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Section 4.44. Graduates

A. Application

A.1. General. – This code applies to subdivided glass measures of capacity, either cylindrical or conical in shape.

A.2. Additional Code Requirements. – In addition to the requirements of this code, Graduates shall meet the requirements of Section 1.10. General Code.

S. Specifications

S.1. Units. – Nominal capacities, graduation ranges, values of graduated intervals, and numbered graduations applicable to single-scale graduates and to the appropriate portions of double scale graduates shall be as shown in Table 1. Design Details for Graduates.

Table 1. Design Details for Graduates				
Nominal Capacity	To be Graduated Between		Value of Graduated Intervals	Number at Each Graduation Divisible by
milliliters	milliliters		milliliters	milliliters
5	1 and	5	$\frac{1}{2}$	1
10	2 and	10	1	2
25	5 and	25	5	5
50	10 and	50	5	10
100	20 and	100	10	20
500	100 and	500	25	50
1000	200 and	1000	50	100
minims	minims		minims	minims
60	15 and	60	5	10 ^a
120	30 and	120	10	20 ^b
fluid drams	fluid drams		fluid drams	fluid drams
4	1 and	4	$\frac{1}{2}$	1
8	2 and	8	1	2
fluid ounces	fluid ounces		fluid ounces	fluid ounces
2	$\frac{1}{2}$ and	2	$\frac{1}{4}$	$\frac{1}{2}$
4	1 and	4	$\frac{1}{2}$	1
8	2 and	8	$\frac{1}{2}$	1
16	4 and	16	1	2
32	8 and	32	2	4
^a And, in addition, at the first (15-minim) graduation. ^b And, in addition, at the first (30-minim) graduation.				

S.2. Initial Interval. – A graduate 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.

S.3. Shape. – A graduate of a capacity of more than 15 mL (4 fl dr) may be of either the cylindrical or circular conical type. A graduate of a capacity of 15 mL (4 fl dr) or less shall be of the single-scale cylindrical type.

S.4. Material. – A graduate shall be made of good-quality, thoroughly annealed, clear, transparent glass, free from bubbles and streaks that might affect the accuracy of measurement. The glass shall be uniform in thickness and shall not be excessively thick.

S.5. Dimensional Proportions.

S.5.1. On a Circular Conical Graduate. – The inside measurement from the bottom of a circular conical graduate to the capacity graduation shall be not less than two times the inside diameter at the capacity graduation. The inside measurement from the bottom of the graduate to the point representing one-fourth of the capacity shall be not less than the inside diameter at that point.

S.5.2. On a Cylindrical Graduate. – The inside measurement from the bottom of a cylindrical graduate to the capacity graduation shall be not less than five times the inside diameter at the capacity graduation.

S.6. Base. – The base of the graduate shall be perpendicular to the vertical axis of the graduate. The diameter of the base shall be of such size that the empty graduate will remain standing on an inclined surface of 25 %, or approximately 15 degrees, from the horizontal.

S.7. Design of Graduations.

S.7.1. General. – Graduations shall be perpendicular to the vertical axis of the graduate and parallel to each other. Graduations shall be continuous, of uniform thickness not greater than 0.4 mm (0.015 in), clearly visible, permanent, and indelible under normal conditions of use.

(Amended 1977)

S.7.2. On a Single-Scale Graduate. – On a single-scale graduate, the main graduations shall completely encircle the graduate and subordinate graduations shall extend at least one-half the distance around the graduate.

S.7.3. On a Double-Scale or a Duplex Graduate. – On a double-scale or duplex graduate, there shall be a clear space between the ends of the main graduations on the two scales, and this space shall be approximately 90 degrees from the lip of the graduate and shall conform to the requirements of Table 2. Clear Space Between Ends of Main Graduations on Double Scale Graduates.

Table 2. Clear Space Between Ends of Main Graduations on Double Scale Graduates	
Inside Diameter of Graduate at the Graduations (inches)	Clear Space Between Ends of Main Graduations (inch)
Less than 1.5	$\frac{1}{8}$ to $\frac{1}{4}$
1.5 to 3, inclusive	$\frac{1}{4}$ to $\frac{1}{2}$
Over 3	$\frac{3}{8}$ to $\frac{5}{8}$

S.8. Basis of Graduation. – A graduate shall be graduated “to deliver” when the temperature of the graduate is 20 °C (68 °F), and shall be marked accordingly in a permanent and conspicuous manner.

S.9. Marking Requirements. – Each main graduation shall be marked to show its value. Intermediate graduations shall not be marked. Value figures shall be uniformly positioned either directly upon or immediately above the graduations to which they refer. Figures placed upon graduations shall be set in from the ends of the graduations a sufficient distance to allow the ends of the graduations to be used in making a setting.

N. Notes

N.1. Test Liquid. – Water shall be used as the test liquid for graduates.

N.2. Temperature Control. – During the test of a graduate, appropriate precautions shall be exercised to reduce any detrimental temperature effects to the practicable minimum.

T. Tolerances

T.1. – Maintenance and acceptance tolerances in excess and in deficiency shall be as shown in Table 3. Maintenance and Acceptance Tolerances, in Excess and Deficiency, for Graduates for graduates that are graduated “to contain” or “to deliver.” (The tolerance to be applied at any graduation is determined by the inside diameter of the graduate at the graduation in question.)

<p align="center">Table 3. Maintenance and Acceptance Tolerances, in Excess and in Deficiency, for Graduates</p>					
<p align="center">Inside Diameter of Graduate</p>		<p align="center">Tolerance</p>	<p align="center">Inside Diameter of Graduate</p>		<p align="center">Tolerance</p>
<p align="center">From</p>	<p align="center">To but Not Including</p>		<p align="center">From</p>	<p align="center">To but Not Including</p>	
<p align="center">millimeters</p>		<p align="center">milliliters</p>	<p align="center">inches</p>		<p align="center">minims</p>
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 ¹³ / ₁₆	4 ¹ / ₁₆	150
86	91	7.2			
91	96	8.1			
96	101	9.0			

(Amended 1974)

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