Designation: E 617 – 97 (Reapproved 2003)

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

This standard is issued under the fixed designation E 617; 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 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 further recognizes that International Recommendation R111 exists, that describes classes E1, E2, F1, F2, M1, M2 and M3. Users may choose to reference either R111 or this specification, depending on requirements.

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 verification of weights of a lower class of accuracy; and

1.3.3 With weighing instruments.

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

2. Referenced Documents

2.1 *ASTM Standards:*

B 46.1-1995 Surface Texture (Surface Roughness, Waviness, and Lay) an American National Standard[2]

2.2 *ISO Standards:*

International Vocabulary of Basic and General Terms in Metrology 1993, VIM, Geneve, Switzerland[3]

Guide to the Expression of Uncertainty in Measurement[3]

ISO/DIS 4287-1, Edition 01-Jun-95, Geometric Product Specification (GPS), Determination of Surface Texture by Profiling Methods, Part 1: Terms, Definitions and Parameters[3]

2.3 *NCSL Standards:*

NCSL Glossary of Metrology—Related Terms[4]

NCSL Recommended Practice-12 Determining and Reporting Measurement Uncertainties[4]

ANSI/NCSL-Z540-1-1994 American National Standard for Calibration-Calibration Laboratories and Measuring and Test Equipment General Requirements[4]

2.4 *NIST Standards:*

NIST NVLAP Draft Handbook 150-2 National Voluntary Laboratory Accreditation Program Calibration Laboratories Technical Guide[5]

NIST NVLAP Handbook 150 National Voluntary Laboratory Accreditation Program (NVLAP), NIST Handbook 150, Procedures and General Requirements[5]

NIST Technical Note 1297 (1994) Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results[5]

2.5 *OIML Standard:*

OIML Recommendation 33 Conventional Value of the Result of Weighing in Air[6]

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.[7]

3.1.2 *calibration*—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

[1] This specification is under the jurisdiction of ASTM Committee E41 on Laboratory Apparatus, and is the direct responsibility of Subcommittee E41.06 on Weighing Devices.

Current edition approved Nov. 10, 1997. Published March 1998. Originally published as E 617 – 78. Last previous edition E 617 – 91.

[2] Available from ASME Service Center, 22 Law Drive, PO Box 2900, Fairfield, New Jersey 07007-2900.

[3] Available from American National Standards Institute, 11 West 42nd Street, New York, New York 10036.

[4] Available from NCSL, National Conference of Standards Laboratories, 1800 30th Street, Suite 305B, Boulder, Colorado 80301.

[5] Available from NIST/NVLAP, National Voluntary Laboratory Accreditation Program, NIST, Gaithersburg, Maryland 20899. HB 150 available on-line: http://ts.nist.gov/nvlap and Technical Note 1297 available on-line: http://physics.nist.gov/Pubs/guidelines/outline.html.

[6] Available from Organisation Internationale de Metrologie Legale, 11 Rue Turgot, 75009 Paris, France.

[7] Definition from OIML R111.

assigned to the stated mass or conventional mass value of the "unknown", or both. 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.[8]

3.1.3 *certificate of tolerance test*—document that certifies that the subject weights are within specified tolerances.

3.1.3.1 *Discussion*—If traceability is claimed, some level of uncertainty must be addressed.

3.1.4 *certificate or report of calibration*—document that presents calibration results and other information relevant to a calibration.[9]

3.1.5 *conventional mass*—conventional value of the result of weighing in air, in accordance to International Recommendation OIML R 33. 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.[10]

3.1.5.1 *Discussion*—Formerly known as apparent mass versus 8.0 g/cm^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.

3.1.7 *international prototype kilogram*—the platinum-iridium cylinder maintained at the International Bureau of Weights and Measures (BIPM), at Sevres, France with an internationally accepted defined mass of 1 kg.

3.1.8 *reference standard*—a standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.[11]

3.1.9 *set of weights*—a series of weights, usually presented in a case so arranged to make possible any weighing of all loads between the mass of the weight with the smallest nominal value and the sum of the masses of all weights of the series with a progression in which the mass of the smallest nominal value weight constitutes the smallest step of the series.[7]

3.1.10 *tolerance (adjustment tolerance or maximum permissible errors)*—the maximum amount by which the conventional mass of the weight is allowed to deviate from the assigned nominal value.

