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Standard Specification for Pharmaceutical Glass Graduates[1]

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1. Scope

1.1 This specification covers glass graduates suitable for laboratory, pharmaceutical, and other uses, in both conical and cylindrical shapes.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E438 Specification for Glasses in Laboratory Apparatus

E671 Specification for Maximum Permissible Thermal Residual Stress in Annealed Glass Laboratory Apparatus

E694 Specification for Laboratory Glass Volumetric Apparatus

E920 Specification for Commercially Packaged Laboratory Apparatus

E921 Specification for Export Packaged Laboratory Apparatus

E1133 Practice for Performance Testing of Packaged Laboratory Apparatus for United States Government Procurements

E1157 Specification for Sampling and Testing of Reusable Laboratory Glassware

2.2 *Other Document:*

NIST Handbook 44, Section 4.44 Graduates[3]

3. Classification

3.1 Graduates shall be in the following types and sizes:

3.1.1 *Type 1*—Graduated in metric scale only.

3.1.1.1 *Sizes*—5, 10, 25, 50, 100, 250, 500, and 1000 mL.

3.1.2 *Type 2*—Graduated in both metric and inch-pound scales.

3.1.2.1 *Sizes*—5 mL and 60 minims, 10 mL and 120 minims, 15 mL and 4 fluid drams, 25 mL and 8 fluid drams, 50 mL and 2 fluid oz, 100 mL and 4 fluid oz, 250 mL and 8 fluid oz, 500 mL and 16 fluid oz, and 1000 mL and 32 fluid oz.

NOTE 1—The term millilitre (mL) is commonly used as a special name for the cubic centimetre (cm^3) in accordance with the International System of Units (SI). (The inch-pound fluid ounce is equivalent to 29.5735 mL, hence, the fluid dram is equivalent to 3.6967 mL and the minim is equivalent to 0.0616 mL).

4. Material and Annealing

4.1 Graduates shall be made of borosilicate glass conforming to the requirements of Type 1, Class A of Specification E438.

4.2 Maximum residual thermal stress shall be such as to conform to Specification E671.

5. Design

5.1 *Style*—Graduates having a capacity of more than 15 mL (4 fluid drams) may be either conical or cylindrical. Those having a capacity of 15 mL or less shall be cylindrical.

5.2 *Dimensions*—The inside measurement from the bottom of the graduate to the top capacity graduation shall be not less than five times the inside diameter on a cylindrical graduate and two times on a conical graduate. The inside measurement from the bottom of the graduate to the point representing one fourth of the capacity shall not be less than the inside diameter at that point.

5.3 *Pour-Out Spout*—All graduates shall have a pour-out spout that ensures delivery of an unbroken stream of liquid without wetting the outside wall of the graduate.

5.4 *Base*—The base shall be perpendicular to the vertical axis of the graduate. The base shall be large enough so that the empty graduate will stand on a surface 15° from the horizontal.

6. Graduations

6.1 Each graduate shall have clear graduation markings perpendicular to the vertical axis of the graduate and parallel to each other. They shall conform to the requirements of Specification E694.

6.1.1 No graduation line shall extend less than one fourth the circumference of the graduate. Graduates shall have an initial interval that is not subdivided, equal to not less than one fifth and not more than one fourth of the capacity of the graduate. Except for this interval, the values of all graduated

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[2] 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* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from National Institute of Standards and Technology (NIST), Gaithersburg, MD 20899.

intervals shall be the same. Each main graduation line shall be marked to indicate its value; intermediate lines shall not be marked. Numerals shall be uniformly positioned, either directly upon or immediately above the graduation line to which they refer. Numerals shall be set in from the ends of the lines a sufficient distance to permit the line ends to be used in making a meniscus setting.

6.1.2 Type 1 graduates shall have main graduation lines that encircle the graduate at least 90 %. Intermediate lines shall extend at least 50 % of the circumference of the graduate.

6.1.3 Type 2 graduates (double scale) shall have a clear space between the ends of the main graduation lines of the two scales. This space shall be approximately 90 % removed from the pour-out spout of the graduate and shall comply to the requirements of Table 1.

