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**National Measurement
Institute**

NITP 4.5



National Instrument Test Procedures for
Graduated Measures

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PREFACE

On 30 June 2010 the uniform test procedures (i.e. relevant NMI V documents) were deemed to be national instrument test procedures (NITPs) for the purposes of section 18GG of the *National Measurement Act 1960* (Cth).

In 2011 the NITPs were renumbered to better align the numbers with the classes of pattern approval and servicing licensee. As a result this document (NMI V 17) became NITP 4.5.

The only changes that have been made to the latest edition of this document are it has been rebranded, renumbered, renamed and its cross-references have been updated. In all other respects it is identical with NMI V 17.

NMI's Chief Metrologist has determined that NITP 4.5 contains the test procedures for the verification of graduated measures.

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EXPLANATION OF TERMS

For explanations of other terms see *General Information for Test Procedures*.

Adjustment

Alteration of the measurement parameters to bring the instrument within the allowable MPEs for an instrument in use.

Calibration

The set of operations that (under specified conditions) establishes the relationship between the indicated or nominal value of an instrument and the corresponding known value of the measured quantity.

Certification

The examination of an instrument by a **certifier** (the holder, or an employee of the holder, of a servicing licence) in order to mark the instrument indicating that it conforms with the relevant test procedures.

- **Initial certification** is the certification of a new instrument by a certifier, which does not bear a verification or certification mark and has never been verified or certified before.
- **Subsequent certification** is any certification of an instrument by a certifier because the mark is no longer valid due to such reasons as:
 - repairs or adjustments have been made that affect metrological performance; or
 - the mark has been defaced or removed.

In-service Inspection

The examination of an instrument by an **inspector or certifier** to check that:

- the verification or certification mark is valid; and
- the errors do not exceed the MPEs permitted for in-service inspection.

In-service inspection does not permit the instrument to be marked with a verification or certification mark.

Verification

The examination of an instrument by an **inspector** in order to mark the instrument indicating that it conforms with the relevant test procedures.

- **Initial verification** is the verification of a new instrument by an inspector, which does not bear a verification or certification mark and has never been verified or certified before.
- **Subsequent verification** is any verification of an instrument by an inspector because the mark is no longer valid due to such reasons as:
 - repairs or adjustments have been made that affect metrological performance; or
 - the mark has been defaced or removed.
- **Re-verification** is the examination of an instrument by an inspector to check that:
 - the verification or certification mark is valid; and
 - the instrument has not been modified in any way since verification or certification;in order to mark the instrument indicating that it conforms with the relevant test procedures.

1. SCOPE

This document relates to graduated measuring cylinders (glass and plastic) and pharmaceutical dispensing measures as covered by general certificates of approval 4/6/0, 4/6/0/A and 4/3/0/A respectively.

NITP 4.5 refers to the test procedures for the verification, certification and in-service inspection of graduated measuring cylinders to ensure that they measure to within the maximum permissible errors specified in the National Measurement Regulations and that they meet the specifications and metrological requirements and be tested in accordance with the following Australian standards, as applicable and as amended or revised from time to time:

- AS 1952 Dispensing Measures — Pharmaceutical — Glass;
- AS 2163 Laboratory Glassware — Measuring Cylinders;
- AS 2770 Measuring Cylinders — Plastics — Graduated.

In addition, refer to the following publications which may be obtained from NMI:

- Humphries, JW (1979) *The Calibration and Verification of Volumetric Measures*, Technical Paper No 1
- Morris, EC and Fen, KMK (2002) *The Calibration of Weights and Balances*

All measures must comply with the relevant Trade Measurement Act and Regulations.

These test procedures supersede *Test Procedure No 7 Graduated Measures*, first edition, May 1990.

2. EQUIPMENT

1. Certificate of approval.
2. Publications listed above.
3. Appropriate reference standards of measurement as follows:
 - (a) For the **volumetric** method, suitable volume measures.
 - (b) For the **gravimetric** method:

- an appropriate weighing instrument;
- a suitable pipette; and
- a suitable thermometer.

