

Manual of Petroleum Measurement Standards Chapter 17.10

Measurement of Cargoes on Board Marine Gas Carriers

Part 1—Liquefied Natural Gas

FIRST EDITION, APRIL 2014

REAFFIRMED, MAY 2020

**ISO 10976:2012 (Identical) Refrigerated light
hydrocarbon fluids—Measurement of cargoes on
board LNG carriers**



AMERICAN PETROLEUM INSTITUTE



Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API'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 nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims 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 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 utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

Classified areas may vary depending on the location, conditions, equipment, and substances involved in any given situation. Users of this publication should consult with the appropriate authorities having jurisdiction.

Users of this publications 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.

The examples 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 instructions 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.

Where applicable, authorities having jurisdiction should be consulted.

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. At all times users should employ sound business, scientific, engineering, and judgment safety when using this publication.

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 publication. At all times users should employ sound business, scientific, engineering, and judgment safety when using this publication.

API is 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.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 1220 L Street, NW, Washington, DC 20005.

Foreword

Nothing contained in any API 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.

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 document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API 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. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API 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, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

This American National Standard is under the jurisdiction of the API Subcommittee on Measurement Accountability. This standard is considered identical to the English version of ISO 10976. ISO 10976 was prepared by Technical Committee ISO/TC 28, Subcommittee 5, Measurement of refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels.

Contents

	Page
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviated terms	2
3.1 Terms and definitions	2
3.2 Abbreviated terms	5
4 General operating safety precautions and regulatory requirements	6
4.1 General	6
4.2 Electrical equipment classification	7
4.3 Electromagnetic disturbance	7
4.4 Maintenance	8
4.5 Service conditions	8
4.6 Compatibility	8
4.7 Personnel protection	8
4.8 Procedures	8
5 Measurement systems and equipment	8
5.1 General	8
5.2 Measurement equipment performance	9
5.3 Calibration and certification of measurement equipment	9
5.4 Verification of measurement equipment between dockings	10
5.5 Inspection of measurement equipment during transfer operations	10
5.6 Static measurement systems and equipment	10
5.7 Dynamic measurement systems and equipment	20
6 Measurement procedures	21
6.1 General	21
6.2 Static measurement	22
6.3 Gas-up and cool-down quantification	27
6.4 Dynamic measurement	28
7 Cargo calculations	28
7.1 General	28
7.2 LNG volume determination	29
7.3 LNG density determination	29
Annex A (informative) LNGC design and marine operations	30
Annex B (informative) Additional considerations for measurement on board an LNGC	37
Annex C (informative) Examples of tank capacity tables for a spherical tank	42
Annex D (informative) Calculation examples	48
Annex E (informative) Sampling	57
Annex F (informative) Marine Measurement Witnessing Checklists	61

Figures

1	Radar (microwave) gauge	19
2	Float gauge	20
3	Capacitance gauge	19
A.1	Simplified longitudinal-sectional view of LNG carriers (not to scale)	30
A.2	Simplified Cross-section of a Membrane Tank (Not to Scale)	31
A.3	Simplified Cross-section of a Spherical Tank (Not to Scale)	32
A.4	Vessel with IMO Type C tanks	32
B.1	Draft readings - US customary units	38
B.2	Draft readings - SI units	38
D.1	Cargo calculation flow chart for quantity and energy	48

Tables

1	LNG Measurement Equipment Performance Criteria	9
C.1	Example of section of a tank capacity table	42
C.2	Example of section of a trim correction table	43
C.3	Example of section of a list correction table	44
C.4	Example of section of thermal correction table for a radar-type level gauge	44
C.5	Example of section of thermal correction table for a tank shell	45
C.6	Example of section of a thermal correction table for a float-type level gauge	45
C.7	Example of section of density correction table for a float-type level gauge	46
C.8	Example of cool-down table for spherical tanks	46

Forms

D.1	Example of custody transfer data-before unloading	49
D.2	Example of custody transfer data-after unloading	50
D.3	Example of certificate of unloading	51

Introduction

This International Standard provides accepted methods for measuring quantities on liquefied natural gas (LNG) carriers for those involved in the LNG trade on ships and onshore. It includes recommended methods for measuring, reporting and documenting quantities on board these vessels.

This International Standard is intended to establish uniform practices for the measurement of the quantity of cargo on board LNG carriers from which the energy is computed. It details the commonly used current methods of cargo measurement, but is not intended to preclude the use or development of any other technologies or methods or the revision of the methods presented. It is intended that the reader review, in detail, the latest editions of the publications, standards and documents referenced in this International Standard in order to gain a better understanding of the methods described.

This International Standard is not intended to supersede any safety or operating practices recommended by organizations, such as the International Maritime Organization (IMO), the International Chamber of Shipping (ICS), the Oil Companies International Marine Forum (OCIMF), the International Group of LNG Importers (GIIGNL) and the Society of International Gas Tanker and Terminal Operators (SIGTTO), or individual operating companies. This International Standard is not intended to supersede any other safety or environmental considerations, local regulations or the specific provisions of any contract.

The International System of units (SI) is used throughout this standard as the primary units of measure since this system is commonly used in the industry for these types of cargoes. However, as some LNG carrier's tanks are calibrated in US customary units and some sales and purchase agreements (SPA) are made in US customary units, both SI and US customary equivalents are shown. Proper unit conversions are intended to be applied, documented and agreed upon among all parties involved in the LNG custody transfer.

Measurement of Cargoes on Board Marine Gas Carriers

Part 1—Liquefied Natural Gas

1 Scope

This International Standard establishes all of the steps needed to properly measure and account for the quantities of cargoes on liquefied natural gas (LNG) carriers. This includes, but is not limited to, the measurement of liquid volume, vapour volume, temperature and pressure, and accounting for the total quantity of the cargo on board. This International Standard describes the use of common measurement systems used on board LNG carriers, the aim of which is to improve the general knowledge and processes in the measurement of LNG for all parties concerned. This International Standard provides general requirements for those involved in the LNG trade on ships and onshore.

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.

ISO 8310, *Refrigerated light hydrocarbon fluids — Measurement of temperature in tanks containing liquefied gases — Resistance thermometers and thermocouples*

ISO 8943, *Refrigerated light hydrocarbon fluids — Sampling of liquefied natural gas — Continuous and intermittent methods*

ISO 18132-1, *Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels — General requirements for automatic tank gauges — Part 1: Automatic tank gauges for liquefied natural gas on board marine carriers and floating storage*

IEC 60533, *Electrical and electronic installations on ships — Electromagnetic compatibility*

EN 1160, *Installations and equipment for liquefied natural gas — General characteristics of liquefied natural gas*

API Standard 2217A, *Guidelines for Work in Inert Confined Spaces in the Petroleum and Petrochemical Industries*

IACS Unified Requirements E10

ICS Tanker Safety Guide - - Liquefied Gas

ICS/OCIMF/IAPH International Safety Guide for Oil Tankers and Terminals (ISGOTT)

IMO International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code)

NOTE — Earlier versions of the gas codes can apply to older ships (see the note to 3.1.13).

SIGTTO Liquefied Gas Handling Principles on Ships and in Terminals

SIGTTO Liquefied Gas Fire Hazard Management