



Standard Specification for Evaluating, Selecting, and Specifying Balances and Scales for Use in Soil, Rock, and Construction Materials Testing¹

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1. Scope *

1.1 This specification provides minimum requirements for general-purpose scales, balances, and standard masses used in testing soil, rock, and related construction materials.

1.2 This specification provides guidance for evaluating, selecting, and specifying general purpose scales, balances, and standard masses used in testing soil, rock, and related construction materials.

1.3 The accuracy requirements for balances and scales are specified in terms of the combined effect of all sources of error contributing to overall balance performance. The measurement of specific sources of error and consideration of details pertaining to balance construction have been intentionally avoided.

1.4 This specification does not include requirements for balances and scales that have accuracies greater than those generally required in normal soil, rock, and related construction materials.

1.5 This specification does not apply to nongraduated balances.

1.6 This specification does not address the methods used to verify or quantify specific parameters dealing with balances and scales. For a description of tests used in evaluating balance performance, see NIST Handbook 44.

1.7 This specification is not intended to be used as a specification for the purchase of balances and scales.

NOTE 1—The National Institute of Standards and Technology (NIST), formerly the National Bureau of Standards (NBS), and the International Organization of Legal Metrology (OIML) publish standards or practices that specify construction requirements as well as performance specifications for balances. ASTM, OIML, and NIST publish construction standards and tolerances for standard masses.

NOTE 2—The terms “mass” and “determine the mass of” are used in this standard instead of the more commonly used terms “weight” and “weigh” to comply with standard metric practice. In addition, the term “standard mass(es)” is used instead of “weight(s)” when referring to a piece of material of known specified mass used to compare or measure the mass of other masses.

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2. Referenced Documents

2.1 ASTM Standards:

E 617 Specification for Laboratory Weights and Precision Mass Standards²

2.2 National Institute of Standards and Technology Documents:

NIST Handbook 44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices³

NIST Handbook 105-1 Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures³

2.3 International Organization for Legal Metrology (OIML):

International Recommendation No. 20 Weights of Accuracy Classes E₁, E₂, F₁, F₂, M₁ from 50 kg to 1 mg⁴

International Recommendation No. 3⁴

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *accurate*—a balance is “accurate” when its performance (its indication as determined by tests made with suitable standards) conforms to the standard within the applicable tolerances and other performance requirements. Balances that fail to conform are “inaccurate.”

3.1.2 *balance*—an instrument for determining the mass of an object by the action of gravity on the object. See *scale*.

NOTE 3—In this specification the terms balance and scale are used interchangeably as is often done. The term balance is more often used in scientific fields of application. See Note 7.

3.1.3 *basic condition*—a basic condition is a condition that must be met before a basic measurement for evaluating a balance can be performed.

3.1.4 *basic measurement (of error)*—a basic measurement for evaluating a balance is performed by (1) determining the change of indication of the balance when a load of known mass is added to or subtracted from any load already on the balance; and (2) taking the difference between the change in the

² Annual Book of ASTM Standards, Vol 14.02.

³ Available from the International Standards, National Institute of Standards and Technology, US Department of Commerce, Gaithersburg, MD 20899.

⁴ Available from the Superintendent of Documents, US Government Printing Office, Washington, DC 20402.

indication determined and the known value of the mass.

3.1.5 *basic tolerance*—basic tolerances are those tolerances that are established by a particular code for a particular device under all normal tests, whether maintenance or acceptance. Basic tolerances include minimum tolerance values when these are specified. Special tolerances, identified as such and pertaining to special tests, are not basic tolerances.

3.1.6 *capacity—of a balance*, the maximum load recommended by the manufacturer, disregarding any additional capability supplied by a taring device.

3.1.7 *general-purpose balance*—any balance used to make a general purpose determination of mass. See *general-purpose determination of mass*.

3.1.8 *general-purpose determination of mass*—a single determination of mass using a balance (not a special purpose determination of mass involving repeat determinations of mass, averages, standard deviations, corrections etc.).

3.1.9 *general-purpose standard mass*—a standard mass used with a balance to make a general purpose determination of mass. See *general-purpose determination of mass*.

