Australian Government
Department of Industry, Science and Resources

National Measurement Institute

36 Bradfield Road, West Lindfield NSW 2070

General Certificate of Approval

No 4/8/0A

Issued by the Chief Metrologist under Regulation 60
of the
National Measurement Regulations 1999

This is to certify that an approval for use for trade has been granted in respect of

Brim Measures for the Determination of the Volume of Flowable Solids.

NOTE: This Certificate relates to the suitability of the pattern of the instrument for use for trade only in respect of its metrological characteristics. This Certificate does not constitute or imply any guarantee of compliance by the manufacturer or any other person with any requirements regarding safety.

This Certificate is issued upon completion of a review of approval No 4/8/0.

DOCUMENT HISTORY

Rev	Reason/Details	Date
0	Pattern approved – certificate issued	19/09/07
1	Test procedure (Testing by Calculation 3. Calculate Theta) corrected – notification of change issued	04/02/08
2	Test procedure (reference to NMI spreadsheet) amended – certificate issued	16/07/24

CONDITIONS OF APPROVAL

General

Instruments purporting to comply with this approval shall be marked with approval number ‘NMI 4/8/0A’ and only by persons authorised by the submittor.

It is the submittor’s responsibility to ensure that all instruments marked with this approval number are constructed as described in this Certificate of Approval and Technical Schedule. Failure to comply with this Condition may attract penalties under Section 19B of the National Measurement Act and may result in cancellation or withdrawal of the approval, in accordance with document NMI P 106.

The National Measurement Institute reserves the right to examine any instrument or component of an instrument purporting to comply with this approval.

Signed by a person authorised by the Chief Metrologist to exercise their powers under Regulation 60 of the *National Measurement Regulations 1999*.

Darryl Hines
Manager
Policy and Regulatory Services

TECHNICAL SCHEDULE No 4/8/0A

1. Description of Pattern approved on 19/09/07

Brim measures of certain capacities for use in determining the volume of flowable solids such as sand, soil, gravel and agricultural materials. The measures are designed for use in association with lifting and tilting mechanisms mounted on a vehicle.

1.1 Approved Capacities

The pattern may be in any capacity in the range from 0.19 m^3 to 5.5 m^3 (inclusive). The capacity shall be expressed as a volume with no more than three significant digits (e.g. 0.256 m^3 or 4.75 m^3, but not 0.2563 m^3 or 4.754 m^3).

Note: The intention is that measures shall be in the range 0.2 m^3 to 5 m^3; the expanded range indicated above is to allow some leeway for manufacturing tolerances.

1.2 Construction

The measure may be of single or multiple parts (for example a two part design may be constructed such that the bottom of the measure is opened to discharge the contents). In the case of multiple part construction, the measure shall be such that for the product normally used with the measure, leakage shall be minimal when the measure is closed.

The measure shall be of welded metal plate construction (it may also be acceptable to use other construction methods which prevent disassembly – not bolted for example), the plate shall be at least 5 mm thick (the intention being to minimise the risk of the volume varying due to bending or denting).

The measure shall have a clear strikable brim (i.e. the edges which form the opening of the measure shall be in the one plane), with the exception that the front lower edge of the measure, which comes into contact with the ground when filling, shall have a reinforcing toe plate of at least 15 mm thickness along its entire length, and this toe plate may project by not more than 100 mm beyond the plane of the clear strikable brim.

Every measure shall be capable of being completely and easily emptied in normal use.

Where the volume of the measure is to be determined by calculation, additional construction requirements apply – see ‘Testing by Calculation’ in the Test Procedure.

1.3 Capacity Definition

The capacity of the measure is defined by the clearly strikable brim.

1.4 Verification Provision

Provision is made for a verification mark to be applied adjacent to the capacity mark.

1.5 Markings and Notices

(a) Brim measures of the pattern shall be marked with the following data:

Manufacturer's identification
Pattern approval mark for the instrument 4/8/0A
Capacity (refer para. (b) below)

(b) The capacity shall be clearly and permanently marked or moulded on the side of the measure, including the unit or its symbol, cubic metres (m^3).

The capacity and its unit symbol shall be in the same alignment, in a position clearly visible when the measure is resting on the ground, on the nearside of the measure as it is, or is to be, mounted on a vehicle.

In the statement of capacity, all numbers and uppercase letters shall be at least 25 mm high and 10 mm wide; all lower case letters shall be at least 20 mm high and 8 mm wide.

TEST PROCEDURE No 4/8/0A

Maximum Permissible Errors

The maximum permissible errors applicable at verification are:

-2% and +5%.

That is, the volume determined in testing (V_{ref}) shall not be less than the volume marked on the measure by more than 2% (of the volume marked), and shall not be greater than the volume marked by more than 5%.

