ASME MFC-7–2016
[Revision and Redesignation of ASME/ANSI MFC-7M–1987 (R2014)]

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Measurement of Gas Flow by Means of Critical Flow Venturis and Critical Flow Nozzles

AN AMERICAN NATIONAL STANDARD

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Two Park Avenue • New York, NY • 10016 USA

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The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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FOREWORD

This Standard was prepared by Subcommittee 7 (SC 7) of the ASME Standards Committee on Measurement of Fluid Flow in Closed Conduits; it has been revised from ASME MFC-7M–1987 in its entirety. During the preparation, reference was made to older ASME standards and documents, including ASME MFC-3M–2004 and ASME PTC 19.5-2004, and to international standards including ISO 9300:2005 and ISO/IEC Guide 98-3:2008. In addition, information was gathered from many published papers and from the experience of the Subcommittee members and other knowledgeable engineers. This standard is a blend of the available technical information and best practices, and it is intended to be a practical guide to the proper use of critical flow venturis (CFV) and critical flow nozzles (CFN).

Changes made during the revision of this Standard are summarized as follows:

(a) The Scope and Field of Application was revised to clarify usage of the terms "critical flow venturi" and "critical flow nozzle."

(b) A few symbols and definitions have been added, and many have been clarified and updated.

(c) Manufacturing tolerances have been updated to be more verifiable and to accommodate smaller CFVs.

(d) The discharge coefficient equations have been brought into alignment with extensive research results and ISO 9300.

(e) Recommendations for the calculation of thermophysical properties have been directed almost entirely toward the NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP), which is maintained by the National Institute of Standards and Technology (NIST).

(f) Uncertainty calculation methods have been extensively modified to be consistent with more modern methods and ISO/IEC Guide 98-3:2008. A statement of uncertainty is now required in order to be compliant with this Standard.

(g) The Nonmandatory Appendices have been modified to provide two new comprehensive examples, including uncertainty calculation, and to derive and clarify the mass flow equation, the real gas critical flow function, other gas property calculations, and humid air considerations.

(h) An "unchoking test procedure" is provided in a Nonmandatory Appendix.

Critical flow venturis are especially suited as transfer standards and reference flowmeters for calibration and testing and for precise flow control applications. CFVs provide a stable flow of compressible fluids, and per this Standard can and should be associated with a precise statement of uncertainty for the measured flow. Although this Standard is a complete guide that provides specific requirements and methods for the proper use of CFVs and CFNs, some latitude and variations in application are allowed if necessary tests are performed and proper judgment is applied.

Suggestions for improvement of this Standard will be welcomed. They should be sent to The American Society of Mechanical Engineers; Attn: Secretary, MFC Main Committee; Two Park Avenue; New York, NY 10016-5990.

This revision was approved as an American National Standard on January 6, 2016.

ASME MFC COMMITTEE
Measurement of Fluid Flow in Closed Conduits

(The following is the roster of the Committee at the time of approval of this Standard.)

CORRESPONDENCE WITH THE MFC COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, MFC Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

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.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the MFC Standards 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.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the MFC Standards Committee at the above address. The request for an 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 in one or two words.
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. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. 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 the format described above may be rewritten in the appropriate 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.

Attending Committee Meetings. The MFC Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the MFC Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at go.asme.org/MFCcommittee.

MEASUREMENT OF GAS FLOW BY MEANS OF CRITICAL FLOW VENTURIS AND CRITICAL FLOW NOZZLES

1 SCOPE AND FIELD OF APPLICATION

This Standard applies only to the steady flow of single-phase gases through critical flow venturis (CFV) of shapes specified herein [also sometimes referred to as critical flow nozzles (CFN), sonic nozzles, or critical flow venturi nozzles]. This Standard applies to CFVs with diverging sections on the downstream side of the throat. When a CFN (no diverging section) is discussed, it is explicitly noted. This Standard specifies the method of use (installation and operating conditions) of CFVs. This Standard also gives information necessary for calculating the mass flow of the gas and its associated uncertainty.

This Standard applies only to CFVs and CFNs in which the flow is critical. Critical flow exists when the mass flow through the CFV is the maximum possible for the existing upstream conditions. At critical flow or choked conditions, the average gas velocity at the CFV throat closely approximates the local sonic velocity.

This Standard specifically applies to cases in which

(a) it can be assumed that there is a large volume upstream of the CFV or upstream of a set of CFVs mounted in a parallel flow arrangement (in a common plenum), thereby achieving higher flow; or

(b) the pipeline upstream of the CFV is of circular cross section with throat to pipe diameter ratio equal to or less than 0.25

2 REFERENCES

The following publications are referenced in this Standard. The latest edition of ASME publications should be used.

ASME MFC-3M, Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi
ASME PTC 19.5, Flow Measurement
Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

ISO 9300:2005, Measurement of gas flow by means of critical flow Venturi nozzles
ISO/IEC Guide 98-3:2008, Uncertainty of measurement—Part 3: Guide to the expression of uncertainty in measurement
Publisher: International Organization for Standardization (ISO) Central Secretariat, Chemin de Blandonnet 8, Case Postale 401, 1214 Vernier, Geneva, Switzerland (www.iso.org)

NIST Standard Reference Database 23, NIST Reference Fluid Thermodynamic and Transport Properties Database (REFPROP): Version 9.1
Publisher: National Institute of Standards and Technology (NIST), 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899 (www.nist.gov)

3 SYMBOLS AND DEFINITIONS

3.1 Symbols and Nomenclature

See Table 3.1-1.

3.2 Definitions

3.2.1 Temperature Measurement

measured gas temperature: temperature of the gas after being irreversibly brought to rest against the temperature probe.