4. Current Regulation 13 or Regulation 80 certificates for all reference standards of measurement. Uncertainties must be in accordance with the National Measurement Regulations and not greater than one-third of the maximum permissible error of the measure being tested. Consult the licensing authority for more information.
5. A suitable test area with ample background light and at a convenient height to ensure that the capacity line of the measure is readily discernable.
6. A supply of distilled water for testing.
7. Test report (see Appendix A).

2.1 Weighing Equipment

Prior to undertaking gravimetric performance testing, the weighing instrument to be used should be tested according to the relevant test procedure appropriate to its type and class in accordance with Morris and Fen (2002).

The readability of the weighing instrument used to determine the accuracy of the measure under test is shown in Table 1.

Table 1. Accuracy of weighing required in determining scale mark accuracy

Type of measure	Scale mark(s) (mL)	Accuracy of weighing
Conical	1, 2, 3, 4, 5	to nearest 0.01 g
Conical	6 to 200	to nearest 0.1 g
Beaker	all	to nearest 1 g
Cylindrical	5 and 10	to nearest 0.01 g
Cylindrical	25 to 250	to nearest 0.1 g
Cylindrical	500 to 4000	to nearest 1 g

The measure shall be installed in a suitable area with ample background light and at a convenient height to ensure that the capacity line of the measure is readily discernible.

3. VISUAL INSPECTION

Visually inspect the graduated measure and record details of the required data and characteristics of the measure on the test report.

Note: Some characteristics will require assessment using an appropriate procedure described in the relevant Australian standard.

3.1 Required Data

1. Test report reference number.
2. Date of test.
3. Type of test: verification, certification or in-service inspection (for in-service inspection ensure that the verification/certification mark is in place).
4. Name of owner/user.
5. Address of owner/user.
6. Name of contact on premises.
7. Address where the measure is located.
8. Description of measure.
9. Certificate of approval number.
10. Capacity or capacities.
11. Number of measures of each denomination selected for testing.

3.2 Characteristics of the Instrument

3.2.1 Pharmaceutical Dispensing Measures

1. Is the measure formed from a clear, colorless, high grade, annealed glass free of any defect that may affect the accuracy of measurement?
2. Is the measure free of bubbles larger than 1 millimetre in the measuring area or larger than 3 mL elsewhere or bubbles which may be broken open?

3. Is the shape and form of the measure appropriate to the nominal capacity?
4. Is the bottom of the measuring space rounded and does it merge smoothly into the sides of the measure?
5. For a conical measure, is the included angle of the external surface:
 - $13.5^\circ \pm 2^\circ$ for nominal capacities of 5mL and 10 mL?
 - $15^\circ \pm 3^\circ$ for nominal capacities of 20 mL up to 200 mL?
6. Is the measure able to contain a volume at least 40% greater than its nominal capacity?
7. When the measure is filled to the highest scale mark with water, can the contents be poured in a narrow stream which falls clear of the outside of the measure?
8. Does the base of the measure allow it to stand vertically on a horizontal flat surface without rocking or spinning?
9. Does the measure remain firm on its base when filled to the uppermost scale mark and stood on a surface inclined at an angle of 15° to the horizontal?

3.2.2 Graduated Glass Measuring Cylinders

1. Is the cylinder formed from clear, high-grade, annealed glass and is free of defects that may affect the accuracy of measurement?
2. Does the cylinder have the required pouring lip that for a cylinder with a polygonal base is orientated correctly?
3. Is the cylinder fitted with a base that allows it to stand vertically on a horizontal flat surface without rocking?
4. Does the empty cylinder remain firm on its base when placed on a surface inclined at an angle of 10° to the horizontal?
5. Is the base of the cylinder either circular or polygonal with six or more equal sides?