3.1.11 *tolerance test*—verification that the conventional mass of the weights and their corresponding uncertainties as tested are correct within the maximum permissible errors of the respective weight class.

3.1.12 *traceability*—property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.[8]

3.1.12.1 *Discussion*—For more information see 3.1.14.

3.1.13 *uncertainty*—parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand.[9] The range of values within which the true value is estimated to lie.

3.1.14 *U.S. National prototype standard*—platinumiridium kilogram identified as K20, maintained at the National Institute of Standards and Technology, with value assigned relative to the International Prototype Kilogram provides the United States access to the mass unit.

3.1.15 *weight (mass standard)*—a material measure of mass, regulated in regard to its physical and metrological characteristics: shape, dimension, material, surface quality, nominal value, and maximum permissible error.[7]

3.1.15.1 *Discussion*—Not to be confused with a gravitational force.

4. Maximum Permissible Errors (Tolerances)

4.1 For each weight, the expanded uncertainty U at 95 % confidence (See Annex B of OIML R 111) of the conventional mass shall be less than or equal to one-third of the maximum permissible error given in Table 1.

4.1.1 For each weight, the conventional mass, m_c (determined with an expanded uncertainty), shall not differ by more than the difference: maximum permissible error δm minus expanded uncertainty, from the nominal value of the weight, m_o:

$$m_o - (\delta m - U) \leq (m_c) \leq m_o + (\delta m - U) \quad (1)$$

4.2 Maximum permissible errors (tolerances) on verification for classes 0, 1, 2, 3, 4, 5, 6 and 7 are given in Table 1. These maximum permissible errors are related to conventional mass values.

NOTE 1—Consistent with OIML R 111 the concept of group tolerances has been dropped in the 1997 revision of this specification.

NOTE 2—Tolerances for weights of denominations intermediate between those listed can be determined as follows. If the unit of measure is non-metric use the conversion factor from the Abbreviations of Terms table in Appendix X3 to convert the nominal value to a metric unit. For weights that are intermediate between those listed, the tolerance for the next lower weight shall be applied.

NOTE 3—Class 0 is a new designation with tolerances that are 50 % of Class 1, with physical characteristics the same as those of OIML R 111 Class E1.

NOTE 4—Class 7 is a new designation with the same tolerances as the former Class T in NBS Circular 3 (out of print).

5. Physical Characteristics

5.1 *Construction*:

5.1.1 *Type*—Weights are divided into two types based upon the design:

5.1.1.1 *Type I*—These weights are of one-piece construction and contain no added adjusting material. They must be specified when weights are to be used as standards for the calibration of weights of Classes 0, 1, 2 and 3, and where maximum stability is required. A precise measurement of density can only be made for one-piece weights.

5.1.1.2 *Type II*—Weights of this type can be of any appropriate design such as screw knob, ring, or sealed plug. Adjusting material can be used as long as it is of a material at

[8] Definition from International Vocabulary of Basic and General Terms in Metrology.

[9] Definition from NCSL Z-540-1-1994.

[10] Definition from OIML R33.

[11] Definition from NIST/NVLAP Handbook 150.

