance on board the vessel. It reveals a shore-to-shore overall NSV cargo loss of 205 barrels (0.097 %) as follows:

Bill of Lading at the Load Port:	211,863 NSV Barrels	
Total Discharged Ashore:	– 211,658 NSV Barrels	(from both Barge "X" and Vessel "A")
Shore-to-shore Loss:	205 NSV Barrels	

### B.1.3.2 Figure B-2: The Vessel-to-vessel VAR

The Vessel-to-vessel VAR (see Figure B-2) should disclose any quantity variations that may have occurred during lightering to Barge "B":

- 1) TCV quantity received by the barge, based on gauging Vessel "A" (VAR line 2);
- 2) TCV quantity received by the barge, based on barge gauging (VAR line M);
- 3) a theoretical TCV quantity received by the barge based on Vessel "A" gauges adjusted for the VEF of Vessel "A" (VAR line R).

The quantity delivered to Barge "B" based on gauging Vessel "A" is calculated follows:

Quantity on board Vessel "A" Upon Arrival at Anchorage:	211,986 TCV Bbl (line K)
Quantity of ROB on Board Vessel "A" after Loading Barge "B":	176,071 TCV Bbl (line L)
Volume transferred to Barge "B" Based on Gauging Vessel "A"	35,915 TCV Bbl (line M)

The quantity received by Barge "B" based on gauging the barge can now be compared to the quantity delivered based on gauging Vessel "A":

Quantity received by Barge "B" Based on Gauging Barge "B":	35,918 TCV Bbl (line 2)
Quantity received by Barge "B" Based on Gauging Vessel "A":	35,915 TCV Bbl (line M)
Difference:	< 3 TCV Bbl > (line N)

A theoretical quantity delivered by Vessel "A" can also be calculated by applying the VEF of Vessel "A" to the volume delivered by Vessel "A":

Theoretical Qty. Delivered from Vessel "A" (line R):	=	35,915 TCV Bbl (Basis Vessel "A" Gauges)
35,877 TCV Bbl		1.0011 (VEF of Vessel "A")

### B.1.3.3 Figure B.3: The Shore Discharge VAR for Vessel "A"

The shore discharge VAR for Vessel "A" (see Figure B-3) allows comparison of the following quantities:

- 1) the quantity received ashore from Vessel "A" based on gauging shore tanks (VAR line 2);
- 2) the quantity on board Vessel "A" on sailing from the anchorage (VAR line A);
- 3) the quantity on board Vessel "A" on arrival at the shore terminal (VAR line K);
- 4) the quantity delivered ashore by Vessel "A" based on gauging vessel tanks (VAR line M);
- 5) a theoretical shore quantity received from Vessel "A" based on Vessel "A" gauges adjusted for the vessel's VEF (VAR line R);
- 6) the transit quantity difference (departure from anchorage to arrival at terminal) (VAR line U).

#### B.1.3.4 Figure B.4: The Loading and Discharge Quantities for Barge “B”

The loading and discharge quantities for Barge “B” allow comparison of the following quantities:

- 1) the quantity received by Barge “B” from Vessel “A” based on barge gauges after application of the barge VEFL (VAR line 1);
- 2) the quantity received from Barge “B” by the shore terminal based on gauging shore tanks (VAR line 2);
- 3) the quantity gauged on board Barge “B” on sailing from the Vessel “A” anchorage before application of the VEFL (VAR line A);
- 4) the quantity gauged on board Barge “B” on arrival at the shore terminal (VAR line K);
- 5) a theoretical quantity on board Barge “B” based on barge gauges after application of the barge VEFL (VAR lines 1 and H);
- 6) a theoretical shore quantity received from Barge “B” based on barge gauges adjusted for the barge’s VEFL (VAR line R);
- 7) the transit quantity difference (barge on departure from anchorage to arrival at the terminal) (VAR line U).

#### B.1.3.5 Figure B.5: The Summary of Vessel-to-vessel Transfers

This form is particularly useful when a mother vessel lighters to several shuttle vessels, where each shuttle vessel is listed individually. However this example illustrates how the Summary is completed by indicating the following:

- 1) the quantity lightered to Barge “B” by Vessel “A” based on gauging Vessel “A”;
- 2) the quantity received by Barge “B” from Vessel “A” based on gauging Barge “B.”

