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

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Contents

Contents

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 characteristic of multiphase flow creates a greater number of variables requiring measurement than seen in single phase flow. Multiphase flow meters (MPFMs) tend to use a combination of measurement principles and software models to delineate component parameters of the specific flow condition undergoing measurement. These elements are further combined to simultaneously resolve the total 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. It is the intent of this Recommended Practice (RP) to outline 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 every bit as complex as the flow itself and only brief descriptions are included herein. It is recommended that the reader be acquainted with API *MPMS* Ch. 20.3 which describes in detail the technologies of multiphase metering, calibration, measurement uncertainty, and operation. API *MPMS* Ch. 20.3 referred to in various parts of this document wherein the reader should seek further information or best practice. API *MPMS* Ch. 20.3 is not specific to subsea applications and some topside measurement methods are included.

Various expertise is required throughout the life cycle of the MPFM to achieve optimal performance. Due to the number of interfaces and design parameters an appropriate strategy is required to ensure the meter is appropriate for its specific application. This RP acts as a guide for the responsible engineer outlining key parameters of the plan that quantifies meter performance based on application, sizing data, technology constraints, and performance checks through supplier, 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 to Section 8 and commissioning/operational issues in Section 9 and Section 10. To ensure accuracy and functionality of the MPFM, there should be a coherent handover between equipment design and long term operation. A number of operational issues are addressed in this RP, as well as metering methodologies, but these are only intended as suggested interfaces that should be addressed by the responsible engineer. 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.

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, and testing of subsea flow meters [henceforth referred to as multiphase flow meters (MPFMs)] for measurement of full stream, multiphase flow. This Recommended Practice (RP) includes wet gas flow meters as a subset of MPFMs. In-line MPFMs are typically used in subsea applications and are the focus of this RP.

These recommendations and guidelines are intended for use by the engineer responsible for the delivery of the MPFM. Due to the nature of multiphase flow measurement it is anticipated that a cross-disciplinary team may be involved throughout its deployment and operational life.

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.

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

API Specification 6A, *Specification for Wellhead and Christmas 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 17N, *Recommended Practice for Subsea Production System Reliability and Technical Risk Management*

3 Terms, Definitions, Acronyms, and Abbreviations

3.1 Terms and Definitions

For the purpose of this document the following terms and definitions apply. For consistency, these are identical to those used in API *MPMS* Ch. 20.3.

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