ASME MFC-3M–2004
[Revision of ASME MFC-3M–1989 (R1995)]

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Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi

AN AMERICAN NATIONAL STANDARD

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The American Society of Mechanical Engineers
Three Park Avenue • New York, NY 10016

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CONTENTS

Foreword v
Committee Roster vi
Correspondence With the MFC Committee vii

Part 1 General 1
1-1 Scope and Application 1
1-2 References and Related Documents 1
1-3 Symbols and Definitions 2
1-4 Principles of the Method of Measurement and Computation 5
1-5 General Requirements for Measurement 6
1-6 Installation Requirements 7
1-7 Uncertainties in the Measurement of Flow Rate 9

Figure
1-1 "Triple-T" Arrangement 6

Table
1-1 Symbols 3

Nonmandatory Appendices
1A Iterative Computations 11
1B Examples of Values of Pipe Wall Uniform Equivalent Roughness, k 12
1C Flow Conditioners and Flow Straighteners 13

Part 2 Orifice Plates 18
2-1 Scope and Field of Application 18
2-2 References and Related Documents 18
2-3 Principles of the Method of Measurement and Computation 19
2-4 Orifice Plates 19
2-5 Installation Requirements 26

Figures
2-1 Standard Orifice Plate 19
2-2 Orifice Plate Flatness Measurement 20
2-3 Spacing of Pressure Taps for Orifice Plates with D and $D/2$ Pressure Taps or Flange Taps 22
2-4 Corner Taps 23
2-5 Layout Including a Full Bore Valve for $\beta = 0.6$ 28
2-6 Examples of Acceptable Installations 30
2-7 19-Tube Bundle Flow Straightener 31
2-8 Examples of Installations With a 19-Tube Bundle Flow Straightener Downstream of a Single Bend 33
2-9 Zanker Flow Conditioner Plate 34

Tables
2-1 Maximum Value of $10^4 R_a/D$ 24
2-2 Minimum Value of $10^4 R_a/D$ (When Required) 24
2-3 Required Straight Lengths Between Orifice Plates and Fittings Without Flow Conditioners 27

2-4 Permitted Range of Straight Lengths Between Orifice Plate and 19-Tube Bundle Flow Straightener (1998) Downstream of Fittings Located at Distance, L_f, From the Orifice Plate 32

Nonmandatory Appendix
2A Tables of Discharge Coefficients and Expansibility Factors 37

Part 3 Nozzles and Venturi Nozzles 49
3-1 Scope and Field of Application 49
3-2 References and Related Documents 49
3-3 Principles of the Method of Measurement and Computation 49
3-4 Nozzles and Venturi Nozzles 50
3-5 Installation Requirements 59

Figures
3-1 ISA 1932 Nozzle 50
3-2 Long Radius Nozzles 54
3-3 Venturi Nozzle 56
3-4 Venturi Nozzle, Pressure Taps 58
3-5 Pressure Loss Across a Venturi Nozzle 59
3-6 Layout Including a Full Bore Valve for $\beta = 0.6$ 62
3-7 Examples of Acceptable Installations 63

Tables
3-1 Upper Limits of Relative Roughness of the Upstream Pipe for ISA 1932 Nozzles . . . 52
3-2 Upper Limits of Relative Roughness of the Upstream Pipe for Venturi Nozzles 58
3-3 Required Straight Lengths for Nozzles and Venturi Nozzles 60

Nonmandatory Appendix
3A Tables of Discharge Coefficients and Expansibility Factors 65

Part 4 Venturi Meters 68
4-1 Scope and Field of Application 68
4-2 References and Related Documents 68
4-3 Principles of the Method of Measurement and Computation 68
4-4 ASME Venturi Tubes 69
4-5 Installation Requirements 74

Figures
4-1 Geometric Profile of the ASME Venturi Tube 70
4-2 Pressure Loss Across an ASME Venturi Tube 74
4-3 Layout Including a Full Bore Valve for $\beta = 0.6$ 76
4-4 Examples of Acceptable Installations 77

Table
4-1 Required Straight Lengths for Classical Venturi Tubes 75

Nonmandatory Appendices
4A Tables of Expansibility Factors 79
4B ASME Venturi Meters Used Outside the Scope of MFC-3M–2004 80
4C Pressure Loss in ASME Venturi Meters 82

FOREWORD

The purpose of this Standard is to provide guidance and recommendations in the applications of fluid flow in pipes using orifice, nozzle, and venturi meters. This Standard was prepared by MFC Subcommittee 2 of the American Society of Mechanical Engineers Standards Committee on Measurement of Fluid Flow in Closed Conduits.

As of the publication of this Standard, differential producers are the single most-used method of full-pipe flow measurement in the United States and worldwide. By utilizing simple physical laws, differential-producing flow meters are capable of providing reliable flow measurement within established uncertainty bands.

