Designation: E617 – 23

Standard Specification for Laboratory Weights and Precision Mass Standards[1]

This standard is issued under the fixed designation E617; 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.

1. Scope

1.1 This specification covers weights and mass standards used in laboratories, specifically classes 000, 00, 0, 1, 2, 3, 4, 5, 6, and 7. This specification replaces National Bureau of Standards Circular 547, Section 1, which is out of print.

1.2 This specification and calibration method is intended for use by weight manufacturers, national metrology institutes, weight calibration laboratories, accreditation bodies, users of weights, and regulatory bodies.

1.3 This specification contains the principal physical characteristics and metrological requirements for weights that are used.

1.3.1 For the verification of weighing instruments;

1.3.2 For the calibration of weights of a lower class of accuracy; and

1.3.3 With weighing instruments.

1.4 Maximum Permissible Errors (formerly tolerances) and design restrictions for each class are described in order that both individual weights or sets of weights can be chosen for appropriate applications.

1.5 Weight manufacturers must be able to provide evidence that all new weights comply with specifications in this standard (for example, material, density, magnetism, surface finish, mass values, uncertainties) to make any claim of compliance to Specification E617, Maximum Permissible Errors, weight classes, or metrological traceability.

1.5.1 During subsequent calibrations, calibration laboratories must meet the requirements of ISO/IEC 17025:2017.

1.5.2 Subsequent calibrations must meet all the requirements, including Sections 7, 8, and 9, Table 8 and Table 11 (environmental parameters) to make any claim of compliance to Specification E617, Maximum Permissible Errors, weight classes, or metrological traceability.

NOTE 1—Requirements set forth in NIST IR 6969 and NIST IR 5672 are compliant with all the requirements of Specification E617, Sections 7, 8, and 9.

1.6 The values stated in SI units are to be regarded as standard.

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ISO Standards:*[2]

ISO/IEC 17025:2017 General Requirements for the Competence of Testing and Calibration Laboratories

2.2 *NIST Standards:*[3]

NIST Handbook 143 State Weights and Measures Laboratories Program Handbook (2019)

NIST SP 811 Guide for the Use of the International System of Unit (SI) 2008 Edition

NIST SP 1038 The International System of Units (SI) – Conversion Factors for General Use (May 2006)

NISTIR 5672 Advanced Mass Calibration and Measurement Assurance Program for State Calibration Laboratories (2019)

NISTIR 6969 Selected Laboratory and Measurement Practices to Support Basic Mass Calibrations (2019)

NIST Technical Note 1297 Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results (1994)

2.3 *OIML Standards:*[4]

OIML D 28 Conventional Value of the Result of Weighing in Air (2004)

OIML R 111–1 Weights of classes E1, E2, F1, F2, M1, M1–2, M2, M2–3 and M3 Part 1: Metrological and Technical Requirements (Edition 2004)

[1] This specification is under the jurisdiction of ASTM Committee E41 on Laboratory Apparatusand is the direct responsibility of Subcommittee E41.06 on Laboratory Instruments and Equipment.

Current edition approved Aug. 15, 2023. Published November 2023. Originally approved in 1978. Last previous edition approved in 2018 as E617 – 18. DOI: 10.1520/E0617-23.

[2] Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, http://www.iso.org.

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

[4] Available from Organisation Internationale de Metrologie Legale, 11 Rue Turgot, 75009 Paris, France, http://www.oiml.org.

2.4 *BIPM Standards:*[5]

VIM: JCGM 200:2012 International Vocabulary of Metrology–Basic and General Concepts and Associated Terms

GUM: JCGM 100:2008 Evaluation of Measurement Data–Guide to the Expression of Uncertainty in Measurement

SI Brochure: 2019 The International System of Units (SI), 9th Edition

2.5 *EURAMET Standards:*[6]

EURAMET/cg-18/V. 4.0 Guidelines on the Calibration of Non-Automatic Weighing Instruments (2015)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *accuracy class of weights*—a class of weights that meets certain metrological requirements intended to keep the errors within specified limits.

