

# **Manual of Petroleum Measurement Standards Chapter 13—Statistical Aspects of Measuring and Sampling**

## **Section 2—Methods of Evaluating Meter Proving Data**

FIRST EDITION, NOVEMBER 1994

ERRATA 1, OCTOBER 2015

REAFFIRMED, APRIL 2016



AMERICAN PETROLEUM INSTITUTE



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### **Measurement Coordination**

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# CONTENTS

	Page
<b>SECTION 2—METHODS OF EVALUATING METER PROVING DATA</b>	
13.2.0 Introduction .....	1
13.2.1 Scope .....	1
13.2.2 Definitions .....	1
13.2.3 Nomenclature .....	2
13.2.4 Referenced Publications .....	2
13.2.5 Meter Factor Logs and Graphs .....	3
13.2.5.1 Meter Factor Log .....	3
13.2.5.2 Meter Factor Graph .....	3
13.2.6 Application of Statistics to Meter Proving Data .....	3
13.2.6.1 Fixed Limits .....	3
13.2.6.2 Evaluating Trends in a Single Set of Meter Proving Data .....	3
13.2.6.3 Statistical Analyses of a Single Set of Meter Proving Data .....	5
13.2.6.4 Uncertainty Analyses of a Single Set of Meter Proving Data .....	8
13.2.6.5 Uncertainty Analyses of a Series of Meter Proving Factors .....	10
13.2.6.6 Uncertainty Analyses of Moving Average in a Series of Meter Factors .....	13
13.2.7 Meter Factor Control Charts Based on Uncertainty Analyses .....	13
13.2.7.1 Control Limits .....	14
13.2.7.2 Control Chart or Log—Fixed Limits Given .....	15
13.2.7.3 Statistical Control Charts for Moving Series—Single Meter, No Fixed Limit .....	16
13.2.7.4 Control Charts for Groups of Meters .....	20
<b>APPENDIX A—EXAMPLES OF METER PROVING UNCERTAINTY COMPUTATIONS</b> .....	
	27
<b>APPENDIX B—EXAMPLES OF OUTLIER TESTS</b> .....	
	31
<b>APPENDIX C—SHEWHART CONTROL CHARTS</b> .....	
	35
<b>Figures</b>	
1—Example of a Meter Factor Log .....	4
2—Example of a Meter Factor Graph .....	5
3—Meter Factors for Example A .....	7
4—Cumulative Distribution of Flow Rates .....	7
5—Individual and Moving Average Meter Factors for Example C .....	14
6—Uncertainty of Individual Meter Factors with Respect to Current Moving Average .....	15
7—Moving Average of Individual Meter Factors and Uncertainties of Moving Average .....	16
8—Meter Factor Control Chart With Fixed Control Limits .....	17
9—Statistics of Moving Series of Meter Factors .....	19
10—Control Chart for Individual Meter Factors .....	19
11—Control Chart for Moving Cumulative Average of Meter Factors .....	21
12—Control Chart for Average Absolute Change Between Consecutive Meter Factors .....	23
13—Revised Control Chart for Average Absolute Change Between Consecutive Meter Factors .....	24
14—Control Chart for Absolute Consecutive Meter Factor Changes for All Meters Used for Control Limits .....	25

	Page
15—Control Chart for Absolute Changes in Consecutive Meter Factors (Meter E Excluded for Control Limits) .....	25
C-1—Examples of Shewhart Control Charts .....	38
C-2—Example of Shewhart Control Chart for Individuals .....	40
C-3—Example of Shewhart Control Chart for Individuals Using Moving Ranges .....	41
 Tables	
1—Example: Sequential Set of Meter Factors .....	5
2—Example: Meter Proving Operating Parameters .....	6
3—Example: Historical Statistical Data on Flow Rates .....	6
4—Example: Modified Meter Proving Set .....	6
5—Standard Deviation Calculation .....	8
6—Range to Standard Deviation Conversion Factors .....	8
7—Uncertainty Conversion Factors for Normal Distribution .....	8
8— <i>t</i> -Distribution Factors for Individual Measurements .....	9
9— <i>t</i> -Distribution Factors for Averages .....	10
10—Range to Estimated Uncertainty Conversion Factors for Individual Measurements .....	11
11—Range to Estimated Uncertainty Conversion Factors for Averages .....	11
12—Example: Statistical Summary of Consecutive Series of Meter Factors .....	12
13—Example: Statistical Summary on Moving Series of Average Meter Factors .....	14
14—Statistical Control Levels .....	16
15—Example: Meter Factor Control Log .....	17
16—Example on Meter Factor Control Levels .....	18
17—Example: Statistical Values for Moving Series .....	18
18—Uncertainties of Individual Meter Factors in Moving Series for Various Control Levels .....	18
19—Control Chart Lines for Individual Meter Factors in a Moving Series .....	20
20—Statistical Values for a Moving Average, $\overline{MF}$ .....	20
21—Control Chart Lines for the Moving Average of Series of Meter Factors ...	21
22—Example: Meter Factors for Five Meters .....	22
23—Summary of Change Between Consecutive Meter Factors .....	22
A-1—Example A-1: Meter Proving Set .....	27
A-2—Statistical Summary of the Moving Average of a Sequence of Meter Proving Factors .....	28
A-3—Variable Ranges for $\pm 0.00027$ Uncertainty in Meter Factors .....	29
A-4—Summary of Uncertainties in the Average in a Moving Series of Meter Proving Factors .....	29
B-1—Initial Meter Factor Sequence .....	31
B-2—Ascending Order for Outlier Test .....	31
B-3—Remaining Data Set After Outlier Test .....	32
B-4—Summary of Uncertainty Estimates .....	33
C-1—Nomenclature for Control Chart Lines .....	36
C-2—Shewhart Control Chart Factors for Averages .....	36
C-3—Statistical Data for Shewhart Control Chart .....	36
C-4—Shewhart Control Chart Factors for Individuals .....	39
C-5—Moving Ranges of Set Averages for Example .....	40