### B.2 Example of a Simple Voyage Analysis and Reconciliation

In this example (Figure B.6, Figure B.7, and Figure B.8), a vessel is loaded with crude oil in England and the entire cargo discharges in Houston, a single load port and a single discharge port. The receiver purchased the cargo on an FOB basis and thus incurred the risk of loss for the voyage. The initial outturn volumes indicated an apparent loss of 2,458 NSV barrels (0.48 %).

Figure B.6, Figure B.7, and Figure B.8 are intended to be examples of how the relevant data may be organized to determine the probable cause(s) for the apparent loss of cargo.

#### B.2.1 Cargo Transfer Used in the Example

- 1) Vessel “C” loads 511,956 barrels of crude oil at England.
- 2) Vessel “C” transports the cargo to Houston where it is discharged.

#### B.2.2 Explanation of the Example Forms (Figure B.6, Figure B.7, and Figure B.8)

- 1) Figure B.6 is the VAR Loading and Discharge report for the entire 511,956 barrels of crude oil.
- 2) Figure B.7 is the VSRR listing the NSV quantities initially measured, and summarizing the differences based VAR report indications.
- 3) Figure B.8 is a VAR detailing quantity adjustments made as a result of analyzing the differences listed on the VSRR.

## B.2.3 Analyzing the Voyage

### B.2.3.1 Figure B.6: The Var Loading/Discharge Report

The VAR Loading/Discharge form (see Figure B.6) accounts for the entire cargo at loading and discharging the vessel. It reveals a shore-to-shore overall NSV cargo loss of 2,458 barrels (0.480 %) as follows:

Bill of Lading at the Load Port:	511,730 Barrels
Total Discharged Ashore:	– 509,272 NSV Barrels
Shore-to-shore Loss:	2,458 NSV Barrels

### B.2.3.2 Figure B.7: The VSRR Report

On the VSRR, six differences are reported from the VAR and information was found to explain four of those differences. Note that the adjustment of the discharge port theoretical difference reflects a combination of all three reconciling items. This leaves most of the apparent loss unexplained and the analyst can focus the investigation on the apparent loss of 1,175 barrels of product indicated by the sharp increase in the theoretical difference at the discharge port.

Reported Difference	Reported Quantity	Cause of Difference	Quantity of Difference	Adjusted Quantity
Transit Difference	+ 236 Bbl	Measurement Error	– 286 Bbl	– 50 Bbl
OBQ/ROB Difference	– 445 Bbl	Undetected ROB	– 77 Bbl	– 522 Bbl
Line Fill Discrepancy	0 Bbl	Discharge Port Line Fill	+ 105 Bbl	0
S & W Difference	– 437 Bbl	Undetected S&W at Load Port	– 437 Bbl	– 437 Bbl
Other Four Differences	– 1,812	No Cause Found	0	– 1,344
TOTAL ALL DIFFERENCES	– 2,458			– 2,353

### B.2.3.3 Figure B.8: The Voyage Analysis Report Adjusted

An adjusted VAR may then be completed that identifies the possible application of the variances found while completing the VSRR. Note that, in this illustration, the 105 barrel line fill discrepancy has been added to the outturn volume. Transit, S & W and OBQ/ROB variances are also included in this example.

The application of line fill or any other variances is shown here for illustration only. Any decision affecting cargo volumes and/or variances must be taken solely by the parties involved and API takes no position regarding such decisions.

