

ASME Y14.5.1-2019

[Revision of ASME Y14.5.1M-1994 (R2012)]

Mathematical Definition of Dimensioning and Tolerancing Principles

**Engineering Product Definition and
Related Documentation Practices**

AN INTERNATIONAL STANDARD



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Mechanical Engineers**

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Two Park Avenue • New York, NY • 10016 USA

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FOREWORD

This edition is a revision of ASME Y14.5.1M-1994, Mathematical Definition of Dimensioning and Tolerancing Principles, supporting Y14.5-2009. Efforts focused on improving usability with Y14.5 have resulted in harmonization of terms where possible and a realignment of sections consistent with Y14.5-2009. This revision also addresses proposals submitted by the public or members of the Y14 Standards Committee and affiliated subcommittees. See [Nonmandatory Appendix A](#), Principle Changes and Improvements.

Work on this revision began in May of 2012 followed by semiannual face-to-face meetings and numerous online collaborative meetings to refine content and disposition comments. Comments on key areas are provided below to add some context to these revisions.

This revision includes a new stabilization definition for irregularities on datum features specified at RMB, which provides an alternative to the candidate datum set. SC5 had moved toward the concept of a single-stable solution that minimizes the separation between the datum feature and the true geometric counterpart, and SC5.1 was asked to study the concept and recommend a mathematical definition. A stable Constrained L2 datum definition was selected, which applies as an alternate stabilization definition for Y14.5-2009 and the default stabilization definition for Y14.5-2018. See [Nonmandatory Appendix B](#) for results of the study and mathematical definitions.

Profile tolerancing was a major focus of development work and the section was completely rewritten. The actual value of profile was changed from the deviation-based two-value definition to a zone-based single-value definition compatible with Y14.5's tolerance zone definitions. This provides a consistent treatment of unequally disposed and unilateral profile zones, with no change in conformance results. The updated definition allows direct comparison of the actual value with the specified tolerance value, and consistency with actual value definitions for other geometric tolerances.

Redevelopment of the profile section also created the requirement to address applications with multiple features and a variety of degree of freedom constraints. This was accomplished by treating profile tolerances as systems with degrees of freedom and constraints, with the Y14.5 tolerance zone and datum reference frame definitions providing the initial conditions. Actual values are defined for a wide variety of profile applications including single features, multifeature groups with and without datum features, simultaneous requirements, and composite profile tolerances.

The mathematical definitions for size have not changed; they continue to use the sweeping ball concept to define the tolerance zone volume. Two nonmandatory definitions for local size have been added: one based on opposed points and the other based on inscribed/circumscribed circular elements.

Text and figure edits were made to improve readability and clarify content. Changes in sentence structure, organization of content, and method of illustration are not an indication of technical changes.

This Standard is available for public review on a continuing basis. This provides an opportunity for additional public review input from industry, academia, regulatory agencies, and the public-at-large.

ASME Y14.5.1-2019 was approved by ANSI as an American National Standard on November 7, 2019.

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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.

This Standard is always open for comment, and the Committee welcomes proposals for revisions. 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.

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Attending Committee Meetings. The Y14 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 Y14 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at <http://go.asme.org/Y14committee>.

Section 1

Scope and Definitions

1.1 SCOPE

This Standard presents a mathematical definition of geometrical dimensioning and tolerancing consistent with the principles and practices of ASME Y14.5-2009, enabling determination of actual values. While the general format of this Standard parallels that of ASME Y14.5-2009, the latter document should be consulted for practices relating to dimensioning and tolerancing for use on engineering product definition and in related documentation.

Textual references are included throughout this Standard which are direct quotations from ASME Y14.5-2009. All such quotations are identified by italicized type and include paragraph reference within square brackets. Any direct references to other documents are identified by an immediate citation.

This Standard applies to product definition in any representation. When reference is made in this Standard to an engineering product definition, it applies to any form of product specification.

1.1.1 Reference to Gaging

This Standard is not intended as a gaging standard. Any reference to gaging is included for explanatory purposes only.

1.2 ASME Y14 SERIES CONVENTIONS

The conventions in [paras. 1.2.1](#) through [1.2.9](#) are used in this and other ASME Y14 standards.

1.2.1 Mandatory, Recommended, Guidance, and Optional Words

- (a) The word “shall” establishes a requirement.
- (b) The word “will” establishes a declaration of purpose on the part of the design activity.
- (c) The word “should” establishes a recommended practice.
- (d) The word “may” establishes an allowed practice.
- (e) The words “typical,” “example,” “for reference,” and the Latin abbreviation “e.g.” indicate suggestions given for guidance only.
- (f) The word “or” used in conjunction with a requirement or a recommended practice indicates that there are two or more options for complying with the stated requirement or practice.

(g) The phrase “unless otherwise specified” or “UOS” shall be used to indicate a default requirement. The phrase is used when the default is a generally applied requirement and an exception may be provided by another document or requirement.

1.2.2 Cross-Reference of Standards

Cross-reference of standards in text with or without a date following the standard designator shall be interpreted as follows:

(a) Reference to other ASME Y14 standards in the text without a date following the standard designator indicates that the edition of the standard identified in the References section ([subsection 1.3](#)) shall be used to meet the requirement.

(b) Reference to other ASME Y14 standards in the text with a date following the standard designator indicates that only that edition of the standard shall be used to meet the requirement.

1.2.3 Invocation of Referenced Standards

The following examples define the invocation of a standard when specified in the References section ([subsection 1.3](#)) and referenced in the text of this Standard:

(a) When a referenced standard is cited in the text with no limitations to a specific subject or paragraph(s) of the standard, the entire standard is invoked. For example, “Dimensioning and tolerancing shall be in accordance with ASME Y14.5” is invoking the complete standard because the subject of the standard is dimensioning and tolerancing and no specific subject or paragraph(s) within the standard are invoked.

(b) When a referenced standard is cited in the text with limitations to a specific subject or paragraph(s) of the standard, only the paragraph(s) on that subject is invoked. For example, “Assign part or identifying numbers in accordance with ASME Y14.100” is invoking only the paragraph(s) on part or identifying numbers because the subject of the standard is engineering drawing practices and part or identifying numbers is a specific subject within the standard.

(c) When a referenced standard is cited in the text without an invoking statement such as “in accordance with,” the standard is invoked for guidance only. For example, “For gaging principles, see ASME Y14.43” is