3.1.10 *hysteresis*—the difference between indications obtained when the value of the applied load is reached by adding mass or by removing mass from the load receiving element of a balance.

3.1.11 *linearity error*—plus or minus deviation from the theoretically straight-lined (linear) course of two interdependent values. In balances, this expression is applied to the plus or minus deviation of the indicated measurement value from the true (actual) value of the load.

NOTE 4—The term linearity implies that the deviation from the true values are a continuous function of the applied load. Thus, obtaining enough values of the true applied load versus balance reading to establish a relation between applied load and output should give the error that will occur at any applied load. Linearity, then, is a statement about the systematic (nonrandom) error of a balance. Superimposed on the linearity are precision and other effects, such as off-center errors, temperature effects, etc. Linearity is a measure of balance performance over its full range, and on most balances adjustments can be made to alter the useableness of a balance with a given linearity for weighings within a particular range of use.

3.1.12 *nongraduated balance*—balances not fitted with a scale numbered in units of mass.

3.1.13 *off-center error—of a top loading or platform balance*, the difference in indicated value when a mass is shifted to various positions on the loading area (pan or platform); eccentric load error.

NOTE 5—The test for off-center error is called the shift test, or offcenter-load test. Information about balance performance under eccentric loadings is not normally found in product literature but such information can usually be obtained by contacting the manufacturers directly.

3.1.14 *precision of a balance*—the degree of agreement between the indications of a balance for repeated determinations of mass of the same mass under essentially the same conditions. It is usually expressed quantitatively as a standard deviation of a series of weighings, or as a function of the range of several determinations of mass. See *repeatability type II, reproducibility*.

3.1.15 *readability type I*—the value of the smallest unit of

mass that can be read without estimation over the given range of measurement either directly or by use of a vernier or micrometer.

3.1.16 *readability type II*—the value of the smallest unit of mass that can be read *with* estimation over the given range of measurement.

3.1.17 *readability type III*—the value of the smallest unit of mass that can be read while the balance is in use, but not smaller than readability Type I.

NOTE 6—Readability Type III refers to the smallest unit of mass that can be read when in-service conditions such as draft, vibration, and other environmental conditions affect the balance.

3.1.18 *repeatability type I*—the degree of agreement between the indications of a balance for repeated determinations of the same mass under essentially the same conditions. The degree of agreement (qualitatively).

3.1.19 *repeatability type II*—see *precision*.

3.1.20 *reproducibility*—see *precision*.

3.1.21 *scale*—see *balance*.

NOTE 7—The term scale usually refers to instruments intended for commercial or industrial applications, and when so used, usually implies an instrument of lesser performance than a balance.

3.1.22 *sensitivity*—the ratio of the deflection (ΔL) of the balance indicator or self-indicating display to the load (ΔM) causing the deflection; $S = \Delta L / \Delta M$ at a given load.

NOTE 8—Values for sensitivity are sometimes seen expressed in terms of mass units. When used in this way in reference to a nonself-indicating balance, sensitivity refers to the reciprocal of sensitivity or the change in mass required to change the position of equilibrium (rest point) a specified amount, usually one division on the balance indicator. When used in reference to self-indicating balances, it refers to the change in mass required to change the indication by one scale division.

3.1.23 *standard mass*—an object of specified mass and construction used with balances, and for the verification of balances and other masses.

3.1.24 *taring range*—a range within which it is possible to reset the display to zero by means of the tare device.

3.1.25 *tolerance*—a value fixing the limit of allowable error or departure from true performance or value.

NOTE 9—For additional terms used in this specification related to balances and standard masses, see NIST Handbook 44 or OIML IR No. 3.

4. Significance and Use

4.1 This specification provides those writing and using test standards related to soil, rock, and related construction materials, with a means for determining the balance capabilities required for a particular test method and for describing the balance selected in a uniform fashion.

4.2 This specification provides agencies conducting soil, rock, and related construction materials, testing with guidance for selecting and evaluating general purpose balances and standard masses.

4.3 This specification provides inspection organizations with criteria for evaluating general purpose balances and standard masses.

5. Requirements for General-Purpose Balances

5.1 General-purpose balances shall be judged accurate for a