ASME B89.7.1-2016
(Technical Report)

Guidelines for Addressing Measurement Uncertainty in the Development and Application of ASME B89 Standards

The American Society of Mechanical Engineers

ASME B89.7.1-2016
(Technical Report)

Guidelines for Addressing Measurement Uncertainty in the Development and Application of ASME B89 Standards

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

Date of Issuance: May 31, 2016

This Technical Report will be revised when the Society approves the issuance of a new edition.

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

CONTENTS

FOREWORD

This Technical Report provides general principles for addressing measurement uncertainty that apply to the use of ASME B89 standards. This Technical Report also provides recommendations regarding measurement uncertainty for use in the development of ASME B89 standards. This Technical Report is concerned with the application and documentation of measurement uncertainty but not with methods for the estimation of measurement uncertainty.

A number of challenging requirements have been introduced to dimensional metrology practice in recent years through new developments in ISO/IEC 17025 accreditation, measurement uncertainty, and conformance decision rules. Many of these requirements are related to the broad concept of measurement uncertainty management. The ASME B89.7 series of standards and technical reports has been developed to help users understand and meet these new uncertainty-related requirements.

To achieve its purpose, this Technical Report introduces general concepts associated with calibration and verification testing. This Technical Report clarifies existing terms and introduces new terms and definitions in an attempt to standardize practices within ASME B89 standards and across the dimensional metrology field.

There are efforts ongoing to develop standards and to prepare industry to address the issues related to measurement uncertainty and the increasing recognition of its importance in commerce. These efforts aim to support the consideration of measurement uncertainty in measurement plans. Until recently, many existing ASME B89 standards did not address measurement uncertainty. This Technical Report provides guidelines for documenting the treatment of uncertainty contributions. These guidelines support the use and documentation of a methodology recognized as consistent with the concepts outlined in JCGM 100, Guide to the Expression of Uncertainty in Measurement (GUM).

Applying common guidelines in development of all ASME B89 standards, where appropriate, will ensure consistency, facilitate the approval process, and improve intelligibility for buyers and sellers who use ASME B89 standards.

Acknowledgment. This work was initiated and originally chaired by the late John Buttress, and his contribution is recognized and appreciated by the ASME B89 Committee.

ASME B89 COMMITTEE
Dimensional Metrology

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

STANDARDS COMMITTEE OFFICERS

T. Charlton, Jr., *Chair*
S. D. Phillips, *Vice Chair*
R. Richmond, *Secretary*

STANDARDS COMMITTEE PERSONNEL

T. Charlton, Jr., Charlton Associates
D. J. Christy, Mahr Federal, Inc.
B. Crowe, Schneider Electric
J. D. Drescher, UTC — Pratt and Whitney
M. L. Fink, Boeing
G. A. Hetland, International Institute of Geometric Dimensioning and Tolerancing
M. Liebers, Professional Instruments Co.
R. L. Long, Laboratory Accreditation Bureau
E. Morse, University of North Carolina at Charlotte
B. Parry, Parry Engineering
P. Pereira, Caterpillar, Inc.
S. D. Phillips, National Institute of Standards and Technology
R. Richmond, The American Society of Mechanical Engineers
J. G. Salsbury, Mitutoyo America Corp.
D. Sawyer, National Institute of Standards and Technology
J. R. Schmidl, Optical Gaging Products, Inc.
C. Shakarji, National Institute of Standards and Technology
R. L. Thompson, U.S. Air Force
K. L. Skinner, *Alternate,* Air Force Metrology and Calibration
E. R. Yaris, Lowell, Inc.

SUBCOMMITTEE 7 — MEASUREMENT UNCERTAINTY

S. D. Phillips, *Chair,* National Institute of Standards and Technology
T. Charlton, Jr., Charlton Associates
K. Doytchinov, Kotem Technologies, Inc.
H. Harary, National Institute of Standards and Technology
G. A. Hetland, International Institute of Geometric Dimensioning and Tolerancing
M. P. Krystek, Physikalisch-Technische Bundesanstalt
M. Liebers, Professional Instruments Co.
R. L. Long, Laboratory Accreditation Bureau
E. Morse, University of North Carolina at Charlotte
B. Parry, Parry Engineering
P. Pereira, Caterpillar, Inc.
J. Raja, University of North Carolina at Charlotte
J. G. Salsbury, Mitutoyo America Corp.
C. Shakarji, National Institute of Standards and Technology
E. R. Yaris, Lowell, Inc.

