API MANUAL OF PETROLEUM MEASUREMENT STANDARDS

Chapter 22 – Testing Protocols

Section 1 – General Guidelines for Developing Testing Protocols for Devices Used in the Measurement of Hydrocarbon Fluids

Type Testing Annex, 2018 Draft Addenda
Annex
(normative)

Type Testing

A.1 Introduction

This Annex provides guidance specific to type testing of measurement devices governed by the individual sections of API MPMS Chapter 22. If applicable, each section of API MPMS Chapter 22 shall include an annex detailing the requirements for type testing of the devices covered by that section. This Annex also provides guidelines for the development of these type testing annexes.

Users of devices for measuring hydrocarbon fluids may choose to test the performance of single or multiple instruments of the same brand, model and measurement range, or to test single or multiple instruments with identical hardware and software features critical to performance. These approaches are commonly called “type testing,” where “type” refers to the brand and model of instrument or to the set of characteristics (such as size, geometric dimensions, instrumentation, software version, or operating range) common to the instruments being tested. The devices under test are subjected to identical test conditions and compared to the performance requirements. After examining the results of the device(s) and evaluating the variations in performance, the user may approve the instrument type for its measurement applications. This approach avoids the need to test all instruments of that type by evaluating only a representative sample of the instruments instead. Government agencies may also require type testing of instruments used by petroleum and natural gas companies. By reviewing and approving the results of type tests, the agencies can approve instruments by type and eliminate the burden of reviewing test results for all instruments in their jurisdiction.

A.2 Identifying Type Testing Requirements

A.2.1 Type Testing Definitions

For the purposes of type testing, a test item or a test unit shall be defined as a complete instrument or piece of equipment that can be removed from a measurement system and replaced by another instrument or piece of equipment (1) of the same manufacturer and design, and/or (2) having identical characteristics affecting performance and measurement accuracy. Examples of a test item include a single pressure transmitter, a single flow computer, or a single gas chromatograph.

Device type shall refer to the common characteristics of a group of units undergoing type tests. A device type shall be defined by brand and model, or by a set of characteristics affecting performance and accuracy. Characteristics of a device type shall be listed or defined in the applicable type testing annex. Acceptable variations among tested units of the defined device type shall also be identified within the type testing annex.

A.2.2 Selection of Test Items

Each type testing annex shall define the minimum number of test units sufficient for type testing, based on a statistical method described in an accepted standard. An informative list of example standards with guidance on selecting the minimum number of test units can be found in the Bibliography to this Annex. Each type testing annex shall also give other appropriate guidance
for selecting test items, such that each unit chosen for type testing shall be representative of the device type being evaluated. The number of items tested [and if applicable, the size(s) of the test items] shall represent the range of devices and equipment available from the manufacturer which are included in the device type and are applicable to the type tests. The number of test units and the selection method shall be agreed to by the manufacturer, the test facility, and the end-user before type testing begins. The method of selection shall be documented in the type testing report.

The type testing annex shall also describe changes in device characteristics that will require new type testing of the device type. These shall include changes that affect device measurements, calculation results, and device performance (as quantified by accuracy, precision, operating range, etc.). Changes in critical dimensions, sensors, electronics, and software are examples of device changes that may require new type testing. Manufacturers, end-users, and other interested parties may use quality assurance documentation to determine whether reduction of tests may be appropriate or when modifications to a device require new type tests.

Test items may have both hardware and software components. If the hardware and software are only available as an integrated unit from a single manufacturer, they shall be tested together as an integral unit.

A.2.3 Test Facility Requirements

In addition to complying with the facility audit and qualification requirements in the main body of this document (API MPMS Chapter 22.1), the test facility shall meet the requirements of the appropriate section of API MPMS Chapter 22. Type testing may be performed at a third-party laboratory or at a manufacturer's facility meeting the appropriate requirements. The facility should be capable of testing the required number of test items under identical conditions.

The total uncertainty of the test facility shall be smaller than the stated uncertainty of the device being tested. The total test facility uncertainty shall be calculated and reported at each test condition used in testing the device. The calculated uncertainty of the device under test shall include the test facility uncertainty.