3.2.3 Graduated Plastic Measuring Cylinders

1. Is the cylinder formed of a plastic material, which, under routine laboratory conditions is rigid, non-brittle and sufficiently transparent to permit inspection of the contents and the accurate reading of the volume?
2. Is the cylinder moulded in one piece?
3. Is the design of the cylinder similar to that shown in Figure 1 of AS 2770?
4. Are the dimensions of in accordance with Table 1 of AS 2770?
5. Is the cylinder provided with a pouring lip?
6. Is the cylinder fitted with a base that allows it to stand vertically on a horizontal flat surface without rocking or spinning?
7. Does the empty cylinder remain firm on its base when placed on a surface inclined at an angle of 10° to the horizontal?
8. Is the base of the cylinder either polygonal with at least five sides, or circular?
9. Where the base is detachable is it constructed of an appropriate plastic material?
10. Does the cylinder have a pouring lip that allows the contents to be poured in a narrow stream without liquid spilling or running down the outside of the cylinder?
11. Are all parts of the cylinder free from sharp edges, projections or roughness?
12. Is the wall thickness of the calibrated portion of the cylinder uniform to within 10% of the mean wall thickness?

4. MARKING OF GRADUATED MEASURES

Markings of graduated measures shall be in accordance with the appropriate Australian standard.

5. TEST PROCEDURES

The test procedures are designed to test Graduated Measures for accuracy and compliance with the certificate of approval and the requirements of the uniform trade measurement legislation.

The accuracy of graduated measures is determined gravimetrically based on techniques described Humphries (1979) and the procedures outlined in the appropriate Australian standard.

5.1 Notes

The following are relevant to the accuracy requirements for graduated measures.

1. Capacity corresponding to any scale mark is the volume of water at 20°C that will fill the measure to that scale mark with the measure:
 - at 20°C;
 - standing on a level surface such that the observer's eye is level with the front scale mark and the lowest point of the meniscus appears to touch the top edge of the scale mark.
2. Graduated glass measures include glass pharmaceutical dispensing measures and glass measuring cylinders.
3. All graduated measures shall be calibrated to contain (see Appendix B).
4. The capacity of graduated measures at any scale mark shall be determined at 20°C.
5. The test medium used is distilled water.
6. The bottom of the meniscus is read (see Appendix B).

5.2 Accuracy Tests

All tests shall be in accordance with the procedures described in one or more of the following documents, whichever is appropriate:

- the certificate of approval;
- Humphries (1979);

- the procedures described in the appropriate Australian standard for the type of graduated measures under test.

5.3 Maximim Permissible Error

For graduated measures, the maximum permissible error shall not exceed the limitation of error specified in one of the appropriate tables described in Appendix C or the certificate of approval.

6. SUGGESTED SEQUENCE FOR TESTING

Unless otherwise described in the appropriate Australian standard or the other reference documents, the following sequence of procedures is a suggestion to assist in the achievement of the criteria described above.

1. Determine the appropriate reference documents (Australian standard and/or other publication) to enable verification or certification conducted.
2. Make sure any electronic instrument has been allowed to warm up for about half an hour.
3. Ensure that the weighing instrument to be used is tested in accordance with NITP 6.1 to 6.4 and can be read to the required accuracy.
4. Check the certificate/s of approval for any additional tests required under test procedures in the certificate/s of approval.
5. Visually inspect the measures to be tested and make a note of the metrological characteristics.
 Note: Some assessments may require an appropriate procedure described in the relevant Australian standard.
6. Conduct the tests in accordance with the appropriate Australian standard.
7. Record the results.
8. Carry out any calculations.

9. Complete any documentation.
10. Conduct any additional tests that are required to complete the testing including if necessary any additional testing required by the Australian standard(s) or certificate/s of approval.

APPENDIX A. TEST REPORTS

The following test report form contains the minimum amount of information that must be recorded whenever a report is required as a record of a measure's performance.