<input checked="" type="checkbox"/> Loading <input type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input checked="" type="checkbox"/> Summary				Reference No. C123456	Voyage/Trip No. 56	C/P Date (M/D/Y) 11 / 25 / 10	Page No. 1 of 5
Vessel Vessel "A"				Cargo Fuel Oil		Type of Voyage Lightering	
Loading Port/Terminal/Berth Venezuela		Arrived (M/D/Y) 12 / 01 / 10	Sailed (M/D/Y) 12 / 02 / 10	Discharge Port/Terminal/Berth Boston		Arrived (M/D/Y) 12 / 09 / 10	Sailed (M/D/Y) 12 / 11 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "B"	Receiver "C"	VCF Table Used			
				Shore Load   6B	Shore Disc 6B	Vessel Load   6B	Vessel Disc   6B
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.	34	211,863	0	211,863	0	211,863	-1
Outturn 2.	34.1	211,890	232	211,658	0	211,658	-2
Diff. 3.		27	232	< 205 >	0	< 205 >	(3) = (2) - (1)
Diff. % 4.		0.013%		< 0.097 > %		< 0.097 > %	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at ( 1 ) Load Port(s)</b>							
Vessel Sailing A.	211,846	212	211,634	LIQUID	NON-LIQUID		(A)
OBQ (All) B.	0	0	0	0	0		(B)
Loaded C.	211,846	212	211,634				(C)=(A) - (B)
Difference D.	< 17 >	212	< 229 >				(D)=(C)-[(1) or (5)]
Difference % E.	< 0.008 > %		< 0.108 > %				(E)=(D)/[(1) or (5)] × 100
Load Vessel Ratio F.	0.99992						(F)=(C)/[(1) or (5)]
Load VEF G.	1.00097						(G)
Theoretical Shore H.	211,641						(H)=(C) / (G)
Theoretical Shore Diff. I.	< 222 >						(I)=(H) - [(1) or (5)]
Theoretical Shore Diff. % J.	< 0.105 > %						(J)=(I)/[(1) or (5)] × 100
<b>III. Vessel/Shore Quantities at ( 2 ) Discharge Port(s)</b>							
Vessel Arrival K.	211,986	194	211,792	LIQUID	NON-LIQUID		(K)
ROB (All) *L.	15	0	15	15	0		(L)
Discharged M.	211,971	194	211,777				(M) = (K) - (L)
Difference N.	81	< 38 >	119				(N) = (M) - (2)
Difference % O.	0.038%		0.056%				(O) = (N) / (2) × 100
Discharge Vessel Ratio P.	1.00038						(P) = (M) / (2)
Discharge VEF Q.	1.00106						(Q)
Theoretical Shore R.	211,747						(R) = (M) / (Q)
Theoretical Shore Diff. S.	143						(S) = (2) - (R)
Theoretical Shore Diff. % T.	0.068%						(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s) VCF Table must be Consistent</b>							
Transit Difference U.	+ 202 *	< 18 >	+ 158				(U) = (K) - (A)
Difference % V.	0.095%		0.075%	LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.	< 15 > *	0	< 15 >	< 15 >			(W) = (B) - (L)
TCV Differences (3) - OBQ (B) + ROB(L)		[S&W(2) / GSV(2)] × 100		[S&W(2) / GSV(2)] × 100			
ADJ TCV DIFF +42 (Quantity) / 0.020%		S&W at Load Port 0%		S&W at Discharge Port 0%			
Comments: * Transit & ROB Difference for all Movements Vessel lighted to Bareg "B"; O/T for Tanks and Barge							
Prepared By	Title		Company		Date Completed (M/D/Y)		

Figure B.1—Voyage Analysis Report (VAR) Summary

<input type="checkbox"/> Loading <input type="checkbox"/> Discharge <input checked="" type="checkbox"/> V-V Transfer <input type="checkbox"/> Summary				Reference No. C123456	Voyage/Trip No. 56	C/P Date (M/D/Y) 11 / 25 / 10	Page No. 2 of 5
Vessel Vessel "A"				Cargo Fuel Oil		Type of Voyage Lightering	
Loading Port/Terminal/Berth Venezuela		Arrived (M/D/Y) 12 / 01 / 10	Sailed (M/D/Y) 12 / 02 / 10	Discharge Port/Terminal/Berth Boston Anchorage		Arrived (M/D/Y) 12 / 09 / 10	Sailed (M/D/Y) 12 / 09 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "B"	Receiver "C"	VCF Table Used			
				Shore Load	Shore Disc 6B	Vessel Load	Vessel Disc 6B
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.							(1)
Outturn 2.	*34.0	35,918	93	35,825	0	35,825	(2)
Diff. 3.							(3) = (2) – (1)
Diff. % 4.		%		%			(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at ( 1 ) Load Port(s)</b>							
Vessel Sailing A.	211,846	212	211,634	LIQUID	NON-LIQUID		(A)
OBQ (All) B.							(B)
Loaded C.							(C) = (A) – (B)
Difference D.							(D) = (C) – [(1) or (5)]
Difference % E.							(E) = (D) / [(1) or (5)] × 100
Load Vessel Ratio F.							(F) = (C) / [(1) or (5)]
Load VEF G.							(G)
Theoretical Shore H.							(H) = (C) / (G)
Theoretical Shore Diff. I.							(I) = (H) – [(1) or (5)]
Theoretical Shore Diff. % J.							(J) = (I) / [(1) or (5)] × 100
<b>III. Vessel/Shore Quantities at (1) Discharge Port(s)</b>							
Vessel Arrival K.	211,986	194	211,792	LIQUID	NON-LIQUID		(K)
ROB (All) L.	176,071	104	175,967	175,967	0		(L)
Discharged M.	35,915	90	35,825				(M) = (K) – (L)
Difference N.	< 3 >	< 3 >	0				(N) = (M) – (2)
Difference % O.	< 0.008 > %		0%				(O) = (N) / (2) × 100
Discharge Vessel Ratio P.	0.99992						(P) = (M) / (2)
Discharge VEF Q.	1.00106						(Q)
Theoretical Shore R.	35,877						(R) = (M) / (Q)
Theoretical Shore Diff. S.	+ 41						(S) = (2) – (R)
Theoretical Shore Diff. % T.	0.114%						(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s)   VCF Tables must be consistent.</b>							
Transit Difference U.	140	< 18 >	158				(U) = (K) – (A)
Difference % V.	0.066%		0.08%	LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.							(W) = (B) – (L)
TCV Difference (3) – OBQ (B) + ROB (L)				[S&W(1) / GSV(1)] × 100		[S&W(2) / GSV(2)] × 100	
ADJ TCV DIFF _____ (Quantity) / _____ %			S&W at Load Port _____ %		S&W at Discharge Port _____ %		
Comments: Outturn Based on Barge Receipt by its VEF. Vessel Lightered to Barge "B". (See Figure 4)							
Prepared by _____ Title _____ Company _____ Date Completed (M/D/Y) _____							

