



AMERICAN PETROLEUM INSTITUTE



Manual of Petroleum Measurement Standards Chapter 12.1.1

**Calculation of Static Petroleum Quantities—
Upright Cylindrical Tanks and Marine Vessels**

**El Hydrocarbon Management
HM 1 Part 1**

FOURTH EDITION, FEBRUARY 2019

Currently in preview, click buy full version

API MPMS Chapter 12.1.1/EI HM 1 Part 1

Calculation of Static Petroleum Quantities—Upright Cylindrical
Tanks and Marine Vessels

Fourth Edition

February 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.

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 utilized. 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 incurring 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 other persons 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

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 two-part publication presents standard calculation procedures for static petroleum liquids. The two parts consist of the following:

- Part 1—Upright Cylindrical Tanks and Marine Vessels
- Part 2—Calculation Procedure for Tank Cars

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 subcommittees 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.

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 catalog of API publications can be found at www.api.org/publications. A catalogue of EI publications can be found at <https://publishing.energyinst.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
2.1 API Documents	1
2.2 EI Documents	1
2.3 Other Documents	2
3 Definitions	2
3.1 General	2
3.2 Abbreviations and Definitions	2
4 Interrelationship between Chapter 12 and Chapter 11.1	5
5 Hierarchy of Accuracies	5
6 Rounding and Discrimination	5
6.1 Data Level	5
6.2 Rounding of Numbers	6
6.3 Discrimination	6
7 Observed Data (Input, Direct, or Primary)	6
8 Calculated Data (Indirect or Secondary)	7
9 Calculation of Gross Observed Volume (GOV)	8
9.1 General	8
9.2 Shore Tanks	8
9.3 Marine Vessel Tanks	10
10 Calculation of Gross Standard Volume (GSV) and Total Calculated Volume (TCV) Shore Tanks and Marine Vessel Tanks	12
10.1 Gross Standard Volume (GSV)	12
10.2 Correction for the Effect of Temperature and Pressure on a Liquid (CTPL) or Volume Correction Factor (VCF)	13
10.3 Total Calculated Volume (TCV)	13
11 Calculation of Net Standard Volume (NSV)	14
11.1 Net Standard Volume (NSV)	14
11.2 Calculation of the Correction for Sediment and Water (CSW)	14
11.3 Calculation of the Volume of Sediment and Water (S&Wvol)	14
12 Calculation of Mass (Weight in Vacuum) and Weight (Weight in Air)	14
12.1 Introduction	14
12.2 Calculation Methods	14
12.3 Converting Between Mass and Weight	15
13 Direct Mass Measurement	16
14 Calculation Sequence	16
14.1 General	16
14.2 Volume at Standard Temperature to Mass/weight Calculation Procedure	16
14.3 Volume at Observed Temperature to Mass/Weight Calculation Procedure	17
15 Calculation of Transferred Volumes for Custody Transfer	18
15.1 General	18
15.2 Small Lease Tanks	18

Contents

	Page
15.3 Volumetric Shrinkage	19
16 Miscellaneous	19
16.1 Precautions When Using an Automatic Sampler	19
16.2 Interrelation of Units	19
Annex A (informative) Examples of Shore Tank and Marine Vessel Tank Calculations	21
Annex B (informative) Example of Shell Temperature Correction Factors for Expansion and Contraction of Upright Cylindrical Steel Tanks Due to Temperature	28
Annex C (informative) Examples of Both Floating Roof Adjustments and Corrections	33
Annex D (informative) Linear Thermal Expansion Coefficients of Steel	37
Annex E (Excerpt from EI HM 43—Temperature Corrections in Tank Calibration and Gauging; Petroleum Measurement Paper No. 11, September 1999 (Annex C—Effect of Temperature on Tank Capacity)	39
Bibliography	42
Figures	
1 Method to Calculate Vessel's List Using Amidships Draft Readings	12
Examples	
A.1 Custody Transfer Flow Chart—Shore Tanks with a Representative Sample	21
A.2 Custody Transfer Flow Chart—Shore Tank(s) with Individual Tank Samples	22
A.3 Shore Tank Calculation Using Volume at Standard Temperature to Mass or Weight Calculation Procedure	23
A.4 Marine Vessel Tank Calculation Using Volume at Standard Temperature to Mass or Weight Calculation Procedure	24
A.5 Shore Tank Calculation of Volume at 15 °C and Weight of p-Xylene using ASTM D1555M	25
A.6 Shore Tank Calculation of Volume at 15 °C, Mass and Weight of MTBE using API MPMS Chapter 11.1/Adjunct to ASTM D1250/Adjunct to IP 200, Table 54C	26
A.7 Shore Tank Calculation of Mass or Weight of Benzene Using Coefficient of Thermal Expansion per Degree (C_s)	27
Tables	
1 Significant Digits	6
2 Observed Data	7
3 Calculated Data	7
4 CTPL Factor	13
5 Mass-to-Weight Density Corrections	15
6 Discrimination Levels for Conversion Factors	20
B.1 Correction Factors for Effect of Temperature on the Tank Shell	31
B.2 Correction Factors for Effect of Temperature on the Tank Shell	32
C.1 Table 6 from API MPMS Chapter 11.1-1980/Adjunct to ASTM D1250-80/Adjunct to IP 200/80, Table 5A Generalized Crude Oils API Correction to 60 °F	35
D.1 Linear Thermal Expansion Coefficients of Steel	37

Introduction

These procedures are intended to encourage a uniform approach to volumetric and mass calculation of crude oil, petroleum products, and petrochemicals when contained in tanks. This publication will also address calculation sequences, rounding, and significant digits, with the aim that different operators can produce identical results from the same observed data.

Currently in preview, click buy full version

Calculation of Static Petroleum Quantities—Upright Cylindrical Tanks and Marine Vessels

1 Scope

This standard is intended to guide the user through the steps necessary to calculate static liquid quantities at atmospheric conditions, in upright, cylindrical tanks and marine tank vessels. The standard defines terms employed in the calculation of static petroleum quantities.

The standard also specifies equations that allow the values of some correction factors to be computed. Fundamental to this process is the understanding that in order for different parties to be able to reconcile volumes, they have to start with the same basic information (tank capacity table, levels, temperatures, and so forth), regardless of whether the information is gathered automatically or manually.

This standard does not address the calculation of clingage, non-liquid material, small quantities (such as onboard quantities, quantities remaining on board, and wedge formula, where material is not touching all bulkheads on marine vessels), and vapor space calculations.

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.

2.1 API Documents

MPMS, Chapter 2.8A, *Calibration of Tanks on Ships and Oceangoing Barges*

MPMS, Chapter 11.5.1, *Conversions of API Gravity at 60 °F*

MPMS, Chapter 11.5.2, *Conversions for Relative Density (60/60 °F)*

MPMS, Chapter 11.5.3, *Conversions for Absolute Density at 15 °C*

MPMS Chapter 12.3, *Calculation of Volumetric Shrinkage From Blending Light Hydrocarbons with Crude Oil*

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

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

MPMS Chapter 17.12, *Procedures for Bulk Liquid Chemical Cargo Inspections*

2.2 ISO Documents

ISO 15911, *Procedures for bulk liquid chemical cargo inspections*

Adjunct to IP 200¹, *Temperature and Pressure Volume Correction Factors for Generalized Crude Oils, Refined Products, and Lubricating Oils*

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