6.2 *Graduation Marking Details:*

6.2.1 Capacities, graduation ranges, values of graduated intervals, and numbered graduations applicable to single-scale graduates and to appropriate portions of double-scale graduates, are shown in Table 2.

6.2.2 *Permanency of Markings*—Graduation markings shall be permanent and legible. They shall be applied by etching and filling with a permanent pigment, by firing a ceramic enamel into the glass without etching, or by applying a stain and firing into the glass without etching.

6.3 Tolerances shall be as shown in Table 3 and in accordance with Table 3 of Section 4.44 of NIST Handbook 44. Pharmaceutical graduates are calibrated "to deliver" and at 20°C. The tolerance applicable at a specific graduation line is determined by the inside diameter of the graduate at the point in question.

7. Markings

7.1 Each graduate shall be permanently marked with the name or trademark, or both, of the manufacturer; the letters "TD" or "EX," or both; the calibration temperature, 20°C; and the units of capacity, such as mL for Type 1 graduates, and mL and minims, fluid drams or fluid oz, for Type 2 graduates.

TABLE 1 Space Between Ends at Main Graduations on Double-Scale Graduates

Inside Diameter at Graduation Line	Space Between Ends
Less than 40 mm	3 to 6 mm
40 to 80 mm	6 to 13 mm
Over 80 mm	10 to 16 mm

TABLE 2 Graduation Line Details Double-Scale Graduates

Capacity	Least Graduation Line	Subdivision	Numbers at Each Even
5 mL	1.0 mL	0.5 mL	1 mL
10 mL	2.0 mL	1.0 mL	2 mL
25 mL	5.0 mL	5.0 mL	5 mL
50 mL	10.0 mL	5.0 mL	10 mL
100 mL	20.0 mL	10.0 mL	20 mL
250 mL	50.0 mL	25.0 mL	50 mL
500 mL	100.0 mL	25.0 mL	50 mL
1000 mL	200.0 mL	50.0 mL	100 mL
60 minims	15.0 minims	5.0 minims	10 minims[A]
120 minims	30.0 minims	10.0 minims	20 minims[B]
4 fluid drams	1.0 fluid drams	0.5 fluid drams	1 fluid dram
8 fluid drams	2.0 fluid drams	1.0 fluid drams	2 fluid drams
2 fluid oz	0.5 fluid oz	0.25 fluid oz	0.5 fluid oz
4 fluid oz	1.0 fluid oz	0.5 fluid oz	1 fluid oz
8 fluid oz	2.0 fluid oz	0.5 fluid oz	1 fluid oz
16 fluid oz	4.0 fluid oz	1.0 fluid oz	2 fluid oz
32 fluid oz	8.0 fluid oz	2.0 fluid oz	4 fluid oz

[A]Also at the first 15-minim graduation.
[B]Also at the first 30-minim graduation.

TABLE 3 Maintenance and Acceptance Tolerances, in Excess and in Deficiency, for Graduates

Inside Diameter of Graduate					
From	To But Not Including	Tolerance	From	To But Not Including	Tolerance
millimetres		milliliters	in.		minims
0	16	0.1	0	9/16	2
16	21	0.2	9/16	13/16	3
21	26	0.4	13/16	1 1/16	6
26	31	0.6	1 1/16	1 5/16	10
31	36	0.8	1 5/16	1 9/16	15
36	41	1.1	1 9/16	1 13/16	20
41	46	1.4	1 13/16	2 1/16	30
46	51	1.8	2 1/16	2 5/16	40
51	56	2.2	2 5/16	2 9/16	50
56	61	2.8	2 9/16	2 13/16	65
61	66	3.4	2 13/16	3 1/16	80
66	71	4.1	3 1/16	3 5/16	95
71	76	4.8	3 5/16	3 9/16	110
76	81	5.6	3 9/16	3 13/16	130
81	86	6.4	3 9/16	4 1/16	150
86	91	7.2			
91	96	8.1			
96	101	9.0			

8. Sampling

8.1 For sampling and testing, refer to Specification E1157.

9. Packaging

9.1 Select from Specifications E920, E921, and E1133.

10. Keywords

10.1 glass; graduate; pharmaceutical