The format of the report of test results for accuracy is as prescribed by the relevant Australian standard or other documents however the format may vary according to the individual needs and requirements of trade measurement authorities and licensees.

Test Report for Graduated Measures

Reference number

Date.../.../...

Required Data (clause 3.1)Tick relevant box: Verification Certification In-service inspection

Contact name		
Name of owner/user		
Address of owner/user		
Address of measure		
Site manager		
Measure details	Description	
	Material	
	Manufacturer/s	
	Certificate/s of approval number/s	
	Denomination (s)	
	Total number of measures	

General Characteristics of Pharmaceutical Dispensing Measures (clause 3.2.1)

Is the measure formed from a clear, colorless, high grade, annealed glass?	yes/no
Is the measure free of any defect that may affect the accuracy of measurement?	yes/no
Is the measure free of bubbles that may be broken open?	yes/no
Is the shape and form of the measure appropriate to the nominal capacity?	yes/no
Is the bottom of the measuring space rounded and does it merge smoothly into the sides of the measure?	yes/no
For a conical measure, is the included angle of the external surface correct?	yes/no
When the measure is filled to the highest scale mark with water, can the contents be poured in a narrow stream which falls clear of the outside of the measure?	yes/no
Is the measure able to contain a volume at least 40% greater than its nominal capacity?	yes/no
Does the base of the measure allow it to stand vertically on a horizontal flat surface without rocking or spinning?	yes/no
Does the measure remain firm on its base when filled to the uppermost scale mark and stood on an inclined surface?	yes/no

General Characteristics of Glass Measuring Cylinders (clause 3.2.2)

Is the cylinder formed from clear, high-grade, annealed glass?	yes/no
Is the cylinder free of defects that may affect the accuracy of measurement?	yes/no
Does the cylinder have the required pouring lip?	yes/no
For a cylinder with a polygonal base, is the pouring lip orientated correctly?	yes/no/na
Is the cylinder fitted with a base that allows it to stand vertically on a horizontal flat surface without rocking?	yes/no
Does the empty cylinder remain firm on its base when placed on an inclined surface?	yes/no
Is the base of the cylinder either circular or polygonal with six or more equal sides?	yes/no

General Characteristics of Graduated Plastic Measuring Cylinders (clause 3.2.3)

Is the cylinder formed of a rigid, non-brittle, plastic material?	yes/no
Is the cylinder sufficiently transparent to permit inspection of the contents and the accurate reading of the volume?	yes/no
Is the cylinder moulded in one piece (except for a permitted detachable base)?	yes/no
Where the base is detachable is it constructed of an appropriate plastic material?	yes/no/na
Is the design of the cylinder similar to that shown in Figure 1 of AS 2770?	yes/no
Are the dimensions of the cylinder in accordance with Table 1 of AS 2770?	yes/no
Is the cylinder provided with a pouring lip?	yes/no
Does the cylinder have a pouring lip that allows the contents to be poured in a narrow stream without liquid spilling or running down the outside of the cylinder?	yes/no
Is the cylinder fitted with a base that allows it to stand vertically on a horizontal flat surface without rocking or spinning?	yes/no
Does the empty cylinder remain firm on its base when placed on an inclined surface?	yes/no
Is the base of the cylinder either polygonal with at least five sides, or circular?	yes/no
Are all parts of the cylinder free from sharp edges, projections or roughness?	yes/no
Is the wall of the calibrated portion of the cylinder of uniform thickness?	yes/no

Markings for Pharmaceutical Dispensing Measures (refer to AS 1952)

Does the measure have appropriate scale marks?	yes/no
Is the numbering arrangement correct?	yes/no
Are the abbreviations correct?	yes/no
Are the scale marks the correct length?	yes/no
Are the levelling lines marked correctly?	yes/no
Are the levelling lines are similar?	yes/no

Markings for Graduated Glass Measuring Cylinders (refer to AS 2163)