PROJECT TEAM 7.1 — GUIDELINES FOR B89 DOCUMENTS

J. G. Salsbury, *Chair,* Mitutoyo America Corp.
T. D. Doiron, National Institute of Standards and Technology
G. A. Hetland, International Institute of Geometric Dimensioning and Tolerancing
M. P. Krystek, Physikalisch-Technische Bundesanstalt
R. L. Long, Laboratory Accreditation Bureau
E. Morse, University of North Carolina at Charlotte
B. Parry, Parry Engineering
S. D. Phillips, National Institute of Standards and Technology
C. Shakarji, National Institute of Standards and Technology
E. R. Yaris, Lowell, Inc.

CORRESPONDENCE WITH THE B89 COMMITTEE

General. ASME Codes, Standards, and Technical Reports are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Technical Report may interact with the Committee by proposing revisions and attending Committee meetings. Correspondence should be addressed to:

Secretary, B89 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 Technical Report to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Technical Report. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Technical Report. 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.

Attending Committee Meetings. The B89 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 B89 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at http://go.asme.org/B89committee.

GUIDELINES FOR ADDRESSING MEASUREMENT UNCERTAINTY IN THE DEVELOPMENT AND APPLICATION OF ASME B89 STANDARDS

1 SCOPE

This Technical Report provides recommendations associated with addressing measurement uncertainty and direction in the application of the existing ASME B89.7 series of uncertainty-related standards and technical reports. This Technical Report also provides general principles and recommendations regarding measurement uncertainty and its documentation for use in the development of ASME B89 standards and technical reports. This Technical Report does not cover methods to be used in the estimation of measurement uncertainty. To achieve these objectives, this Technical Report

(a) outlines guidelines for documenting measurement uncertainty in ASME B89 standards and technical reports

(b) defines general calibration and verification testing principles, terms, and concepts for use in dimensional metrology

(c) discusses general topics associated with addressing measurement uncertainty, such as operating conditions, conformance testing, decision rules, and traceability

This Technical Report takes advantage of the technical content developed in other ASME B89.7 standards and technical reports, whenever possible. That technical content is referenced, but not repeated, in this Technical Report.

2 DEFINITIONS

For the purposes of this Technical Report, the definitions in JCGM 200:2012 (VIM3) apply; any differences or additions are included below. When definitions from JCGM 200 are included in this Technical Report, some notes may not be shown for brevity. When notes have been added to the JCGM 200 definitions in this Technical Report, a parenthetical statement indicates the notes are specific to this Technical Report.

artifact verification: provision of sufficient objective evidence that a given material measure (artifact) conforms to a specified maximum permissible error or tolerance limit.

calibration: operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication. (This definition is identical to JCGM 200:2012, definition 2.39, but with the notes not shown for brevity. The note below is specific to this Technical Report.)

NOTE: Verification tests are frequently used as calibrations when they satisfy both the first and second step in the above definition (see para. 4.4.2).

decision rule: documented rule that describes how measurement uncertainty will be accounted for with regard to accepting or rejecting an item, given a specified requirement and the result of a measurement. (This definition is identical to JCGM 106:2012, definition 3.3.12. The note below is specific to this Technical Report.)

NOTE: See further discussion of decision rules in ASME B89.7.3.1.

indication: quantity provided by a measuring instrument or measuring system.

NOTE:
(1) An indication is often given as the position of a pointer for an analog output or the displayed or printed number for a digital output.
(2) An indication is also known as a reading.

(The definition above, including the Notes, is identical to JCGM 106:2012, definition 3.2.9.)

instrument verification: provision of sufficient objective evidence that a given indicating measuring instrument conforms to a specified maximum permissible error or tolerance limit.

maximum permissible error (MPE): for a measuring instrument, maximum difference, permitted by specifications or regulations, between the instrument indication and the quantity being measured. (This definition is identical to JCGM 106:2012, definition 3.3.18, but with notes not shown for brevity. The note below is specific to this Technical Report.)

NOTE: A maximum permissible error is a specific type of tolerance limit.