Figure B.2—Voyage Analysis Report (VAR)



<input type="checkbox"/> Loading <input checked="" type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input type="checkbox"/> Summary				Reference No. C123456	Voyage/Trip No. 56	C/P Date (M/D/Y) 11 / 25 / 10	Page No. 3 of 5
Vessel "A"				Cargo Fuel Oil		Type of Voyage Lightering	
Loading Port/Terminal/Berth Boston Anchorage		Arrived (M/D/Y) 12 / 09 / 10	Sailed (M/D/Y) 12 / 09 / 10	Discharge Port/Terminal/Berth Boston		Arrived (M/D/Y) 12 / 10 / 10	Sailed (M/D/Y) 12 / 11 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "B"	Receiver "C"	VCF Table Used			
				Shore Load	Shore Disc 6B	Vessel Load	Vessel Disc 6B
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.							(1)
Outturn 2.	34.1	175,897	159	175,738	0	175,738	(2)
Diff. 3.							(3) = (2) - (1)
Diff. % 4.		%		%		%	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at (1) Load Port(s)</b>							
Vessel Sailing A.	176,071	104	175,967	LIQUID	NON-LIQUID		(A)
OBQ (All) B.							(B)
Loaded C.							(C)=(A) - (B)
Difference D.							(D)=(C)-[(1) or (5)]
Difference % E.							(E)=(D)/[(1) or (5)]×100
Load Vessel Ratio F.							(F)=(C)/[(1) or (5)]
Load VEF G.							(G)
Theoretical Shore H.							(H)=(C) / (G)
Theoretical Shore Diff. I.							(I)=(H) - [(1) or (5)]
Theoretical Shore Diff. % J.							(J)=(I)/[(1) or (5)]×100
<b>III. Vessel/Shore Quantities at (1) Discharge Port(s)</b>							
Vessel Arrival K.	176,061	115	175,946	LIQUID	NON-LIQUID		(K)
ROB (All) L.	10	0	10	10	0		(L)
Discharged M.	176,051	115	175,936				(M) = (K) - (L)
Difference N.	154	< 44 >	+ 199				(N) = (M) - (2)
Difference % O.	0.088%		0.113%				(O) = (N) / (2) × 100
Discharge Vessel Ratio P.	1.00088						(P) = (M) / (2)
Discharge VEF Q.	1.00106						(Q)
Theoretical Shore R.	175,865						(R) = (M) / (Q)
Theoretical Shore Diff. S.	32						(S) = (2) - (R)
Theoretical Shore Diff. % T.	0.018%						(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s) VCF Tables must be consistent</b>							
Transit Difference U.	< 10 >	11	< 21 >				(U) = (K) - (A)
Difference % V.	< 0.006 > %		< 0.012 > %	LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.							(W) = (B) - (L)
TCV Difference (3) - OBQ (B) + ROB (L)		[S&W(1) / GSV(1)] × 100		[S&W(2) / GSV(2)] × 100			
ADJ TCV DIFF _____ (Quantity) / _____ %		S&W at Load Port 0 %		S&W at Discharge Port 0 %			
Comments: No Problem at Discharge Port							
Prepared by		Title		Company		Date Completed (M/D/Y)	

