AGA Report No. 9

Measurement of Gas by Multipath Ultrasonic Meters

Fourth Edition

Sponsored by
Transmission Measurement Committee

Catalog No. XQ2105

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FOREWORD

This report is a revision of the previous AGA Report No. 9, 2017 edition. It is a performance-based specification for multipath ultrasonic meters for gas flow measurement. AGA's Transmission Measurement Committee (TMC) worked diligently for several years on its revision. It is the result of a collaborative effort of users, meter manufacturers, independent consultants, flow-measurement service providers and research organizations. This report was made available for comments from other relevant AGA committees, the Committee on Gas Fluid Measurement (COGFM) of the American Petroleum Institute (API), Section H of the GPA Midstream Association (GPA), ISO/TC 30/SC 5/WG 1 of the International Organization for Standardization, and the committee for Measurement of Fluid Flow in Closed Conduit of the American Society of Mechanical Engineers (ASME - MFC).

This version of AGA Report No. 9 is intended to supersede all prior versions of this document. However, this document does not reference existing multipath ultrasonic meter installations. The decision to apply this document to existing installations shall be at the discretion of the parties involved.

Research conducted in support of this report and cited herein has demonstrated that multipath ultrasonic meters can accurately measure gas flow and, therefore, should be able to meet the requirements specified in this report when calibrated and installed according to the recommendations contained herein. In consultation with a competent professional, users should follow appropriate installation, use and maintenance of an ultrasonic meter as applicable in each case.

Flow-calibration guidelines are provided for occasions when a flow calibration is requested or required to verify the meter's performance or to apply a calibration factor to minimize the measurement uncertainty. (See Appendix A (Informative))

Unlike most traditional gas meters, multipath ultrasonic meters inherently have an embedded microprocessor system. Therefore, this report includes, by reference, a standardized set of testing specifications applicable to electronic gas meters. These tests, summarized in Appendix B (Normative), are used to demonstrate the acceptable performance of the multipath ultrasonic meter's electronic system under different influences and disturbances.

The flow metering package and/or flow conditioner performance verification test found in Appendix C (Normative) is intended to provide a method by which they can be shown to perform under varying test flow conditions within the limit set in this Appendix.

An example of overall measurement uncertainty calculations is provided in Appendix D (Informative) with assumed numerical values for estimating measurement uncertainty for sites using ultrasonic gas flow meters.

In this document the words shall, should and recommended are to be used to mean as follows:

"Shall" means a requirement to conform to the specific task.

"Should" and "recommended" are used synonymously to indicate good practices to follow, but not required to conform to the specific task.

ACKNOWLEDGEMENTS

AGA Report No. 9, ***Measurement of Gas by Multipath Ultrasonic Meters***, was revised by a task group of the American Gas Association's Transmission Measurement Committee under the chairmanship of **Rick Spann** of Dominion Energy Questar Pipeline Services and joint vice chairmanship of **John Lansing** of RMG and **Reese Platzer** of Enterprise Products Partners.

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1.0 Introduction

1.1 Scope

This report is for multipath ultrasonic transit-time flow meters used for the measurement of natural gas. It may be used for the measurement of other gases in consultation with the meter manufacturer and a competent professional. Multipath ultrasonic meters have at least two independent pairs of measuring transducers (acoustic paths). Applications may include, but are not limited to, measurement of single-phase gas flow through production facilities, transmission pipelines, storage facilities, distribution systems and by end-use customers.

1.2 Principle of Measurement

Transit-time multipath ultrasonic meters are inferential meters that derive the gas flow rate by measuring the transit times of high-frequency sound pulses. Sound pulse transit times are measured between pairs of transducers. Pulses transmitted along the acoustic path in the direction of the gas flow have a greater average velocity relative to pulses transmitted against the gas flow. The difference in the sound pulse transit times is related to the average gas flow velocity along that specific acoustic path. Numerical calculation techniques are used to compute the average axial gas flow velocity and the gas volume flow rate at line conditions through the meter by combining the measurements of all active acoustic paths.

The accuracy of an ultrasonic gas meter depends on several factors, such as:

- Precisely measured dimensions of the flow meter body and ultrasonic transducer locations
- The velocity integration technique inherent in the design of the meter
- The shape of the velocity profile of the flowing gas stream at the meter
- Stability of the flowing gas stream
- The accuracy of transit-time measurements
- Flow calibration

The accuracy of transit-time measurements depends on several factors, including:

- The electronic clock accuracy and stability
- Accurate and consistent detection of sound pulse transit times
- Proper compensation for signal delays of electronic components and transducers
- Dimensional integrity of the flow meter body

Ultrasonic meter (USM) accuracy is dependent on these fundamental characterizations and their continued integrity over time. These accuracy dependencies may be adversely influenced by operational degradation of the USM over time (e.g., erosion, corrosion and dirt build up on internal meter surfaces, electronics drift, etc.). Emphasis on USM diagnostic data collection and interpretation in this document is made to impress upon users the need to monitor USM integrity so that accuracy is maintained.