

# Recommended Practice for the Design, Testing, and Operation of Subsea Multiphase Flow Meters

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## Introduction

Multiphase flow is a complex fluid phenomenon presenting many observable and distinctly different spatial patterns. These flow regimes are a function of fluid composition, velocity, flow orientation, geometry, and operating conditions. This creates a greater number of variables requiring measurement than single phase flow. Multiphase flow meters (MPFMs) use a combination of measurement principles and software models to delineate component parameters of the specific flow condition being measured. These elements are further combined to simultaneously resolve the true flow state and inform the user of the flow rate of each phase.

This document is intended for use by persons familiar with the principles of multiphase flow and the technologies used to measure its constituent parts. This Recommended Practice (RP) outlines a strategy for the correct sizing, specification, integration, and testing of MPFMs to maximize their performance for a specific application. Measurement techniques used in MPFMs are complex and only brief descriptions are included herein. It is recommended that the reader be acquainted with API *MPMS* Chapter 20.3 which describes in detail the technologies of multiphase metering, calibration, measurement uncertainty, and operation. API *MPMS* Chapter 20.3 is referred to in this document wherein the reader should seek further information or best practice. API *MPMS* Chapter 20.3 is not specific to subsea applications.

Various expertise is required throughout the life cycle of the MPFM to achieve optimal performance. Due to the number of interfaces and design parameters a strategy is required to ensure the meter is appropriate for its specific application. This RP acts as a guide outlining key parameters of the strategy that quantifies meter performance based on application, sizing data, technology constraints, and performance checks through manufacturer, independent facilities, and in-situ tests.

There is a distinct separation in ownership between MPFM specification, testing, and installation versus commissioning and operation. This RP addresses equipment design in Section 4 through Section 7 and commissioning/operational issues in Section 8 and Section 9. To ensure accuracy and functionality of the MPFM, a coherent handover between equipment design and long-term operations is required. Several operational issues are managed in this RP, as well as metering methodologies, but these are only intended as suggested interfaces to be addressed. This RP should be used in combination with appropriate measurement and operational standards to develop a comprehensive strategy for the design, installation, and long-term operation of an MPFM.

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# Recommended Practice for the Design, Testing, and Operation of Subsea Multiphase Flow Meters

## 1 Scope

This document provides recommendations for the sizing, specification, system integration, testing and operation of in-line subsea multiphase flow meters (MPFMs) for measurement of full stream, multiphase flow for well testing, allocation measurement, fiscal measurement, well management, and in flow assurance applications. This Recommended Practice (RP) includes wet gas flow meters as a subset of MPFMs.

## 2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API *Manual of Petroleum Measurement Standards (MPMS)*, Chapter 20.3—*Measurement of Multiphase Flow*

API Specification 6A, *Specification for Wellhead and Tree Equipment*

API Specification 17D, *Design and Operation of Subsea Production Systems—Subsea Wellhead and Tree Equipment*

API Standard 17F, *Standard for Subsea Production Control Systems*

API Recommended Practice 17H, *Remotely Operated Tools and Interfaces on Subsea Production Systems*

API Recommended Practice 17N, *Recommended Practice for Subsea Production System Reliability and Technical Risk Management*

API Recommended Practice 17P, *Recommended Practice for Subsea Structures and Manifolds*

API Recommended Practice 17Q, *Recommended Practice on Subsea Equipment Qualification*

## 3 Terms, Definitions, Acronyms, and Abbreviations

### 3.1 Terms and Definitions

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

#### 3.1.1

##### **accuracy**

The degree of conformity of a measurement to a known standard for the unit of measurement.

#### 3.1.2

##### **actual conditions**

##### **measurement conditions**

##### **in conditions**

##### **flowing conditions**

Conditions of pressure and temperature of the fluid at the point where fluid properties or flows are measured.