Figure B.3—Voyage Analysis Report (VAR)

<input checked="" type="checkbox"/> Loading <input checked="" type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input type="checkbox"/> Summary				Reference No. C123456 -A	Voyage/Trip No. 742	C/P Date (M/D/Y)	Page No. 4 of 5
Vessel Barge "B"				Cargo Fuel Oil		Type of Voyage Simple	
Loading Port/Terminal/Berth Boston Anchorage		Arrived (M/D/Y) 12 / 09 / 10	Sailed (M/D/Y) 12 / 09 / 10	Discharge Port/Terminal/Berth Braintree, Mass.		Arrived (M/D/Y) 12 / 10 / 10	Sailed (M/D/Y) 12 / 10 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "C"	Receiver "D"	VCF Table Used			
				Shore Load 6B	Shore Disc 6B	Vessel Load 6B	Vessel Disc 6B
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.	34.0	*35918	93	35,825	0	35,825	( 1 )
Outturn 2.	34.0	35,993	73	35,920	0	35,920	( 2 )
Diff. 3.		+75	< 20 >	+95	0	+95	(3) = (2) - (1)
Diff. % 4.		0.209%		0.265%		0.265%	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at (1) Load Port(s)</b>							
Vessel Sailing A.	35,986	93	35,893	LIQUID	NON-LIQUID	(A)	
OBQ (All) B.	0	0	0	0	0	(B)	
Loaded C.	35,986	93	35,893			(C)=(A) - (B)	
Difference D.	+ 68	0	+ 68			(D)=(C)-[(1) or (5)]	
Difference % E.	0.189%		0.190%			(E)=(D)/[(1)or(5)]×100	
Load Vessel Ratio F.	1.00189					(F)=(C)/[(1) or (5)]	
Load VEF G.	1.0019					(G)	
Theoretical Shore *H.	35,918					(H)=(C) / (G)	
Theoretical Shore Diff. I.	0					(I)=(H) - [(1) or (5)]	
Theoretical Shore Diff. % J.	0%					(J)=(I)/[(1) or (5)]×100	
<b>III. Vessel/Shore Quantities at (1) Discharge Port(s)</b>							
Vessel Arrival K.	36,057	83	35,974	LIQUID	NON-LIQUID	(K)	
ROB (All) L.	5	0	5	5	0	(L)	
Discharged M.	36,052	83	35,969			(M) = (K) - (L)	
Difference N.	+ 59	+ 10	+ 49			(N) = (M) - (2)	
Difference % O.	0.164%		0.136%			(O) = (N) / (2) × 100	
Discharge Vessel Ratio P.	1.00164					(P) = (M) / (2)	
Discharge VEF Q.	1.00202					(Q)	
Theoretical Shore R.	35,979					(R) = (M) / (Q)	
Theoretical Shore Diff. S.	+ 14					(S) = (2) - (R)	
Theoretical Shore Diff. % T.	0.038%						
<b>IV. Vessel's Comparison of Loading and Discharge Port(s) VCF Tables must be consistent.</b>							
Transit Difference U.	+ 71	< 10 >	+ 81			(U) = (K) - (A)	
Difference % V.	0.197%		0.226%	LIQUID	NON-LIQUID	(V) = (U) / (A) × 100	
OBQ/ROB Difference W.	< 5 >	0	< 5 >	< 5 >	0	(W) = (B) - (L)	
TCV Difference (3) - OBQ (B) + ROB (L)		[S&W(2) / GSV(2)] × 100		[S&W(2) / GSV(2)] × 100			
ADJ TCB DIFF +80 (Quantity) / 0.223%		S&W at Load Port 0%		S&W at Discharge Port 0%			
Comment: * Transfer volume based on barge receipt by its VEF.							
Prepared by	Title		Company		Date Completed (M/D/Y)		

Figure B.4—Voyage Analysis Report (VAR)

