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Measurement of Natural Gas by Coriolis Meter

Prepared by

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FOREWORD

This report is published in the form of a performance-based specification for Coriolis meter for natural gas flow measurement. It is the result of collaborative effort of natural gas users, Coriolis meter manufacturers, flow measurement research organizations and independent consultants forming Task Group 11 of AGA's Transmission Measurement Committee (TMC). In addition, comments to this report were made by the Alternative Meter Task Group under the Committee on Gas Flow Measurement (COGFM) of the American Petroleum Institute (API). Throughout the process, AGA Task Group 11 met several times and developed drafts reflective of comments received.

This report contains general guidance and information for consideration. The material may not be adequate under all conditions and does not restrict the use of other methods. Use of this publication is entirely within the control and discretion of the user and is wholly voluntary. Any use should be taken after an independent review of the applicable facts and circumstances.

At the time the writing of this report was initiated, all the known manufacturers of Coriolis meter for natural gas flow measurement were invited to join Task Group 11 and participate in the process of developing this report. Changes to this report may become necessary from time to time. If changes in this report are believed appropriate by any manufacturer, individual or organization, such suggested changes should be communicated to AGA by completing the last page of this report titled "**FORM FOR SUGGESTION TO CHANGE IN THE AGA REPORT NO. 11**" and sending it to: **Operating Section, American Gas Association, 400 North Capitol Street, NW, 4th Floor, Washington, DC 20001, U.S.A.**

Methods for verifying a meter's accuracy and/or applying a Flow Weighted Mean Error (FWME) correction factor to minimize the measurement uncertainty are contained in Appendix A - *Coriolis Gas Flow Meter Calibration Issues*. Depending on the design, a flow calibration of each meter on a gas similar to that which it will be applied may be necessary. In order to guide the designers and users in the specification of a Coriolis meter, Appendix B – *Coriolis Meter Data Sheet,* has been provided.

As a reference for background information on Coriolis natural gas metering, Appendix C - AGA Engineering Technical Note XQ0112 - *Coriolis Flow Measurement for Natural Gas Applications*, is provided. Due to the unique principle of operation and atypical performance characteristics of Coriolis mass flow meters, in comparison to volumetric flow meters, readers who are not familiar with the technology are encouraged to read this document prior to applying the general concepts and guidelines of this report.

As a reference for assessing the applicability of Coriolis meter technology to natural gas flow measurement, Appendix D - Gas Research Institute Topical Report GRI-01/0222 - *Metering Research Facility Program, Coriolis Mass Flow Meter Performance with Natural Gas*, is provided. This report outlines methods for baseline and installation effects testing of Coriolis meters for natural gas applications. The test data presented are an indicator of the state of Coriolis technology at the time of the tests. This report is intended as a general guide of testing methods to be used for the qualification of Coriolis meters as meeting the performance specifications of this report and the identification of the flow conditioning requirements of a particular meter design.

ACKNOWLEDGEMENTS

Report No. 11, Measurement of Gas by Coriolis Meters, was developed by a Transmission Measurement Committee (TMC) task group, **chaired by Stephen Baldwin, Unocal Corp.** Subsequently, a special subcommittee of the task group was formed to assemble technical information, compose drafts of the report, evaluate and resolve comments received through balloting, and prepare a final report.

The members of the special subcommittee, who devoted an extensive amount of their time, deserve special thanks:

Stephen Baldwin, Unocal Corp.
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1. Introduction

1.1. Scope

This report was developed to assist designers and users in operating, calibrating, installing, maintaining and verifying Coriolis flow meters used for natural gas flow measurement. Coriolis meters infer mass flow rate by measuring tube displacement resulting from the Coriolis effect. The scope of this document is limited to the measurement of natural gas and associated hydrocarbon gases either as pure hydrocarbons, as a mixture of pure hydrocarbons, and diluents. Although not within the scope of this document, Coriolis meters are used to measure a broad range of compressible fluids (gases), other than natural gas.

This report is applies to Coriolis meters used in medium to high-pressure natural gas applications. Typical applications include measuring single-phase gas flow found in production, process, transmission, storage, distribution, and end-use fuel measurement systems.

1.2. Principle of Measurement

Coriolis meters operate on the principle of the apparent bending force known as the Coriolis force (named after the French mathematician Gustave-Gaspard de Coriolis). When a fluid particle inside a rotating body moves in a direction toward or away from a center of rotation, that particle generates an inertial force (known as the Coriolis force) that acts on the body. In the case of a Coriolis flow meter, the body is a tube through which fluid flows. Coriolis meters create a rotating motion by vibrating the tube or tubes through which the fluid flows. Coriolis meters have the inherent ability to measure flow in either direction with comparable measurement accuracy in either flow direction. The inertial force that results is proportional to the mass flow rate. Numerical calculation techniques utilizing the calculated base density of the gas are used to convert the measured mass flow rate into standard volumetric flow rate. At the date of publication of this report the flowing density of a gas as indicated by a Coriolis meter is not of sufficient accuracy to be used to infer the flowing volume of gas and shall not be used for this purpose. Appendix C (Engineering Technical Note), Section 2.1, 3.2, and Appendix D of the Engineering Technical Note discusses in detail the conversion of mass flow rate to standard volume. For more information on the theory and physical dynamics that govern the operation of Coriolis meters, refer to Appendix C, Section 2.1.