TABLE 1 Maximum Tolerances

Denomination	ASTM Tolerance Table ±mg except as noted							
	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7
5000 kg	...	...	...	...	100 g	250 g	500 g	750 g
3000 kg	...	...	...	...	60 g	150 g	300 g	450 g
2000 kg	...	...	...	...	40 g	100 g	200 g	300 g
1000 kg	...	...	...	...	20 g	50 g	100 g	150 g
500 kg	...	...	...	...	10 g	25 g	50 g	75 g
300 kg	...	...	...	...	6.0 g	15 g	30 g	45 g
200 kg	...	...	...	...	4.0 g	10 g	20 g	30 g
100 kg	...	...	...	...	2.0 g	5 g	10 g	15 g
50 kg	63	125	250	500	1.0 g	2.5 g	5 g	7.5 g
30 kg	38	75	150	300	600 mg	1.5 g	3 g	4.5 g
25 kg	31	62	125	250	500	1.2 g	2.5 g	4.5 g
20 kg	25	50	100	200	400	1.0 g	2 g	3.8 g
10 kg	13	25	50	100	200	500 mg	1 g	2.2 g
5 kg	6	12	25	50	100	250	500 mg	1.4 g
3 kg	3.8	7.5	15	30	60	150	300	1.0 g
2 kg	2.5	5.0	10	20	40	100	200	750 mg
1 kg	1.3	2.5	5.0	10	20	50	100	470
500 g	0.60	1.2	2.5	5.0	10	30	50	300
300 g	0.38	0.75	1.5	3.0	6.0	20	30	210
200 g	0.25	0.50	1.0	2.0	4.0	15	20	160
100 g	0.13	0.25	0.50	1.0	2.0	9	10	100
50 g	0.060	0.12	0.25	0.60	1.2	5.6	7	...
30 g	0.037	0.074	0.15	0.45	0.90	4.0	5	44
20 g	0.037	0.074	0.10	0.35	0.70	3.0	3	33
10 g	0.025	0.050	0.074	0.25	0.50	2.0	2	21
5 g	0.017	0.034	0.054	0.18	0.36	1.3	2	13
3 g	0.017	0.034	0.054	0.15	0.30	0.95	2.0	9.4
2 g	0.017	0.034	0.054	0.13	0.26	0.75	2.0	7.0
1 g	0.017	0.034	0.054	0.10	0.20	0.50	2.0	4.5
500 mg	0.005	0.010	0.025	0.080	0.16	0.38	1.0	3.0
300 mg	0.005	0.010	0.025	0.070	0.14	0.30	1.0	2.2
200 mg	0.005	0.010	0.025	0.060	0.12	0.26	1.0	1.8
100 mg	0.005	0.010	0.025	0.050	0.10	0.20	1.0	1.2
50 mg	0.005	0.010	0.014	0.042	0.085	0.16	0.50	0.88
30 mg	0.005	0.010	0.014	0.038	0.075	0.14	0.50	0.68
20 mg	0.005	0.010	0.014	0.035	0.070	0.12	0.50	0.56
10 mg	0.005	0.010	0.014	0.030	0.060	0.10	0.50	0.4
5 mg	0.005	0.010	0.014	0.028	0.055	0.080	0.20	...
3 mg	0.005	0.010	0.014	0.026	0.052	0.070	0.20	...
2 mg	0.005	0.010	0.014	0.025	0.050	0.060	0.20	...
1 mg	0.005	0.010	0.014	0.025	0.050	0.050	0.10	...

least as stable as the base material and is contained in such a way that it will not become separated from the weight.

5.1.2 Class 0 must be Type I, one piece construction.

5.1.3 Class 1, 2, 3, 4, 5, 6 and 7 can be either Type I or Type II depending on the application.

5.2 *Design*—A weight may have any shape that does not introduce features that reduce the reliability. All weights shall be free of ragged or sharp edges or ends. Both sheet metal and wire weights shall be free of cracks such as may be formed from bending.

5.3 *Surface Area*—For classes 0, 1, 2, 3 and 4 the surface area is not to exceed twice the area of a cylinder of equal height and diameter for weights 1 g and above. Sheet metal weights or wire weights may be used below 1 g.

5.4 *Material*:

5.4.1 *Class 0, 1, 2 and 3 Weights*—The hardness of this material and its resistance to wear and corrosion shall be similar to or better than that of austenitic stainless steel.

5.4.2 *Class 4, 5, 6 and 7*—The hardness and brittleness of the materials used for weights of Classes 4, 5, 6, and 7 shall be at least equal to that of drawn brass.

5.5 *Magnetism*—Weights shall not exceed maximum permissible magnetic properties as listed in Table 2 for any portion of the weight:

NOTE 5—Cast iron cannot have a susceptibility specification of any real value.

NOTE 6—The measurement method is incorporated from OIML R 111-2 (8th draft) in section A5.3.2, Susceptometer.

5.6 *Density*—Because of the effect of the buoyant force of air on a weight, precision measurements of mass require that the volume of the weight be known, as well as the density of the air in which it is being measured, so that appropriate corrections can be made. For weights of higher precision, the

TABLE 2 Magnetic Properties

Class	Volume Magnetic Susceptibility (χ)	Maximum Magnetic Field	
		μT	mG
0	0.01	2.0	20
1	0.03	4.0	40
2, 3, 4	0.05	6.0	60
5, 6, 7	[A]	[A]	[A]

[A] Requirements for these classes have not been developed.