All references used to establish the measurement uncertainty or performance of the device type shall be traceable to nationally or internationally recognized standards. The test facility system uncertainty and the uncertainty of each measured variable included in the type testing report shall include the measurement uncertainty at the 95% confidence level.

A.2.4 Test Conditions and Test Requirements

The test conditions and test parameters required for units undergoing type testing shall be defined in the type test annex of the applicable section of API MPMS Chapter 22. End-user requirements for the items being tested should be considered in selecting test conditions, and in selecting characteristics of the test items such as size or measurement span and range.

At a minimum, type testing under the appropriate section of API MPMS Chapter 22 shall require the following:

- the mandatory baseline and non-ideal testing outlined in Sections 6.4 and 6.5 of Chapter 22.1, and
- the performance tests outlined in Section 6.

The type testing annex may specify any additional testing required to determine any long-term changes in the performance of the test item(s).

Uniformity of the test conditions and of device treatment among all the test items is critical for valid type testing. If possible, tests should be performed on all test units in the same location,
using the same test fluids, the same power supply, the same installation configurations, and identical values of all other conditions. This will help to ensure that all test items are treated uniformly and are not subjected to variations that could affect performance. Variables not being tested should also be held as consistent as possible to minimize their effect on the test results.

If it is not practical or feasible to test all items simultaneously using the same test fluids or at the same conditions, the variations between test items and test conditions shall be quantified and noted in the type testing report (see Section A.4 of this Annex).

A.3 Uncertainty Analysis and Calculation for Type Testing

Each test protocol in API MPMS Chapter 22 defines the methodologies for calculating uncertainties in the test facility, for calculating uncertainties in measurements by individual test items, and for determining non-ideal operating conditions that cause statistically significant shifts in device performance. The end-users should choose acceptance criteria for all test items of the device type based on their own applications and requirements, since the test protocols of API MPMS Chapter 22 do not establish acceptance criteria.

Any test method not defined by the applicable test protocol shall be documented. Any statistical methodology for calculating and assigning measurement uncertainties shall be documented in the type testing report. The method should comply with standard or accepted industry practice, such as the ISO Guide to the Expression of Uncertainty in Measurement (GUM). An example of a methodology that may be adapted to type testing can be found in GUM Annex H.5.

A.4 Type Testing Report

In addition to meeting the reporting requirements of the applicable API MPMS Chapter 22 test protocol for individual test items, reports for type tests shall include the following:

- Test date(s)
- Information on test units:
  - Method for selecting units to be tested and selection criteria
  - Model numbers of units tested and quantity of each model tested
  - Serial numbers of units tested
  - Manufacturing location(s) of units tested
  - Software or firmware revision of units tested
  - Any certification dates and/or expiration dates of units tested
  - Dimensional drawings of each unit tested for which dimensions can affect performance (such as flow meters)
  - Verification of dynamic similarity for tested flow measurement primary devices
- Information on test facility:
  - Lab certification documents
  - For hardware testing, traceability and calibration information on test equipment and calibration references
- Information on type test conditions:
  - Test setup drawings and/or descriptions
  - Dimensional drawings of pipework (if included as part of the test)
  - Detailed description of the complete test matrix
  - Environmental conditions during tests or other uncontrolled factors that may impact test results
- Information on test results:
A comparison of predicted results for each test point (if available) to actual test results
- For software testing, sources of expected calculation results or verification or validation data
- Required uncertainty calculations for facility reference values
- Measurement uncertainties of individual test units based on the test results and the calculation method discussed in Section A.3 of this Annex
- Variations in test parameters or environmental conditions between test items and estimated effects on type test results
Bibliography

Examples of Standards for Selecting the Number of Test Units in a Type Test

Note that guidance in these standards on accepting test results may not apply to API MPMS Chapter 22 type testing protocols.

[1] ANSI/ASQ Z1.4, ¹ Sampling Procedures and Tables for Inspection by Attributes

[2] ISO 2859-1, ² Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection


Example of Standard for Calculating and Assigning Measurement Uncertainties


