Manual of Petroleum Measurement Standards Chapter 17.10

Measurement of Cargoes On Board Marine Gas Carriers

Part 2—Liquefied Petroleum and Chemical Gases

EI Hydrocarbon Management HM 55

SECOND EDITION, MARCH 2016

ERRATA 1, MARCH 2021

API MPMS Chapter 17.10.2/EI HM 55

Measurement of Cargoes on Board Marine Gas Carriers

Liquefied Petroleum and Chemical Gases

Second Edition

March 2016

Errata 1, March 2021

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.

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 assure 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.

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

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 specification.

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

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, 1220 L Street, NW, Washington, DC 20005, 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, 1220 L Street, NW, Washington, DC 20005, USA, or the EI Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK.

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

A catalogue of EI publications can be found at www.energypublishing.org.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, USA, standards@api.org or to the Technical Department, Energy Institute, 61 New Cavendish Street, London, W1G 7AR, UK.

Contents

Page

1 Scope . . . 1

2 Normative References . . . 1

3 Terms, Definitions, Acronyms, and Abbreviations . . . 2
3.1 Terms and Definitions . . . 2
3.2 Acronyms and Abbreviations . . . 4

4 General Operating Safety Precautions and Regulatory Requirements . . . 5
4.1 General . . . 5
4.2 Electrical and Operating Safety . . . 5
4.3 Maintenance . . . 5
4.4 Service Conditions . . . 5
4.5 Compatibility . . . 5
4.6 Personnel Protection . . . 6
4.7 Letter of Protest . . . 6

5 Measurement Systems and Equipment . . . 6
5.1 General . . . 6
5.2 Calibration Considerations . . . 6
5.3 Verification of Measurement Equipment Between Dry Dockings . . . 7
5.4 Independent Inspector Checks of Measurement Equipment During Transfer Operations . . . 7
5.5 Static Measurement Systems and Equipment . . . 8
5.6 Dynamic Measurement Equipment . . . 19

6 Measurement Procedures . . . 19
6.1 General . . . 19
6.2 Static Measurement . . . 19
6.3 Dynamic Measurement Procedures . . . 27

7 Cargo Quantity Determination . . . 28
7.1 General . . . 28
7.2 Shipboard Readings . . . 28
7.3 Calculation Overview . . . 28
7.4 Liquefied Petroleum Gas (LPG) and Chemical Gas Calculations . . . 30

8 Measurement-related Operational Notes . . . 38
8.1 General . . . 38
8.2 General Operations . . . 38
8.3 Measurement on Board Gas Carriers in an Exposed Environment . . . 40
8.4 Vessels Not on Even Keel (Out-of-Trim) . . . 40
8.5 Static Accumulator Cargoes . . . 40

Annex A (informative) Barge or Small Vessel Considerations . . . 41

Annex B (informative) Example Forms . . . 47

Annex C (informative) Additional Instructions and Cautionary Notes . . . 55

Annex D (informative) Checklists . . . 61

Annex E (informative) Physical Characteristics and Fire Considerations . . . 66

Bibliography . . . 67

Contents

Page

Figures

1 Microwave Type Level Gauge 10
2 Float Gauge 11
3 Typical Pressure-balanced Piston Cylinder 15
5 Single Cavity Cylinder with Ullage Tube 17
4 Typical Single Cavity Sample Cylinder 17
6 Typical Vapor Balloon 17
7 Typical Vapor Bag 18
8 Measurement Process Flow Chart 29
9 Overview of Cargo Calculation Process Flow Chart 31
A.1 Rod-type Magnetic Gauging Device 42
A.2 Slip-tube Gauging Device with Quick-release Cover 44
A.3 Tape-type Magnetic Gauging Device 45
B.1 Vessel Quantity Report ROB/OBQ 48
B.2 Report of Shore Quantity 49
B.3 Time Log 50
B.4 Vessel Discharge Record 51
B.5 Laboratory Report of Quality 52
B.6 Cargo Quantity Options Certificate 53
B.7 Sample Receipt 53
B.8 Letter of Protest and/or Notice of Apparent Discrepancy 54
C.1 Draft Readings: U.S. Customary Units 58
C.2 Draft Readings: SI Units 58

Tables

1 Equipment Performance Criteria, LPG and Chemical Gas 6
2 Typical Gas Carrier Types and Influence on Sampling (Excluding LNG) 25
3 Typical Corrections for a Float Gauge 32
4 Chemical Gas Typical Vapor and Liquid Correction Tables and Algorithms 32
5 LPG Example Calculation Method A, Correction Applied to Cargo Volume 34
6 LPG Example Calculation Method B, Correction Applied to Tank Shell 35
7 Chemical Gas Example Calculation Method A 36
8 Chemical Gas Example Calculation Method B 37
A.1 Measurement Device Tolerances for Barges and Small Vessels 41
D.1 Marine Measurement Checklist 61

Introduction

This standard provides guidance to vessel and shore personnel regarding accepted methods for determining quantities of Liquefied Petroleum and Chemical Gas cargoes on board refrigerated and/or pressurized gas carriers. It includes recommended methods for measuring, sampling, documenting, and reporting quantities on board these vessels.