The first edition of this Standard was approved by the ASME MFC Standards Committee in 1985. The MFC Standards Committee approved the second edition of this Standard in 1989, and reaffirmed it in 1995. This revision, approved by the MFC Standards Committee in 2004, includes extensive changes to content and format from the MFC-3M–1989 (R1995) edition.

Given the global nature of the flow measurement market, this Standard is as consistent and technically equivalent with ISO 5167 as practical. There are, however, technical and editorial differences made in consideration of recent technical insights and operational practices common in the United States.

This Standard provides information in both SI (metric) units and U.S. Customary units. For reference, U.S. Customary units are shown in parentheses.

Suggestions for improvement to this Standard are welcome. They should be sent to Secretary, ASME MFC Standards Committee, Three Park Avenue, New York, NY, 10016-5990.

This edition of the Standard was approved by the American National Standards Institute on April 30, 2004.

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Measurement of Fluid Flow in Closed Conduits

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Secretary, MFC Standards Committee
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Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Interpretations. Upon request, the MFC Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the MFC Standards Committee.

The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. The inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in this format will be rewritten in this format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

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MEASUREMENT OF FLUID FLOW IN PIPES USING ORIFICE, NOZZLE, AND VENTURI

Part 1 General

1-1 SCOPE AND APPLICATION

This Standard specifies the geometry and method of use (installation and operating conditions) for pressure differential devices (including, but not limited to, orifice plates, flow nozzles, and venturi tubes) when installed in a closed conduit running full and used to determine the flow-rate of the fluid flowing in the conduit. This Standard applies to pressure differential devices in which the flow remains subsonic throughout the measuring section and where the fluid is considered as single-phase. The Standard is limited to single-phase Newtonian fluid flow in which the flow can be considered sufficiently free from pulsation effects. It gives information for calculating the flow-rate and the associated uncertainty when each of these devices is used within specified limits of pipe size and Reynolds number.

This Standard covers flow meters that operate on the principle of a local change in flow velocity and/or flow parameters caused by meter geometry, resulting in a corresponding change of pressure between two set locations. Although there are several types of differential pressure meters available, it is the purpose of this Standard to address the applications of each meter and not to endorse any specific meter. The operating principle of a pressure differential flow meter is based on two physical laws: conservation of energy and conservation of mass, realized when changes in flow cross-sectional area and/or flow path result in a change of pressure. This differential pressure, in turn, is a function of the flow velocity, fluid path, and fluid properties.

Included within the scope of this Standard are devices for which direct calibration experiments have been made, sufficient in number and data coverage, to enable valid systems of application to be based on their results and coefficients to be given with known uncertainties.

The devices installed in the pipe are referred to as *primary devices*, *primary elements*, or simply, *primaries*. The primary device may also include the associated upstream and downstream piping. The other instruments required for the flow measurement are often referred to as *secondary devices* or *secondaries*. For further information on secondary instrumentation, see ASME/ANSI MFC-8M.

The different primary elements covered in this Standard are as follows:

(a) orifice plates (Part 2) that can be used with the following pressure tap arrangements:
- *(1)* flange pressure taps
- *(2)* corner pressure taps
- *(3)* D and $D/2$ pressure taps

(b) nozzles (Part 3), each of which differs in the following shape and position of the pressure taps:
- *(1)* ASME long radius nozzles
- *(2)* Venturi nozzles
- *(3)* ISA 1932 nozzles

(c) ASME venturi tubes (Part 4), also known as Herschel or classical venturi tubes

Part 1 of this Standard contains general material such as definitions, symbols, and principles that apply to all the devices covered in Parts 2, 3, and 4 of this Standard with respect to the flow measurement of any single phase fluid.

This Standard does not apply to ASME Performance Test Code measurements. This Standard does not address those devices that operate on the principle of critical or choked flow condition of fluids. This Standard does not address issues of safety. It is the responsibility of the user to ensure that all systems conform to applicable safety requirements and regulations.

1-2 REFERENCES AND RELATED DOCUMENTS

Unless indicated otherwise, the latest issue of a reference standard shall be used.

ASME B36.10, Welded and Seamless Wrought Steel Pipe

ASME MFC-1M, Glossary of Terms Used in the Measurement of Fluid Flow in Pipes

ASME MFC-2M, Measurement of Uncertainty for Fluid Flow in Closed Conduits

ASME MFC-8M, Fluid Flow in Closed Conduits—Connections for Pressure Signal Transmission Between Primary and Secondary Devices

ASME PTC 6, Steam Turbines

ASME PTC 19.5, Flow Measurement

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ISO 3313, The Effect of Flow Pulsation on Flow Measuring Instruments: Orifice Plates, Nozzles, or Venturi Tubes, Turbine and Vortex Flow Meters