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Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications¹

This standard is issued under the fixed designation E 29; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense. Consult the DoD Index of Specifications and Standards for the specific year of issue which has been adopted by the Department of Defense.

1. Scope

1.1 This practice is intended to assist the various technical committees in the use of uniform methods of indicating the number of digits which are to be considered significant in specification limits, for example, specified maximum values and specified minimum values. Its aim is to outline methods which should aid in clarifying the intended meaning of specification limits with which observed values or calculated test results are compared in determining conformance with specifications. Reference to this practice is valid only when a choice of method has been indicated, that is, either *absolute method* or *rounding-off method*.

1.2 This practice is intended to be used in determining conformance with specifications when the applicable ASTM specifications or standards make direct reference to this practice.

1.3 This practice describes two commonly accepted methods of rounding data, identified as the Absolute Method and the Rounding-Off Method. In the application of this practice to a specific material or materials it is essential to specify which method is intended to apply. In the absence of such specification, reference to this practice, which expresses no preference as to which method should apply, would be meaningless. The choice of method is arbitrary, depending upon the current practice of the particular branch of industry or technology concerned, and should therefore be specified in the prime publication.

1.4 Section 7 of this practice gives guidelines for use in recording, calculating, and reporting the final result for test data.

2. Referenced Documents

2.1 ASTM Standards:

E 456 Terminology Related to Quality and Statistics

E 380 Practice for Use of the International System of Units (SI) the Modernized Metric System

2.1 ANSI Standard:

ANSI Z25.1 Rules for Rounding Off Numerical Values

3. Terminology

3.1 *significant digit, n*—any of the figures 0 through 9, excepting leading zeros and some trailing zeros, which is used with its place value to denote a numerical quantity to some desired approximation.

3.1.1 The digit zero may either indicate a specific value or indicate place only. Zeros leading the first nonzero digit of a number indicate order of magnitude only and are not significant digits. For example, the number 0.0034 has two significant digits. Zeros trailing the last nonzero digit for numbers represented with a decimal point are significant digits. For example, the numbers 1270. and 32.00 each have four significant digits. The significance of trailing zeros for numbers represented without use of a decimal point can only be identified from knowledge of the source of the value. For example, a tensile strength, stated as 140 000 psi, may have as few as two or as many as six significant figures. To avoid ambiguity, the exponential notation may be used; thus, 1.40×10^5 psi indicates that the tensile strength is reported to the nearest 0.01×10^5 or 1000 psi.

4. Expression of Numerical Requirements

4.1 The unqualified statement of a numerical limit, such as “2.50 in. max,” cannot, in view of different established practices and customs, be regarded as carrying a definite operational meaning concerning the number of digits to be retained in an observed or a calculated value for purposes of determining conformance with specifications.

4.2 *Absolute Method*—In some fields, specification limits of 2.5 in. max, 2.50 in. max, and 2.500 in. max are all taken to imply the same absolute limit of exactly two and a half inches and for purposes of determining conformance with specifications, an observed value or a calculated value is to be compared directly with the specified limit. Thus, any deviation, however small, outside the specification limit signifies nonconformance with the specifications. This will be referred to as the *absolute method*.

4.3 *Rounding-Off Method*—In other fields, specification limits of 2.5 in. max, 2.50 in. max, 2.500 in. max are taken to imply that, for the purposes of determining conformance with specifications, an observed value or a calculated value should be rounded off to the nearest 0.1 in., 0.01 in., 0.001 in., respectively, and then compared with the specification limit. This will be referred to as the *rounding-off method*.

¹ This practice is under the jurisdiction of ASTM Committee E-11 on Quality and Statistics and is the direct responsibility of Subcommittee E11.03 on Statistical Analysis and Control Techniques.

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5. Absolute Method

5.1 Where Applicable—The absolute method applies where it is the intent that all digits in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications. Under these conditions, the specified limits are referred to as absolute limits.