Does the measure have appropriate scale marks?	yes/no
Is the numbering arrangement correct?	yes/no
Are the scale marks clean lines of uniform thickness?	yes/no
Is the measure inscribed with the nominal capacity?	yes/no
Are the abbreviations correct?	yes/no
Are the scale marks the correct length?	yes/no
Is the measure inscribed 'In 20°C'?	yes/no
Is the measure inscribed 'A/AS 2163' or 'B/AS 2163' as applicable?	yes/no
Is the measure marked with the manufacturer's name or mark?	yes/no

Markings for Graduated Plastic Measuring Cylinders (refer to AS 2770)

Does the measure have appropriate scale marks?	yes/no
Is the numbering arrangement correct?	yes/no
Are the scale marks clean lines of uniform thickness?	yes/no
Is the position & spacing of the scale marks correct?	yes/no
Is the measure marked with the nominal capacity?	yes/no
Are the abbreviations correct?	yes/no
Are the scale marks the correct length?	yes/no
Is the measure marked 'In 20°C'?	yes/no
Is the measure marked with the name of material of which it is composed?	yes/no

Signed Print name

Comments

.....

APPENDIX B. MEASURES GRADUATED TO CONTAIN, AND SETTING THE MENISCUS

Measures Graduated to Contain

A measure graduated to contain shall be filled to a distance of a few millimetres above the scale mark to be verified.

Before the final setting is made, any air bubbles trapped on the wall of the measure are to be removed.

The final setting of the meniscus to the scale mark is made by withdrawing the surplus water by means of a tube drawn down to a jet, i.e. a pipette.

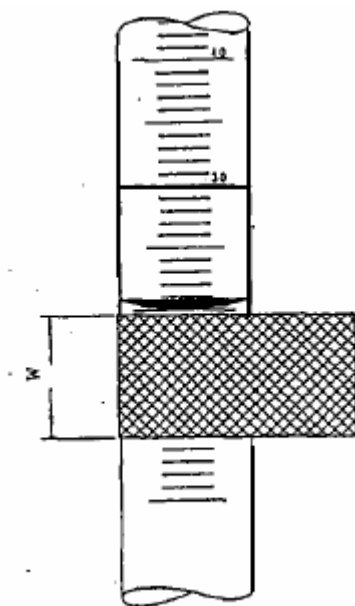
Setting the Meniscus

To make an accurate reading of the meniscus the lighting should be arranged so that the meniscus appears dark and distinct in outline.

Therefore the meniscus should be viewed against a white background and shaded from undesirable illumination.

This effect can be achieved by securing a suitable strip of black paper around the measure, not more than 1 mm below the scale mark. The paper shall have the edge nearest the meniscus cut clean and straight and may be held in place by a paper clip. The width of the paper strip shall be at least equal to the diameter of the measure at the point where the meniscus is located.

The meniscus is correctly set when the lowest point of the meniscus is set to the upper edge of the scale mark.



APPENDIX C. MAXIMUM PERMISSIBLE ERRORS

Table C1. Maximum permissible error for graduated glass measuring cylinders

Nominal capacity (mL)	Maximum permissible error (mL)
5	± 0.1
10	± 0.2
25	± 0.5
50	± 1
100	± 1
250	± 2
500	± 5
1000	± 10
2000	± 20

Note: The tolerance represents the maximum permissible error at any point and also the maximum permissible difference between any errors at any two points.

For example: a 100 mL measuring cylinder may be in error by +1 mL at any point, provided the difference between errors at any two points does not exceed 1 mL.