Mother Vessel Vessel "A"		No. of Transfers One	Reference No. C 123456	Voyage/Trip No. 56	C/P Date (M/D/Y) 12 / 09 / 10	Page No. 5 of 5
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L	Supplier "B"	Receiver "C"	VCF Table Used			
			Shore Load	Shore Disch. 6B	Vessel Load	Vessel Disch. 6B
Note: Volume data and line reference can be taken from Voyage Analysis Report(s) (VAR).						
Summary of Transfers						
	TCV	FW	GSV	Calculation REF		
Total Discharged 1. Mother Vessel	35,877	90	35,787	Total R (5 + 9 +13 +17 + 21 + 25)		
Total Receipts 2. Shuttle Vessels	35,918	93	35,825	Total H (6 +10 +14 +18 + 22 +26)		
3. Difference from Mother Vessel	+41		+38	H – R		
4. Difference %	0.114%		0.106%	(H – R) / R × 100		
Detail of Transfers						
First Transfer - Line (R) 5. From Mother Vessel	Page Number 2 of 5	35,877	90	35,787	R	
Shuttle Receipt Ref # 6. Vessel Name	Page Number 4 of 5	35,918	93	35,825	H	
7. Difference from Mother Vessel		+41		+38	H -R	
8. Difference %		0.114%		0.106%	(H -R) / R × 100	
Second Transfer - Line (R)						
9. From Mother Vessel	Page Number _____ of _____				R	
Shuttle Receipt Ref # 10. Vessel Name	Page Number _____ of _____				H	
11. Difference from Mother Vessel					H -R	
12. Difference %		%		%	(H -R) / R × 100	
Third Transfer - Line (R)						
13. From Mother Vessel	Page Number _____ of _____				R	
Shuttle Receipt Ref # 14. Vessel Name	Page Number _____ of _____				H	
15. Difference from Mother Vessel					H -R	
16. Difference %		%		%	(H -R) / R × 100	
Fourth Transfer - Line (R)						
17. From Mother Vessel	Page Number _____ of _____				R	
Shuttle Receipt Ref # 18. Vessel Name	Page Number _____ of _____				H	
19. Difference from Mother Vessel					H -R	
20. Difference %		%		%	(H -R) / R × 100	
Fifth Transfer - Line (R)						
21. From Mother Vessel	Page Number _____ of _____				R	
Shuttle Receipt Ref # 22. Vessel Name	Page Number _____ of _____				H	
23. Difference from Mother Vessel					H -R	
24. Difference %		%		%	(H -R) / R × 100	
Sixth Transfer - Line (R)						
25. From Mother Vessel	Page Number _____ of _____				R	
Shuttle Receipt Ref # 26. Vessel Name	Page Number _____ of _____				H	
27. Difference from Mother Vessel					H -R	
28. Difference %		%		%	(H -R) / R × 100	

Figure B.5—Voyage Analysis Report (VAR)

<input checked="" type="checkbox"/> Loading <input checked="" type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input type="checkbox"/> Summary				Reference No. C123451	Voyage/Trip No. 24	C/P Date (M/D/Y) 10 / 15 / 10	Page No. 1 of 3
Vessel "C"				Cargo Crude Oil		Type of Voyage	Simple
Loading Port/Terminal/Berth England		Arrived (M/D/Y) 11 / 03 / 10	Sailed (M/D/Y) 11 / 04 / 10	Discharge Port/Terminal/Berth Houston		Arrived (M/D/Y) 11 / 19 / 10	Sailed (M/D/Y) 11 / 22 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "E"	Receiver "F"	VCF Table Used			
				Shore Load 6A	Shore Disc 6A	Vessel Load 6A	Vessel Disc 6A
Description	API/ Density	TCV	FW	GSV	S&W	NSV	Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.	39.7	511,956	0	511,956	226	511,730	(1)
Outturn 2.	39.8	509,935	0	509,935	663	509,272	(2)
Diff. 3.		< 2,021 >	0	< 2,021 >	437	< 2,458 >	(3) = (2) - (1)
Diff. % 4.		< 0.395 > %		< 0.395 > %		< 0.480 > %	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at (1) Load Port(s)</b>							
Vessel Sailing A.	512,051	201	511,850	LIQUID	NON-LIQUID		(A)
OBQ (All) B.	320	0	320	320	0		(B)
Loaded C.	511,731	201	511,530				(C) = (A) - (B)
Difference D.	< 225 >	+ 201	< 426 >				(D) = (C) - [(1) or (5)]
Difference % E.	< 0.044 > %		< 0.083 > %				(E) = (D) / [(1) or (5)] × 100
Load Vessel Ratio F.	0.99956						(F) = (C) / [(1) or (5)]
Load VEF G.	0.99966						(G)
Theoretical Shore H.	511,905						(H) = (C) / (G)
Theoretical Shore Diff. I.	< 51 >						(I) = (H) - [(1) or (5)]
Theoretical Shore Diff. % J.	< 0.010 > %						(J) = (I) / [(1) or (5)] × 100
<b>III. Vessel/Shore Quantities at (1) Discharge Port(s)</b>							
Vessel Arrival K.	512,287	578	511,709	LIQUID	NON-LIQUID		(K)
ROB (All) L.	765	0	765	720	45		(L)
Discharged M.	511,522	578	510,944				(M) = (K) - (L)
Difference N.	+ 1,587	+ 578	+ 1,009				(N) = (M) - (2)
Difference % O.	0.311%		0.198%				(O) = (N) / (2) × 100
Discharge Vessel Ratio P.	1.00311						(P) = (M) / (2)
Discharge VEF Q.	0.99989						(Q)
Theoretical Shore R.	511,578						(R) = (M) / (Q)
Theoretical Shore Diff. S.	< 1,643 >						(S) = (2) - (R)
Theoretical Shore Diff. % T.	< 0.322 > %						(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s)</b> VCF tables must be consistent.							
Transit Difference U.	+236	377	< 141 >				(U) = (K) - (A)
Difference % V.	0.046%		< 0.028 > %	LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.	< 445 >		< 445 >	< 400 >	< 45 >		(W) = (B) - (L)
TCV Difference (3) - OBQ (B) + ROB (L)		[S&W(1) / GSV(1)] × 100		[S&W(2) / GSV(2)] × 100			
ADJ TCV DIFF < 1,576 > (Quantity) / < 0.308 > %		S&W at Load Port 0.044 %		S&W at Discharge Port 0.130 %			
Comments:							
Prepared by		Title		Company		Date Completed (M/D/Y)	