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## ERRATA 1

Page 9, **Table 8**, row  $n = 5$ , 95% Confidence Level, *replace*

2.770

*with*

2.776



## Chapter 13—Statistical Aspects of Measuring and Sampling

### SECTION 2—METHODS OF EVALUATING METER PROVING DATA

#### 13.2.0 Introduction

Minimizing systematic and random errors, estimating remaining errors, and informing affected parties of errors are becoming increasingly important to the petroleum industry. A consistent basis of estimating the size and significance of errors is essential for communications between affected parties. A consistent basis of estimating and controlling errors can help to avoid disputes and dispel delusions on the accuracy of activities and equipment related to meter proving operations.

A wide range of designs, equipment, and service operating conditions is experienced in meter proving operations. Because of these variations, it is impractical to establish fixed procedures for maintenance, calibration, and proving activities for all installations.

Meter proving factors (meter factors) are normally monitored to detect trends or sudden deviations as indications of when to perform maintenance and calibration of measurement equipment.

The purpose of this chapter is to provide procedures for recording, analyzing, and controlling variations in meter factors so that random uncertainties are understood and consistent with the objectives of parties affected by the measurement operations. Limits on meter factor variations are left to the agreement of parties affected by the measurement operations.

#### 13.2.1 Scope

Chapter 13.2 will address procedures for evaluating any meter's performance where meter proving factors are developed in accordance with Chapter 12.2. The data in examples used in this chapter are intended to be typical of custody transfer operations of low-vapor-pressure fluids using displacement or turbine meters in accordance with Chapters 4, 5, and 6 of the *Manual of Petroleum Measurement Standards*. However, the procedures in Chapter 13.2 can be used for non-custody transfer metering applications and for custody transfer metering of high-vapor-pressure and gaseous fluids where meter proving data are available.

Procedures and examples are given for analyzing the random uncertainties associated with meter proving data (see note). Procedures and examples are also given for evaluating and controlling trends in meter factors with control charts and control logs to ensure that meter factor variations exhibit a random nature that results in the propagation of a lower average uncertainty in measurements with time and throughput.

Note: Uncertainty computations are based on procedures given in Chapter 13.1 of the *Manual of Petroleum Measurement Standards*.

Since no single document can cover all of the statistical procedures and applications being practiced, procedures other than those appearing herein may be used. Alternate statistical procedures are not expected to duplicate the computational values provided by procedures in this chapter. However, alternative procedures should achieve the same purpose intended by the procedures given herein. When alternative statistical computational procedures are to be used and affect metered quantities, parties directly involved with the metering operations should be notified prior to their implementation.

Some of the procedures in Chapter 13.2 are suitable for hand calculations and graphs employed by field personnel. These procedures are discussed and illustrated in 13.2.5 of this chapter. However, the statistical evaluations and control charts are generally too rigorous for manual field computations, and computers should be employed. The statistical procedures in this document may serve as a guide for developing software for computer applications.

#### 13.2.2 Definitions

The following definitions supplement the definitions appearing in Chapter 13.1.

*Action limits* are control limits applied to a control chart or log to indicate when action is necessary to inspect or calibrate equipment and possibly issue a correction ticket. Action limits are normally based on 95 percent to 99 percent confidence levels for statistical uncertainty analyses of the group of measurements.

*Control chart* is a graphical method for evaluating whether meter proving operations are in or out of a state of statistical control.

*Control log* is a tabular method for evaluating whether meter proving operations are in or out of a state of statistical control.

*Control chart or log, fixed limit* is a control chart or log whose control limits are based on adopted fixed values applicable to the statistical measurements displayed on the log or chart. Historically, fixed limits have been used to control the limits on meter factor changes.

*Control chart or log, no fixed limit* is a control chart or log whose control limits are based on the statistical variations of measurements displayed on the chart or log.

*Control limits* are limits applied to a control chart or log to indicate the need for action and/or whether or not data is in a state of statistical control. Several control limits can be applied to a single control chart or log to determine when various levels of action are warranted. Terms used to describe