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# Standard Specification Guide for Evaluating, Selecting, and Specifying Balances and Scales Standard Masses for Use in Soil, Rock, and Construction Materials Testing<sup>1</sup>

This standard is issued under the fixed designation D4753; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

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

1.2 This ~~specification guide~~ 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 guide~~ does not include requirements for balances and scales ~~that have having~~ accuracies greater than those generally required in ~~normal testing~~ soil, rock, and related construction materials ~~or for research programs or specialized testing requirements~~.

1.5 This ~~specification guide~~ does not apply to nongraduated balances.

1.6 This ~~specification guide~~ 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 guide~~ 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-~~guides 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. 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 standard “standard weight(s)” when referring to a piece of material of known specified mass used to compare or measure the mass of other masses.

1.8 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education or experience and should be used in conjunction with professional judgement. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged nor should this document be applied without consideration of a project’s many unique aspects. The word “Standard” in the title of this document means only that the document has been approved through the ASTM consensus process.*

## 2. Referenced Documents

2.1 ~~ASTM Standards:~~ ASTM Standards:<sup>2</sup>

D653 Terminology Relating to Soil, Rock, and Contained Fluids

E617 Specification for Laboratory Weights and Precision Mass Standards

2.2 *National Institute of Standards and Technology Documents:*

<sup>1</sup> This ~~specification guide~~ is under the jurisdiction of ASTM Committee ~~D-18~~D18 on Soil and Rock and is the direct responsibility of Subcommittee ~~D18.91~~D18.91 on Standards Development and Review.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards*, Vol 14.02, volume information, refer to the standard’s Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

NIST Handbook 44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices  
~~NIST Handbook 105-1 Specifications and Tolerances for Reference Standards and Field Standard Weights and Measures~~<sup>3,3</sup>

2.3 *International Organization for Legal Metrology (OIML):*

International Recommendation No. 20 Weights of Accuracy Classes E<sub>1</sub>, E<sub>2</sub>, F<sub>1</sub>, F<sub>2</sub>, M<sub>1</sub> from 50 kg to 1 mg<sup>4</sup>

International Recommendation No. 3<sup>4</sup>

### 3. Terminology

~~3.1~~

3.1 Definitions: For definitions of terms used in this guide refer to Terminology D653.

3.2 Definitions of Terms Specific to This Standard:

~~3.1.1~~

3.2.1 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~~

3.2.2 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~~

3.2.2.1 Discussion—In this guide and in common usage, the terms balance and scale are used interchangeably. The term balance is more often used in scientific fields of application. 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.

3.2.3 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~~

3.2.4 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 mass already on the balance; and (2) taking the difference between the change in the indication determined and the known value of the mass.

~~3.1.5~~

3.2.5 basic tolerance—~~basic tolerances are those tolerances—~~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~~3.2.6 capacity—of a balance, the maximum load mass recommended by the manufacturer, disregarding any additional capability supplied by a taring device.

~~3.1.7~~3.2.7 general-purpose balance—any balance used to make a general purpose determination of mass. See *general-purpose determination of mass*. <https://standards.iteh.ai/catalog/standards/sist/b22667c-4821-43e9-9280-8be356234630/astm-d4753-07>

~~3.1.8~~

3.2.8 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~~3.2.9 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~~

3.2.10 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—the difference between successive measurements of a standard mass when the standard mass is measured after a cycle of adding, and then removing (or removing, then adding) mass from the balance.

3.2.11 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 mass.

3.2.11.1 Discussion—Linearity implies that the deviation from the true values are a continuous function of the applied load mass. Thus, obtaining enough values of the true applied load mass versus balance reading to establish a relation between applied load mass and output should give the error that will occur at any applied load mass. Linearity, then, is a statement about

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

<sup>3</sup> Available from National Institute of Standards and Technology (NIST), 100 Bureau Dr., Stop 1070, Gaithersburg, MD 20899-1070, <http://www.nist.gov>.

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

<sup>4</sup> Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

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/measurements within a particular range of use.

~~3.1.123.2.12~~ 3.2.12 *nongraduated balance*—balances not fitted with a scale numbered in units of mass.

~~3.1.13~~

3.2.13 *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

3.2.13.1 *Discussion*—The test for off-center error is called the shift test, or off-center-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.

~~3.1.143.2.14~~ 3.2.14 *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, mass determinations, or as a function of the range of several ~~determinations of mass~~. mass determinations. See *repeatability type II, reproducibility*.

~~3.1.15~~

3.2.15 *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~~

3.2.16 *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~~

3.2.17 *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~~ 3.2.18 *the value of the smallest unit of mass that can be read when in-service conditions such as draft, vibration, and other environmental conditions affect the balance while the balance is in use, but not smaller than readability Type I.*

3.2.18 *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~~

3.2.19 *repeatability type II*—see ~~precision~~ precision of a balance.

~~3.1.20~~

3.2.20 *reproducibility*—see ~~precision~~ precision of a balance.

~~3.1.21~~

3.2.21 *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~~

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

~~Note 8~~—~~Values 3~~—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.

~~3.1.233.2.23~~ 3.2.23 *standard mass*—an object of specified mass and construction used with balances, and for the verification of balances and other masses.

~~3.1.24~~

3.2.24 *taring range*—a range within which it is possible to reset the indicator or display to zero by ~~means~~ use of the tare device.

~~3.1.253.2.25~~ 3.2.25 *tolerance*—a value fixing the limit of allowable error or departure from true performance or value.

~~Note 9~~—For 4—For additional terms used in this specification/guide 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.