Figure B.6—Voyage Analysis Report (VAR)

Vessel	Vessel "C"	Cargo	Crude Oil	Type of Voyage	Simple	Reference Number	C123451	Voyage/Trip No.	24	Page Number	2 of 3
Loading Port/Terminal/Berth	England	Arrived (M/D/Y)	11/3/10	Discharge Port/Terminal/Berth	Houston, TX	Arrived (M/D/Y)	11/19/10	Sailed (M/D/Y)	11/21/10		
Information may be taken for a completed Voyage Analysis Report (VAR).											
				Quantity Units		<input checked="" type="checkbox"/> Bbls		<input type="checkbox"/> Gals		<input type="checkbox"/> M3 <input type="checkbox"/> L	
NSV Shore-to-Shore Difference											
Reported QTY				Adjusted Qty							
1				511,730							
2				509,272							
3				< 2,458 >							
4				< 0.480 >							
Reconciliation											
Summary of Reported Differences		Reported Quantity		Evaporation Loss		Shipboard Loss		Volumetric Shrinkage		Undetected ROB	
Transit Difference		+236		-		-					
OBO/ROB Difference		< 445 >								< 77 >	
Shore FW Difference		0									
Shore S&W Difference		< 437 >									
Table Difference*		0									
Load Port Theoretical Difference		< 51 >									
Discharge Port Theoretical Difference		< 1,643 >									
Load/Discharge VEF Difference**		< 118 >									
Total All Differences		< 2,458 >									
*Table difference is the difference between the bill or lading figure and the recalculated quantity based on applicable VCF table (e.g. 6A).											
**Load/discharge VEF Difference is A - B = C.											
Reported				Vessel Loaded Volume Divided by the VEFD				Adjusted			
A) 511,787								A) 511,787			
B) 551,905				Vessel Loaded Volume Divided by the VELF				B) 511,905			
C) <118>				Load/Discharge VEF Difference				C) <118>			
Comments: *A- Adjusted transit gain by 286 Bbls for error found in #4 port tank on Discharge Inspection Report.											
*B- Adjusted ROB by 77 extra Bbls that were found at next port.											
*C- Discharge Inspection Report indicated line was slack by 105 Bbls, which was not added to outturn (see Figure #8 for Recalculation).											
Prepared By		Title		Company		Date Completed					

Figure B.7—Voyage Summary and REconciliation Report (VSRR)

