

Manual of Petroleum Measurement Standards Chapter 4.8

Operation of Proving Systems

THIRD EDITION, JULY 2021



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. The use of API publications is voluntary. In some cases, third parties or authorities having jurisdiction may choose to incorporate API standards by reference and may mandate compliance.

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 ensure 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 used. 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.

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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001-5571.

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.

The verbal forms used to express the provisions in this document are as follows.

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

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required 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 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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001. 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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

Currently in preview, click buy full version

Contents

	Page
1 Scope.....	1
2 Normative References.....	1
3 Terms and Definitions.....	1
4 Basic Principles.....	1
5 The Need to Prove.....	1
6 Frequency of Meter Proving.....	2
7 General Considerations for Meters and Provers.....	2
7.1 General.....	2
7.2 Data Recording.....	2
7.3 Temperature and Pressure Measurements.....	3
7.4 Operating Pressure.....	3
7.5 Density.....	3
7.6 Proving Meters with Pulse Output.....	4
7.7 Proving Meters Using Totalizers.....	4
8 Proving Locations.....	4
8.1 General.....	4
8.2 In Situ Proving.....	5
8.3 Laboratory Proving.....	5
8.4 Ex Situ Proving.....	5
9 Types of Provers.....	5
9.1 General.....	5
9.2 Displacement Provers.....	5
9.3 Tank Prover.....	8
9.4 Master Meter Prover.....	8
10 Prover Calibration Frequency.....	9
10.1 Displacement and Tank Provers.....	9
10.2 Master Meter Provers.....	10
11 Proving Methods.....	11
11.1 Volumetric Proving.....	11
11.2 Direct Mass Proving.....	11
11.3 Inferred Mass Proving.....	12
12 Assessment of Proving Results.....	12
12.1 The Number of Runs.....	12
12.2 Meter Factor.....	13
12.3 Application of Meter factors.....	13
13 Proving Concerns.....	13
13.1 Flow Conditioning.....	13
13.2 Temperature and Pressure Variations.....	14
13.3 Viscosity Variation.....	14

Contents

	Page
13.4 Valve(s) Leakage	14
13.5 Displacer Slippage	15
13.6 Meter Wear	15
13.7 Effect of Electrical Disturbance	15
13.8 Flow Rate Variation	15
13.9 Meter Registration (Head) Check	15
13.10 Meter and Prover Design	15
13.11 Meter and Prover Combinations	16
13.12 Air/Vapor in the Proving System	16
13.13 Cavitation	16
13.14 Debris and Coating	16
13.15 Physical Damage	16
13.16 Computational Master Meter Provers Zero	16
 Annex A (normative) Evaluating Meter Proving Data	 18
 Annex B (normative) Method for Determining the Frequency of Calibrating Prover	 21
 Annex C (informative) Meter Prover Operation	 24
 Annex D (informative) Proving Form Examples	 36
 Bibliography	 39
 Figures	
B.1 Determining the Frequency of Prover Calibration	23
D.1 Proving Example—Inferred Mass Proving	36
D.2 Proving Example—Direct Mass Proving	37
D.3 Proving Example—Volumetric Proving	38
 Tables	
A.1 Repeatability Criteria for 0.027 % Uncertainty (Preferred Uncertainty) for ± 0.00027 Random Uncertainty in Average Meter Factor	19
A.2 Repeatability Criteria for 0.073 % Uncertainty (Limited Volume Proving) for ± 0.00073 Random Uncertainty in Average Meter Factor	20
B.1 Prover Calibration Frequency Example	22
B.2 Example Table—Dynamic or Tank Prover Calibration Frequency for 0.06 % Volume Change Benchmark	23
C.1 Repeatability Criteria for 0.027 % Uncertainty for ± 0.00027 Random Uncertainty in Average Meter Factor	34
C.2 Repeatability Criteria for 0.027 % Uncertainty for ± 0.00027 Random Uncertainty in Average Meter Factor	34
C.3 Suggested Minimum Prover Volume for ± 0.027 % Uncertainty of Meter Factor when Proving Ultrasonic Flow Meters	35

Operation of Proving Systems

1 Scope

This guide provides information for operating meter provers on single-phase liquid hydrocarbons. It is intended for use as a reference manual for operating proving systems.

The requirements of this chapter are based on customary practices for single-phase liquids. This standard is primarily written for hydrocarbons, but much of the information in this chapter may be applicable to other liquids. Specific requirements for other liquids should be agreeable to the parties involved.

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 4.2, *Displacement Provers*

API MPMS Chapter 4.4, *Tank Provers*

API MPMS Chapter 4.5, *Master-Meter Provers*

API MPMS Chapter 5.1, *General Considerations for Measurement by Meters*

API MPMS Chapter 5.6, *Measurement of Liquid Hydrocarbons by Coriolis Meters*

API MPMS Chapter 12.2, *Calculation of Petroleum Quantities Using Dynamic Measurement Methods and Volumetric Correction Factors*

3 Terms and Definitions

There are no definitions unique to this document. Terms of more general use may be found in the API MPMS Chapter 1—Online Terms and Definitions Database.

4 Basic Principles

The object of proving meters with a prover is to provide a number with a defined discrimination level, which can be used to convert the meter indication to an accurate quantity of fluid passed through the meter. Refer to API MPMS Ch. 12.2 for volumetric discrimination levels and calculations or API MPMS Ch. 5.6 for mass discrimination levels and calculations.

5 The Need to Prove

A meter in service should be periodically proved to confirm its accuracy. The previously determined meter factor may no longer be applicable because of changes in fluid characteristics, operating conditions, and meter wear. Specific reasons for proving meters include the following:

- a) minimize financial impact of potential undetected accuracy changes;
- b) contractual requirements exist, such as scheduled meter maintenance based on throughput or elapsed time, or both;