Manual of Petroleum Measurement Standards Chapter 4—Proving Systems

Section 1—Introduction

THIRD EDITION, FEBRUARY 2005

REAFFIRMED, JUNE 2014

AMERICAN PETROLEUM INSTITUTE

Manual of Petroleum Measurement Standards Chapter 4—Proving Systems

Section 1—Introduction

Measurement Coordination

THIRD EDITION, FEBRUARY 2005

REAFFIRMED, JUNE 2014

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.

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 under local, state, or federal laws.

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.

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.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. Sometimes a one-time extension of up to two years will be added to this review cycle. This publication will no longer be in effect five years after its publication date as an operative API standard or, where an extension has been granted, upon republication. Status of the publication can be ascertained from the API Measurement Coordination Department [telephone (202) 682-8000]. A catalog of API publications and materials is published annually and updated quarterly by API, 1220 L Street, N.W., Washington, D.C. 20005.

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 standard or comments and questions concerning the procedures under which this standard was developed should be directed in writing to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the general manager.

API standards are published to facilitate the broad availability of proven, sound engineering and operating practices. These standards are not intended to obviate the need for applying sound engineering judgment regarding when and where these standards should be utilized. The formulation and publication of API standards 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, 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, N.W., Washington, D.C. 20005.

Copyright ©2005 American Petroleum Institute

FOREWORD

Chapter 4 of the *Manual of Petroleum Measurement Standards* was prepared as a guide for the design, installation, calibration, and operation of meter-proving systems commonly used by the majority of petroleum operators. The devices and practices covered in this chapter may not be applicable to all liquid hydrocarbons under all operating conditions. Other types of proving devices that are not covered in this chapter may be appropriate for use if agreed on by the parties involved.

The information contained in this edition of Chapter 4 supersedes the information contained in the previous edition (First Edition, May 1978), which is no longer in print. It also supersedes the information on proving systems contained in API Std 1101 *Measurement of Petroleum Liquid Hydrocarbons by Positive Displacement Meter* (First Edition, 1960); API Std 2531 *Mechanical Displacement Meter Provers*; API Std 2533 *Metering Viscous Hydrocarbons*; and API Std 2534 *Measurement of Liquid Hydrocarbons by Turbine-Meter Systems*, which are no longer in print.

This publication is primarily intended for use in the United States and is related to the standards, specifications, and procedures of the National Institute of Standards and Technology (NIST). When the information provided herein is used in other countries, the specifications and procedures of the appropriate national standards organizations may apply. Where appropriate, other test codes and procedures for checking pressure and electrical equipment may be used.

For the purposes of business transactions, limits on error or measurement tolerance are usually set by law, regulation, or mutual agreement between contracting parties. This publication is not intended to set tolerances for such purposes; it is intended only to describe methods by which acceptable approaches to any desired accuracy can be achieved.

Chapter 4 now contains the following sections:

Section 1—"Introduction"

Section 2—"Displacement Provers"

Section 4—"Tank Provers"

Section 5—"Master-Meter Provers"

Section 6—"Pulse Interpolation"

Section 7—"Field-Standard Test Measures"

Section 8—"Operation of Proving Systems"

Section 9—"Calibration of Provers"

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 federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to the standardization manager, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

CONTENTS

Manual of Petroleum Measurement Standards
Chapter 4—Proving Systems

SECTION 1—INTRODUCTION

1 Scope

Section 1 is a general introduction to the subject of proving. The requirements in Chapter 4 are based on customary practices that evolved for crude oils and products covered by API *MPMS* Ch. 11.1. The prover and meter uncertainties should be appropriate for the measured fluids and should be agreeable to the parties involved.

2 Referenced Publications

Several documents served as references and as a resource of information in the revision of this standard.

Manual of Petroleum Measurement Standards

Chapter 1—"Vocabulary"

Chapter 4—"Proving Systems"

Chapter 5—"Metering"

Chapter 7—"Temperature Determination"

Chapter 11.1—"Physical Properties Data"

Chapter 12—"Calculation of Petroleum Quantities"

Chapter 13—"Statistical Aspects of Measuring and Sampling"

3 Definition of Terms

Terms used in this chapter are defined in 3.1 through 3.9.

3.1 calibration: The procedure used to determine the volume of a prover.

3.2 meter proof: The multiple passes or round trips of the displacer in a prover for purposes of determining a meter factor.

3.3 meter prover: An open or closed vessel of known volume that is used as a volumetric reference standard for the calibration of meters in liquid petroleum service. Such provers are designed, fabricated, and operated within the recommendations of Chapter 4.

3.4 meter pulse: A single electrical pulse generated by flow induced effects in the meter. The flow induced effects are normally caused by movement of physical elements within the meter's primary flow element but may be caused by other flow induced effects that are proportional to flow rate. The pulses produced by the meter shall not be multiplied to increase the number of pulses to conform to the requirements of Chapter 4.

3.5 prover pass: One movement of the displacer between the detectors in a prover.

3.6 prover round trip: The forward and reverse passes in a bi-directional prover.

3.7 proving: The procedure used to determine a meter factor.

3.8 standard conditions: ***60°F and atmospheric pressure***.

4 Liquid Metering Hierarchies

4.1 OVERVIEW OF HIERARCHY

Liquid metering systems designed and operated in conformance with API's *Manual of Petroleum Measurement Standards* typically have one or more of the following levels of hierarchy as shown in Table 1.

Level 1.
Primary standards involve mass, volume, and/or density standards developed and/or maintained by National Institute of Standards and Technology (NIST) and/or other national laboratories to calibrate secondary working standards.

Level 2.
Secondary working standards include mass, volume, density, and/or weighing systems maintained by NIST and/or other national laboratories to calibrate field transfer standards conforming to Chapter 4.7. Secondary working standards may also be maintained by state and other certified metrology laboratories to calibrate field transfer standards.

These additional secondary working standards, however, increase uncertainty in the final custody transfer quantities.

Level 3.
Field transfer standards conforming to Chapter 4.7 are devices used to calibrate meter provers conforming to Chapters 4.2, 4.3, and 4.4.

Level 4.
Meter provers conforming to Chapter 4 are used to determine meter factors that correct the indicated volumes of meters.