<input checked="" type="checkbox"/> Loading <input checked="" type="checkbox"/> Discharge <input type="checkbox"/> V-V Transfer <input checked="" type="checkbox"/> Summary				Reference No. C123451	Voyage/Trip No. 24	C/P Date (M/D/Y) 10 / 15 / 10	Page No. 3 Of 3
Vessel Vessel "C"				Cargo Crude Oil		Type of Voyage Simple	
Loading Port/Terminal/Berth England		Arrived (M/D/Y) 11 / 03 / 10	Sailed (M/D/Y) 11 / 04 / 10	Discharge Port/Terminal/Berth Houston		Arrived (M/D/Y) 11 / 19 / 10	Sailed (M/D/Y) 11 / 22 / 10
Quantity Unit <input checked="" type="checkbox"/> Bbls <input type="checkbox"/> Gals <input type="checkbox"/> M3 <input type="checkbox"/> L		Supplier "E"	Receiver "F"	VCF Table Used			
Description		API/ Density	TCV	FW	GSV	S&W	NSV
							Calculation Reference
<b>I. Comparison of Shore Quantities in Custody Transfer</b>							
Bill of Lading 1.	39.7	511,956	0	511,956	226	511,730	(1)
Outturn 2.	39.8	*510,040	0	510,040	663	509,377	(2) *1
Diff. 3.		< 1,916 >	0	< 2,021 >	437	< 2,353 >	(3) = (2) – (1)
Diff. % 4.		< 0.374 > %		< 0.374 > %		< 0.460 > %	(4) = (3) / (1) × 100
Recalc. B/L 5.	(a)		Recalculate if B/L and O/T use different tables				(5) (a) Vol.Diff.
<b>II. Vessel/Shore Quantities at (1) Load Port(s)</b>							
Vessel Sailing A.	512,051	201	511,850	LIQUID	NON-LIQUID		(A)
OBQ (All) B.	320	0	320	320	0		(B)
Loaded C.	511,731	201	511,530				(C)=(A) – (B)
Difference D.	< 225 >	+ 201	< 426 >				(D)=(C)–[(1) or (5)]
Difference % E.	< 0.044 > %		< 0.083 > %				(E)=(D)/[(1)or(5)]×100
Load Vessel Ratio F.	0.99956						(F)=(C)/[(1) or (5)]
Load VEF G.	0.99966						(G)
Theoretical Shore H.	511,905						(H)=(C) / (G)
Theoretical Shore Diff. I.	< 51 >						(I)=(H) – [(1) or (5)]
Theoretical Shore Diff. % J.	< 0.010 > %						(J)=(I)/[(1) or (5)]×100
<b>III. Vessel/Shore Quantities at (1) Discharge Port(s)</b>							
Vessel Arrival *K.	512,001	578	511,423	LIQUID	NON-LIQUID		(K) *2
ROB (All) *L.	842	0	842	722	120		(L) *3
Discharged M.	511,159	578	510,581				(M) = (K) – (L)
Difference N.	1,119	578	541				(N) = (M) – (2)
Difference % O.	0.219%		0.106%				(O) = (N) / (2) × 100
Discharge Vessel Ratio P.	1.00219						(P) = (M) / (2)
Discharge VEF Q.	0.99989						(Q)
Theoretical Shore R.	511,215						(R) = (M) / (Q)
Theoretical Shore Diff. S.	< 1,175 >						(S) = (2) – (R)
Theoretical Shore Diff. % T.	<0.230 > %						(T) = (S) / (2) × 100
<b>IV. Vessel's Comparison of Loading and Discharge Port(s)</b> VCF tables must be consistent.							
Transit Difference U.	<50>	377	<427>				(U) = (K) – (A) *2
Difference % V.	<0.010>%		< 0.083 > %	LIQUID	NON-LIQUID		(V) = (U) / (A) × 100
OBQ/ROB Difference W.	< 522 >		< 522 >	< 402 >	< 120 >		(W) = (B) – (L) *3
TCV Difference (3) – OBQ (B) + ROB (L)		[S&W(1) / GSV(1)] × 100		[S&W(2) / GSV(2)] × 100			
ADJ TCV DIFF < 1,394 > (Quantity) / < 0.272 > %		S&W at Load Port 0.044 %		S&W at Discharge Port 0.130 %			
Comments: *1- Added 105 Bbls for L. Fill. *2- Reconciled arrival ullage to reflect a 50Bbl transit loss. *3- Added 77 extra OBQ Bbls							
Prepared by _____ Title _____ Company _____ Date Completed (M/D/Y) _____							

Figure B.8—Voyage Analysis Report (VAR)

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- [23] ISO 8697 <sup>3</sup>, *Crude petroleum and petroleum products – Transfer accountability – Assessment of on board quantity (OBQ) and quantity remaining on board (ROB)*

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<sup>3</sup> International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, [www.iso.org](http://www.iso.org).

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