Table C2. Maximum permissible errors for beaker dispensing measures

Nominal capacity (mL)	Maximum permissible error at each scale mark on the measure (mL)
500	± 5
1000	± 7

Table C3. Maximum permissible errors for conical dispensing measures

Scale mark (mL)	Maximum permissible error at each scale mark (irrespective of nominal capacity) (mL)
1	± 0.08
2	± 0.12
3	± 0.16
4	± 0.20
5	± 0.25
6, 7, 8	± 0.3
9, 10	± 0.4
15	± 0.5
20	± 0.6
30	± 0.8
40, 50	± 1
60, 70, 80, 90	± 1.5
100, 120, 140,	± 2
160, 180, 200	± 3

Table C4. Maximum permissible errors for graduated plastic measuring cylinders

Nominal capacity (mL)	Maximum permissible error (mL)
10	± 0.2
25	± 0.5
50	± 1
100	± 1
250	± 2
500	± 5
1000	± 10
2000	± 20
4000	± 50

Note: The error shown represents the maximum permissible error at any point and also the maximum permissible difference between any errors at any two points.

APPENDIX E. CORRECTION FOR VOLUME AT 20°C

To determine gravimetrically the volume of water in a glass dispensing measure at 20°C fill the measure to the required scale mark and record the temperature and the mass of the water as described in the relevant test procedure.

The mass of the water in a conical dispensing measure when filled to the 50 mL scale mark is 49.28 g. The temperature of the water is 18.5°C and the material used in the measure is Pyrex (borosilicate) glass. Calculate the corrected volume for the 50 mL scale mark.

$$\text{Mass of water (m}_t\text{)} = 49.28 \text{ g}$$

$$\text{Observed temperature (t}^\circ\text{C)} = 18.5^\circ\text{C}$$

By linear interpolation from Table G2 (Appendix G) the correction for 50 mL at 18.5°C:

$$= 0.128$$

$$\text{Volume of water at } 20^\circ\text{C} = m_t + \text{correction factor}$$

$$= 49.28 + 0.128$$

$$= 49.408$$

$$= 49.41 \text{ mL}$$

At the 50 mL scale mark the measure is deficient by 0.59 mL.

APPENDIX F. USING THE CORRECTION FACTOR FOR EXPANSION OF PLASTIC

To determine the volume of water in a plastic measuring cylinder fill the measure to the required scale mark and record the temperature and the mass of the water as described in the test procedure.

$$V_{20} = m_t (1 + c)$$

Where:

V_{20} = cylinder capacity at graduation line at 20°C

m_t = apparent mass of water in cylinder at t °C

c = coefficient of cubical thermal expansion of the plastic material at t°C

Example Calculation

The mass of the water in a plastic measuring cylinder when filled to the 300 mL scale mark is 301 g. The temperature of the water is 17.4°C and the coefficient of cubical thermal expansion (c) of the plastic is $45 \times 10^{-5}/^{\circ}\text{C}$. Calculate the corrected volume for the 300 mL scale mark at 20°C.

Mass of water (m_t) = 301 g

Observed temperature ($t^{\circ}\text{C}$) = 17.4°C

Coefficient of cubical thermal expansion $45 \times 10^{-5}/^{\circ}\text{C}$

17.4°C rounded to the nearest 1°C = 17

By linear interpolation from Table G3 (Appendix G) the value of:

$$\begin{aligned} c &= (38 + 35)/2 \times 10^{-4} \\ &= 36.5 \times 10^{-4} \end{aligned}$$

$$\begin{aligned} V_{20} &= m_t (1 + c) \\ &= 301 (1 + 36.5 \times 10^{-4}) \text{ mL/g} \\ &= 302.099 \\ &= 302.1 \text{ mL} \end{aligned}$$

At the 300 mL scale mark the measuring cylinder is in excess by 2.1 mL.