3.1.2 *balance*—instrument indicating apparent mass that is sensitive to the following forces:

$F_g = m \cdot g$	Force due to gravity
$F_b = v \cdot \rho_a \cdot g = \frac{m}{\rho} \rho_a \cdot g$	Air buoyancy equal to the weight of the displaced air.
$F_z = \mu_o \int\int\int_v (M + \chi H) \frac{\partial H}{\partial Z} dV$	Vertical component of the magnetic interaction between the weight and the balance or the environment, or both.

H and M are vectors; z is the vertical cartesian coordinate. If magnetic effects are negligible, that is, the permanent magnetization (M) of the weight and the magnetic susceptibility (χ) are sufficiently small, and the balance is calibrated with reference weights of well-known mass, the balance can be used to indicate the conventional mass, m_c, of a body under conventionally chosen conditions.

3.1.3 *calibration (of weights)*—the acts of determining the mass difference between a standard of known mass value and an "unknown" test weight or set of weights, establishing the mass value and conventional mass value of the "unknown," and of determining a quantitative estimate of the uncertainty to be assigned to the stated mass or conventional mass value of the "unknown," or both, and providing metrological traceability to the "unknown."

3.1.3.1 *calibration (generally)*—set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards.

3.1.4 *calibration certificate*—certificate issued by calibration laboratories to document the results of a calibration.

3.1.5 *conventional mass*—conventional value of the result of weighing in air, in accordance to International Recommendation OIML D 28. For a weight taken at 20 °C, the conventional mass is the mass of a reference weight of a density of 8000 kg m^{-3} which it balances in air of density of 1.2 kg m^{-3}.

3.1.6 *correction*—mass values are traditionally expressed by two numbers, one being the nominal mass of the weight, and the second being a correction. The mass of the weight is the assigned nominal value plus the assigned correction. Positive corrections indicate that the weight embodies more mass than is indicated by the assigned nominal value. Negative corrections indicate that the weight embodies less mass than is indicated by the assigned nominal value. The correction is equivalent to the "error."

3.1.7 *kilogram*—the SI base unit of mass. Formerly the international prototype kilogram (IPK), the platinum-iridium cylinder maintained at the International Bureau of Weights and Measures (BIPM) in Sèvres, France, was internationally accepted as having a defined mass of 1 kg. In 2018 the kilogram was redefined in terms of the Planck constant h (taken to be 6.626 070 15 × 10^{-34} kg m^2 s^{-1}) where the mass of primary mass standards may be determined by any primary method such as those described in the mise en pratique for the definition of the kilogram in the BIPM SI Brochure. The redefinition process ensured continuity of mass measurements before and after redefinition such that all mass values traceable to the IPK remained the same when the new definition came into effect, but the uncertainties of these mass values were increased by the relative standard uncertainty of the IPK immediately after the redefinition (1.0 × 10^{-8}).

3.1.8 *magnetism*—effect that generates an attractive or repulsive force without the presence of charged species.

3.1.8.1 *(volume) magnetic susceptibility (χ)*—measure of the ability of a medium to modify a magnetic field. It is related to the magnetic permeability (μ) by the relation: $\mu/\mu_0 = 1 + \chi$. The quantity μ/μ_0 is sometimes referred to as the relative permeability, μ_r.

3.1.8.2 *(permanent) magnetization (M)*—parameter that specifies a magnetic state of material bodies such as weights, in the absence of an external magnetic field (most generally, magnetization is a vector whose magnitude and direction are not necessarily constant within the material). The magnetization of a body generates an inhomogeneous magnetic field in space and thus may produce magnetic forces on other materials.

3.1.9 *mass*—physical quantity, which can be ascribed to any material object and which gives a measure of its quantity of matter. The unit of mass is the kilogram.

3.1.10 *maximum permissible errors*—the maximum amount by which the sum of the conventional mass correction of the weight, and its associated uncertainty is allowed to deviate from the assigned nominal value.

3.1.11 *metrological traceability*—property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. Metrological

[5] Available from Bureau International des Poids et Mesures (BIPM), Pavilion de Breteuil, F-92312, Sèvres Cedex, France, http://www.bipm.org.

[6] Available from Euramet, Bundesallee 100, 38116 Braunschweig, Germany, http://www.euramet.org.