5.2 How Applied—With the absolute method, an observed value or a calculated value is not to be rounded off, but is to be compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

5.3 How Expressed—This intent may be expressed in the standard in one of the following forms:

5.3.1 If the absolute method is to apply to all specified limits in the standard, this may be indicated by including the following sentence in the standard:

For purposes of determining conformance with these specifications, all specified limits in this standard are absolute limits, as defined in ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

5.3.2 If the absolute method is to apply to all specified limits of some general type in the standard (such as dimensional tolerance limits), this may be indicated by including the following sentence in the standard:

For purposes of determining conformance with these specifications, all specified (dimensional tolerance) limits are absolute limits, as defined in ASTM Practice E 29, Using Significant Digits in Test Data to Determine Conformance with Specifications.

5.3.3 If the absolute method is to apply to all specified limits given in a table, this may be indicated by including a footnote with the table as follows:

Width, in.	Width Tolerances ⁴ Plus and Minus, in.	
	0.032 in. and under in Thickness	Over 0.032 in. in Thickness
2 and under	0.005	0.010
Over 2 to 8 incl	0.008	0.013
Over 8 to 14 incl	0.010	0.015
Over 14 to 20 incl	0.013	0.018

⁴ Tolerance limits specified are absolute limits as defined in ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6. Rounding-Off Method

6.1 Where Applicable—The rounding-off method applies where it is the intent that a limited number of digits in an observed value or a calculated value are to be considered significant for purposes of determining conformance with specifications.

6.2 How Applied—With the rounding-off method, an observed value or a calculated value should be rounded off by the procedure prescribed in 4.3 to the nearest unit in the designated place of figures stated in the standard, as, for example, “to the nearest 100 psi,” “to the nearest 10 ohms,” “to the nearest 0.1 percent,” etc. The rounded-off value should then be compared with the specified limit, and conformance or nonconformance with the specification based on this comparison.

6.3 How Expressed—This intent may be expressed in the standard in one of the following forms:

6.3.1 If the rounding-off method is to apply to all specified limits in the standard, and if all digits expressed in the specification limit are to be considered significant, this may be indicated by including the following statement in the standard:

The following applies to all specified limits in this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off “to the nearest unit” in the last right-hand digit used in expressing the specification limit, in accordance with the rounding-off method of ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.2 If the rounding-off method is to apply only to the specified limits for certain selected requirements, this may be indicated by including the following statement in the standard:

The following applies to specified limits for requirements on (tensile strength), (elongation), and (...) given in ..., (applicable section number and title) and (...) of this standard: For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest (1000 psi) for (tensile strength), to the nearest (1 percent) for (elongation), and to the nearest (...) for (...) in accordance with the rounding-off method of ASTM Practice E 29 Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3 If the rounding-off method is to apply to all specified limits in a table, this may be indicated by a note in the manner shown in the following examples:

6.3.3.1 Example 1—Same significant digits for all items:

	Chemical Composition, %
Copper	4.5 ± 0.5
Iron	1.0 max
Silicon	2.5 ± 0.5
Other constituents (magnesium + zinc + manganese)	0.5 max
Aluminum	remainder

NOTE 1—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off to the nearest 0.1 percent, in accordance with the rounding-off method of ASTM Practice E 29, for Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3.2 Example 2—Significant digits not the same for all items; similar requirements:

	Chemical Composition, percent	
	min	max
Nickel	57	...
Chromium	14	18
Manganese	...	3
Silicon	...	0.40
Carbon	...	0.25
Sulfur	...	0.03
Iron		remainder

NOTE 2—For purposes of determining conformance with these specifications, an observed value or a calculated value shall be rounded off “to the nearest unit” in the last right-hand significant digit used in expressing the limiting value, in accordance with the round-off method of ASTM Practice E 29, Using Significant Digits in Test Data to Determine Conformance with Specifications.

6.3.3.3 Example 3—Significant digits not the same for all items; dissimilar requirements:

	Tensile Requirements
Tensile strength, psi	60 000 to 72 000
Yield point, min, psi	33 000
Elongation in 2 in., min %	32



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