

Manual of Petroleum Measurement Standards Chapter 22.4

Testing Protocol for Pressure, Differential Pressure, and Temperature Measuring Devices

SECOND EDITION, FEBRUARY 2025



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 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.

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.

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 in order to conform to the standard.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order 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 Field of Application	2
5 Parameter Variations Affecting Device Performance	2
5.1 API 22.4 Baseline Tests	2
5.2 Influence Testing	3
5.3 Special Testing	3
6 Tests	3
6.1 General	3
6.2 Test Conditions	3
6.3 Transmitter and Data Acquisition Conditioning and Installation.....	4
6.4 Test Data and Calculated Results.....	5
6.5 API 22.4 Baseline Testing.....	5
6.6 Influence Testing.....	9
6.7 External Interference Testing.....	12
7 Test Facility Requirements.....	12
7.1 Lab/Facility Qualification.....	12
7.2 Audit Process	13
8 Uncertainty Analysis and Calculation	13
8.1 Types of Uncertainty Calculations	13
9 Test Report.....	13
Annex A (informative) Refinement of Transmitter API 22.4 Baseline Accuracy with Verification Data.....	21
Annex B (normative) Linearity, CRH, and API 22.4 Baseline Accuracy and Calculations	26
Annex C (normative) Rangeability	30
Annex D (normative) Field Calibration vs. Field Verification	32

Figures

1 Typical Test Installation for Digital and Analog Output Transmitters	4
2 Section 6.5.1, API 22.4 Baseline Accuracy—Test Data and Calculations	15
3 Section 6.5.1, API 22.4 Baseline Accuracy—Repeatability/Hysteresis Calculations	15
4 Section 6.5.1, API 22.4 Baseline Accuracy—Summary Calculations.....	16
5 Section 6.5.1, API 22.4 Baseline Accuracy—Test Results	16
6 Section 6.5.2, API 22.4 Temperature Transmitter Testing.....	17
7 Section 6.6.2, Ambient Operation Temperature Influence—Zero and Slope	17
8 Section 6.6.3, Day/Night Cycle Test—Pressure and Differential Pressure.....	18
9 Section 6.6.4, Pressure Operating Effect on Differential Pressure Transmitter	19
10 Section 6.6.5.1, Pressure—Pressure Transmitter	19
11 Section 6.6.5.2, Pressure—Differential Pressure Transmitter	20
12 Section 6.6.5.3, Operating Over Range—Differential Pressure Transmitter	20
A.1 Percentage of Span and Percentage of Reading Representation of a 0.1 % of Span Accuracy ..	21

A.2	Verification Data with API 22.4 Baseline Accuracy Error Bars and Percent of Reading Uncertainty	22
A.3	Uncertainty Calculation Limited by the Next Lower Verification Point.....	23
A.4	Slope Trim of the 40 % Verification Point and the As-left Verification Results	24
A.5	API 22.4 Baseline Accuracy Nonlinearity and Uncertainty Based on Verification Data	25
A.6	Simplified API 22.4 Baseline Accuracy Nonlinearity and Uncertainty Based on Verification Data	25
B.1	Example of Transmitter Digital Test Results	26
B.2	Example of Transmitter Digital Test Results Linearity Calculations	27
B.3	Example of Transmitter Digital Test Results CRH Calculations.....	28
B.4	Example Calculations Based on Test Results in Figure B.1.....	29
C.1	Example of Standard and Extended Calibrated Span Turndown Rangeability.....	31

Tables

1	Matrix of API 22.4 Testing Requirements for Transmitters	3
2	Minimum Required Test Points.....	5
3	Electronics Ambient Temperature and Sensor Temperature Test Points.....	8
4	Ambient Temperature Test Cycle	9
5	Differential Pressure Transmitter—Operating Pressure Test Cycle	10
6	Pressure Maximum Operating Pressure Test Cycle.....	10
7	Differential Pressure Maximum Pressure Test Cycles	11
8	150 % Over-range Test Cycle	12
9	Required Tests and Example Test Reports	14

Testing Protocol for Pressure, Differential Pressure, and Temperature Measuring Devices

1 Scope

This testing protocol documents the method for testing the performance characteristics specific to pressure, differential pressure, and temperature sensors and transmitters used in petroleum measurement. The testing protocol includes a listing of parameters affecting the performance of the devices, a description of the tests required, requirements for the test facility, a data reporting format, and an uncertainty determination methodology.

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.

IEC 62828-5: 2020¹, *Reference conditions and procedures for testing industrial and process measurement transmitters—Part 5: Specific procedures for flow transmitters*

ISO²/IEC Guide 98-3:2008 (GUM:1995), *Uncertainty of measurement—Part 3: Guide to the expression of uncertainty in measurement*

ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1

analog signal

A signal that varies continuously in amplitude rather than in discrete steps.

3.2

API 22.4 baseline accuracy

A measure of the accuracy at a near ambient temperature determined by the testing procedure defined in this document. The API MPMS Ch. 22.4 (API 22.4) baseline accuracy is calculated from the combination of the linearity and combined repeatability and hysteresis (CRH) data calculations. API 22.4 baseline accuracy is used to compare the results of other transmitters tested at the same time and is also used in the calculation of influence factor effects.

3.3

combined repeatability and hysteresis

CRH

The combined effect of repeatability and hysteresis. Due to the manner in which the API 22.4 baseline accuracy is determined, it may be impossible to differentiate between repeatability and hysteresis; therefore, the two effects are combined into one test.

¹ International Electrotechnical Commission, 3 rue de Varembé, 1st Floor, PO Box 131, CH-1211 Geneva 20, Switzerland, www.iec.ch.

² International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, www.iso.org.