APPENDIX G. USEFUL REFERENCE TABLES

Table G1. Correction factors for soda glass
(add to apparent mass¹ (g) of pure water at t°C to obtain capacity (millilitres) at 20°C)

Nominal capacity	Temperature of water °C									
	mL	16	17	18	19	20	21	22	23	24
1	0.002214	0.002356	0.002508	0.002671	0.002846	0.003030	0.003225	0.003431	0.003646	0.003870
2	0.004	0.005	0.005	0.005	0.006	0.006	0.006	0.007	0.007	0.008
5	0.011	0.012	0.013	0.013	0.014	0.015	0.016	0.017	0.018	0.019
10	0.022	0.024	0.025	0.027	0.028	0.030	0.032	0.034	0.036	0.039
20	0.044	0.047	0.050	0.053	0.057	0.061	0.065	0.069	0.073	0.077
50	0.111	0.118	0.125	0.134	0.142	0.152	0.161	0.172	0.182	0.194
100	0.221	0.236	0.251	0.267	0.285	0.303	0.323	0.343	0.365	0.387
200	0.443	0.471	0.502	0.524	0.569	0.606	0.645	0.686	0.729	0.774
500	1.107	1.178	1.254	1.336	1.423	1.515	1.613	1.715	1.823	1.935
1000	2.214	2.356	2.506	2.671	2.846	3.030	3.225	3.431	3.646	3.870
2000	4.429	4.771	5.016	5.343	5.691	6.061	6.451	6.861	7.291	7.741

Table G2. Correction factors for borosilicate glass
(add to apparent mass* (grams), of pure water at t°C to obtain capacity (millilitres) at 20°C)

Nominal capacity	Temperature of water °C									
	mL	16	17	18	19	20	21	22	23	24
1	0.002147	0.002305	0.002474	0.002654	0.002846	0.003047	0.003259	0.003481	0.003713	0.003955
2	0.004	0.005	0.005	0.005	0.006	0.006	0.007	0.007	0.007	0.008
5	0.011	0.012	0.012	0.013	0.014	0.015	0.016	0.017	0.019	0.020
10	0.021	0.023	0.025	0.027	0.028	0.030	0.033	0.035	0.037	0.040
20	0.043	0.046	0.049	0.053	0.057	0.061	0.065	0.070	0.074	0.079
50	0.107	0.115	0.124	0.133	0.142	0.152	0.163	0.174	0.186	0.198
100	0.215	0.230	0.247	0.265	0.285	0.305	0.326	0.348	0.371	0.396
200	0.429	0.461	0.495	0.531	0.569	0.609	0.652	0.696	0.743	0.791
500	1.073	1.152	1.237	1.327	1.423	1.524	1.630	1.741	1.857	1.978
1000	2.147	2.305	2.474	2.654	2.846	3.047	3.259	3.481	3.713	3.955
2000	4.293	4.609	5.948	5.309	5.691	6.095	6.519	6.963	7.427	7.910

¹ Apparent mass is usually referred to as 'observed weight' or 'weight in air'.

Table G3. Correction factors (*c*) for the expansion of plastic material

t°C	Values of (<i>c</i>) in units of 10 ⁻⁴ mL/g				
	Coefficient of cubical thermal expansion, 10 ⁻⁵ /°C				
	20	30	40	50	60
15	30	35	40	45	50
16	29	33	37	41	45
17	29	32	35	38	41
18	29	31	33	35	37
19	29	30	31	32	33
20	29	29	29	29	29
21	29	28	27	26	25
22	29	27	25	23	21
23	29	26	23	20	17
24	30	26	22	18	14
25	30	25	20	15	10
26	31	25	19	13	6.6
27	32	25	18	11	3.6
28	32	24	16	8.4	0.4
29	33	24	15	6.3	-2.7
30	34	24	14	4.3	-5.5

The values of (*c*) given in the table are applicable at barometric pressure of 101.3 kPa and an atmospheric temperature of 20°C.

The value of (*c*) is given for plastic materials whose coefficient of cubical thermal expansion fall in the range $20 \times 10^{-5}/^{\circ}\text{C}$ to $60 \times 10^{-5}/^{\circ}\text{C}$.

Where possible manufacturers should be consulted for the actual value of the coefficient for the plastic material. If coefficients fall between the values given in the table, (*c*) can be obtained by linear interpolation between the data in the table.