



AMERICAN PETROLEUM INSTITUTE



Manual of Petroleum Measurement Standards Chapter 17.5

**Guidelines for Voyage Analysis and
Reconciliation of Cargo Quantities**

**EI Hydrocarbon Management
HM 64**

FOURTH EDITION, JULY 2019

API *MPMS* Chapter 17.5/EI HM 64

Guidelines for Voyage Analysis and Reconciliation of Cargo
Quantities

Fourth Edition

July 2019

Published jointly by

API
and

ENERGY INSTITUTE LONDON

The Energy Institute is a professional membership body incorporated by Royal Charter 2003

Registered charity number 1097899

Special Notes and Disclaimers

API and EI publications are recommended for general adoption but should be read and interpreted in conjunction with Weights and Measures, Safety, Customs and Excise and other regulations in force in the country in which they are to be applied. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed. Such regulatory requirements have precedence over corresponding clauses in API/EI publications. However, where requirements of API/EI publications are more rigorous, then their use is recommended.

The information contained in this publication is provided as guidance only. Neither API and EI nor any of API/EI's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API and EI nor any of API/EI's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

The scenarios in this publication are merely examples for illustration purposes only. [Each company should develop its own approach.] They are not to be considered exclusive or exhaustive in nature. API makes no warranties, express or implied, for reliance on or any omissions from the information contained in this document.

Users of this publication should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

API/EI joint publications may be used by anyone desiring to do so. Every effort has been made by the Institutes to ensure the accuracy and reliability of the data contained in them; however, the Institutes make no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaim any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API/EI joint publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilised. The development and publication of API/EI joint publications is not intended in any way to inhibit anyone from using any other practices.

Nothing contained in any API/EI joint publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

API/EI are not undertaking to meet the duties of employers, manufacturers, or suppliers to warn and properly train and equip their employees, and others exposed, concerning health and safety risks and precautions, nor undertaking their obligations to comply with authorities having jurisdiction.

Information concerning safety and health risks and proper precautions with respect to particular materials and conditions should be obtained from the employer, the manufacturer or supplier of that material, or the material safety data sheet.

Work sites and equipment operations may differ. Users are solely responsible for assessing their specific equipment and premises in determining the appropriateness of applying the instructions in this publication. At all times, users should employ sound business, scientific, engineering, and judgment safety when using this publication.

The above disclaimer is not intended to restrict or exclude liability for death or personal injury caused by own negligence.

The Energy Institute is a professional membership body incorporated by Royal Charter 2003.

Registered charity number 1097899, England

Copyright © 2019 by API, Washington DC and Energy Institute, London:

All rights reserved.

No part of this work may be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher.

Foreword

This publication was prepared jointly by the American Petroleum Institute Committee on Petroleum Measurement and the Energy Institute Hydrocarbon Management Committee.

The American Petroleum Institute Committee on Petroleum Measurement (COPM) and the Energy Institute's Hydrocarbon Management Committee (HMC) are responsible for the production and maintenance of standards and guides covering various aspects of static and dynamic measurement of petroleum. API COPM and EI HMC, their sub-committees and work groups consist of technical specialists representing oil companies, equipment manufacturers, service companies, terminal and ship owners and operators. API COPM and EI HMC encourage international participation and when producing publications their aim is to represent the best consensus of international technical expertise and good practice. This is the main reason behind the production of joint publications involving cooperation with experts from both the API and EI.

API/EI standards are published as an aid to procurement of standardized equipment and materials and/or as good practice procedures. These standards are not intended to inhibit purchasers or producers from purchasing or producing products made to specifications other than those of API or EI.

Shall: As used in a standard, "shall" denotes a minimum requirement in order to conform to the standard.

Should: As used in a standard, "should" denotes a recommendation or that which is advised but not required in order to conform to the standard.

May: As used in a standard, "may" denotes a course of action permissible within the limits of a standard.

Can: As used in a standard, "can" denotes a statement of possibility or capability. This publication was produced following API/EI standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API/EI standard.

Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, USA, or the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK.

Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the Director of Standards (API) or the Technical Department (EI). Generally, API/EI standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, USA, or the EI Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK.

A catalog of API publications can be found at www.api.org/publications.

Contents

	Page
1 Scope	1
2 Normative References	1
2.1 General	1
2.2 API/EI Joint Documents	1
2.3 API Documents	1
2.4 EI Documents	1
2.5 Other Documents	2
3 Definitions	2
4 Cargo Reconciliation	3
4.1 General	3
4.2 Collecting Information and Data	3
4.3 The Voyage Analysis Report (VAR)	3
4.4 The Voyage Summary and Reconciliation Report (VSRR)	6
5 Possible Causes of Losses or Gains	7
5.1 General	7
5.2 Cargo Transfer Measurement Points	7
5.3 Shore Measurements	8
5.4 Vessel Measurements	10
5.5 Water Determination	14
5.6 Additional Factors	16
5.7 Measurement Uncertainties and Errors	18
Annex A (informative) Instructions for Completion of Voyage Analysis Forms	19
Annex B (informative) Examples of Cargo Analysis and Reconciliation	26
Bibliography	38
Figures	
1 Four Point Reconciliation	8
A.1 Voyage Analysis Report (VAR)	22
A.2 Summary of Vessel-to-Vessel Transfers	23
A.3 Field Facts	24
A.4 Voyage Summary and Reconciliation Project	25
B.1 Voyage Analysis Report (VAR) Summary	30
B.2 Voyage Analysis Report (VAR)	31
B.3 Voyage Analysis Report (VAR)	32
B.4 Voyage Analysis Report (VAR)	33
B.5 Summary of Vessel-to-Vessel Transfers	34
B.6 Voyage Analysis Report (VAR)	35
B.7 Voyage Summary and Reconciliation Report (VSRR)	36
B.8 Voyage Analysis Report (VAR)	37
Tables	
1 Bill of Lading to Outturn Comparison	5
2 Shore to Vessel Comparison—Load Port(s)	5
3 Vessel to Shore Comparison—Discharge Port(s)	5
4 Vessel Transit Comparison	6
5 OBQ/ROB Comparison	6
A.1 Recommended Forms for Complex Voyage Analysis	21

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 cargoes 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 Documents

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

EI HM28, *Procedures for crude oil cargo inspections*

EI HM29, *Procedures for petroleum product cargo inspections*

EI HM30, *Procedures for Liquefied Petroleum Gas (LPG) cargo inspections*

EI HM 51, *Procedures for bulk liquid chemical cargo inspections*

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