Accounting for quantities on refrigerated and/or pressurized gas carriers requires some additional steps and care which may be contained in specific commercial agreements, operational guidelines or regulations. Other requirements should be discussed at the key meeting (pre-transfer conference), as detailed in API *MPMS* Chapter 17.1, or as noted in this section. All should be referred to and taken into account during the measurement process for these cargoes. General considerations and precautions that should be taken during the measurement of these cargoes are as follows.

Prior to Loading

Personnel performing measurement procedures should be made aware of the specific relevant safety and operational requirements for the refrigerated and/or pressurized gas carrier and its cargo. Specific conditions of carriage should be determined prior to loading including any relevant terminal regulations and restrictions enforced at the discharge port. It should also be determined if the cargo being loaded will be placed into tanks already containing cargo or whether the vessel's tanks need to first be prepared, which may include gassing-up and cooling down operations. The amount of cargo on board prior to loading (on board quantity [OBQ]) shall be measured, documented, and reported.

If tank inspection is required, it shall be carried out according to the procedure as detailed in API *MPMS* Chapter 17.8 or other defined operating instructions and in accordance with all appropriate safety guidelines. If the tank is to be gassed up and cooled down, one should account for the amount of product used in the process. See Section 8 for further discussion of special operational considerations.

During Loading

While loading the liquid cargo, vapor in the tanks will be displaced. Either the vapor is reliquefied on board the vessel or sent ashore for reliquefaction, flaring, or other combustion. The amount of vapor returned to the shore should be accounted for and the method of doing so agreed to by all parties.

After Loading

Ensure the cargo is at equilibrium at conditions with lines drained and no movement into or out of the tanks.

During Transit

During the transit from the load port to the discharge port, any vaporization of the cargo is reliquefied, contained at higher pressure, or vented, depending on vessel configuration and regulations. Such operations should be duly noted in the vessel's logs and made available to concerned parties at the discharge port.

Prior to Discharge

Ensure the cargo is at equilibrium at conditions with lines drained and no movement into or out of the tanks.

During Discharge

Any vapors supplied by the discharge port or returned to the cargo tanks to maintain proper pressure should be monitored and their source noted in the cargo inspection report.

After Discharge

Vessels in continuous service will often intentionally sail from the discharge port with cargo left on board after discharge (heel) in order to keep their cargo tanks cold, gassed up and in a “ready to load” state at the next load port. If the tanks are to be emptied of liquid cargo (no liquid remaining on board [ROB]) at the discharge port, the method of vaporization and the amount of vapor discharged and remaining on board should be reported.

If cargo is left on board after discharge (ROB), then the amount of vapor and liquid left in the tanks should be measured, calculated, documented and reported. The variance between the ROB and the OBQ should be reported, and an appropriate protest filed as needed and the concerned parties notified.

Measurement of Refrigerated and/or Pressurized Cargoes on Board Marine Gas Carriers

Liquefied Petroleum and Chemical Gases

1 Scope

This standard details the steps needed to properly measure and account for the quantities of liquefied petroleum and chemical gas cargoes described in *IGC* Chapter 19, excluding liquefied natural gas (LNG), on board refrigerated and/or pressurized gas carriers. This standard covers all measurement systems commonly used on refrigerated and/or pressurized gas carriers designed to carry those types of cargoes.

2 Normative References

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.

API *MPMS* Chapter 3.5, *Standard Practice for Level Measurement of Light Hydrocarbon Liquids Onboard Marine Vessels by Automatic Tank Gauging*

API *MPMS* Chapter 3.6, *Measurement of Liquid Hydrocarbons by Hybrid Tank Measurement Systems*

API *MPMS* Chapter 7, *Temperature Determination*

API *MPMS* Chapter 7.3, *Fixed Automatic Tank Temperature Systems*

API *MPMS* Chapter 16.2, *Mass Measurement of Liquid Hydrocarbons in Vertical Cylindrical Storage Tanks by Hydrostatic Tank Gauging*

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

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

API *MPMS* Chapter 17.8, *Guidelines for Pre-Loading Inspection of Marine Vessel Cargo Tanks*

ASTM D2598[1], *Standard Practice for Calculation of Certain Physical Properties of Liquefied Petroleum (LP) Gases from Compositional Analysis*

IMO Gas Codes[2], including amendments thereto

International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) (generally applies to ships built after 17 July 1986)

IMO Code for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (*GC Code*) (generally applies to ships built on or after 31 December 1976 but prior to 17 July 1986)

IMO Code for Existing Ships Carrying Liquefied Gases (generally applies to ships delivered before 31 December 1976.

[1] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
[2] International Maritime Organization, 4 Albert Embankment, London, SE1 7SR, United Kingdom, www.imo.org.