1. Testing by Measurement

Testing by measurement is carried out with the clearly strikable brim positioned in a horizontal plane.

For a measure of multiple parts (see clause **1.2 Construction**), it may be necessary to prevent leakage by lining the measure with plastic, and sealing with tape prior to testing.

The volume being determined is the minimum volume (i.e. without any overfilling or 'hilling' of the measure).

The following describes two methods for testing by measurement which may be used.

NOTE: Alternative methods may be used with the agreement of the NMI .

1.1 Testing Using Water

With the clearly strikable brim positioned in a horizontal plane, fill the measure with water using a suitable certified meter or suitable certified measures to determine the reference volume (V_{ref}). Stop filling as soon as water commences to flow out of the measure. Determine the error using the formulae $E = (V_{ref} - \text{Volume Marked}) \div V_{ref}$

1.2 Testing Using a Dry Material

For this test (dry) sand is preferred as it has minimal settling and a density can be readily determined.

(i) Place the measure in a position such that the clearly strikable brim is in a horizontal plane.

(ii) Take a rigid container (e.g. bucket) and place on a suitable and calibrated weighing instrument. Zero the weighing instrument using the tare facility.

(iii) Fill the container with the test material and strike off the surface.

(iv) Weigh the filled container on the weighing instrument and record this value.

(v) Empty the container into the measure.

(vi) Repeat steps (iii) and (iv) until the measure is full – use a straight object (screed) to strike off along the brim and hence ensure the measure is full.

Note: Care must be taken to minimise spillage, either by carefully distributing the test material over the volume of the measure or by collecting any spillage on a sheet, weighing the spillage and deducting this from the total.

When filling the measure, avoid allowing the material to 'hill' in the centre of the measure by emptying the containers evenly across the measure.

(vii) Determine the density (d) of the test material by weighing samples of suitable known volume (v) at the beginning, middle and end of the test to obtain the mass (m) of each sample.

Find the densities of the test material from the equation d = m/v and determine the average density (D).

(viii) Determine reference volume from the equation V_{ref} = M /D, where M = total mass of test material as measured, and D = average density as determined above

Determine the error using the formulae E = (V_{ref} – Volume Marked) ÷ V_{ref}

Note: Where a partially-full container is required to complete filling of the measure, an additional calculation to account for this may also be required.

2. Testing by Calculation

The capacity of the measure may be determined by calculation based on the internal measurements of the measure.

In this case the construction shall be similar to that shown in Figure 1 and in particular, the side plates (which are in a vertical plane when the measure is in use) shall be normal to the upper and lower plates and parallel to each other, and the base of the measure is in the form of a segment of a circle (or cylinder). Incorrect results may be obtained if these calculations are used for constructions which are not similar to those shown in Figure 1.

The volume is calculated by multiplying the width of the measure (F) between the side plates, by the area of cross-section of the measure.

The area of the cross-section is calculated by calculating the area (Area 1) of the triangle (I+A)-G-E, subtracting from this the area (Area 2) of the triangle I-C-J, and adding the area (Area 3) of the segment of a circle (defined by B & C).

A procedure for these calculations is as follows:

1. Calculate $S1 = 0.5 \cdot (G + E + I + A)$
2. Calculate $S2 = 0.5 \cdot (C + E + I - D)$
3. Calculate $Theta = H / B$
4. Calculate Area 1.

$$Area1 = \sqrt{S1(S1 - G)(S1 - E)(S1 - A - I)}$$

5. Calculate Area 2.

$$Area2 = \sqrt{S2(S2 - C)(S2 + D - E)(S2 - I)}$$

6. Calculate Area 3.

$$Area3 = 0.5 \cdot B^2[Theta - \sin(Theta)]$$

Note: Theta is an angle in radians – when calculating this formula the calculator used must be set to use angles in radians.

7. Calculate the cross sectional area of the bucket.

$$Area = Area1 - Area2 + Area3$$

8. Calculate the volume of the bucket

$$Volume = F \cdot Area$$

Note: In the version General Certificate 4/8/0 dated 30 April 1992 the following formula was used.

$$\text{Capacity} = 0.5F \times \left\{ \begin{array}{l} E\sqrt{G^2 - \left[\frac{\left\{G^2 + E^2 - (A+E-D)^2\right\}}{2E}\right]^2} - \\ (E-D)\sqrt{C^2 - \left\{\frac{C^2}{(2E-2D)}\right\}^2} + \\ BH - C\sqrt{B^2 - \frac{C^2}{4}} \end{array} \right\}$$

The above formula uses an assumption that I is approximately equal to E – D, and also an approximation for the area of the segment of a circle. Differences between the current formula and the previous formula are generally small, however they may be significant for unusually shaped buckets.

NOTE: All measurements should be internal, so allowance may need to be made for the wall thickness of the measure.

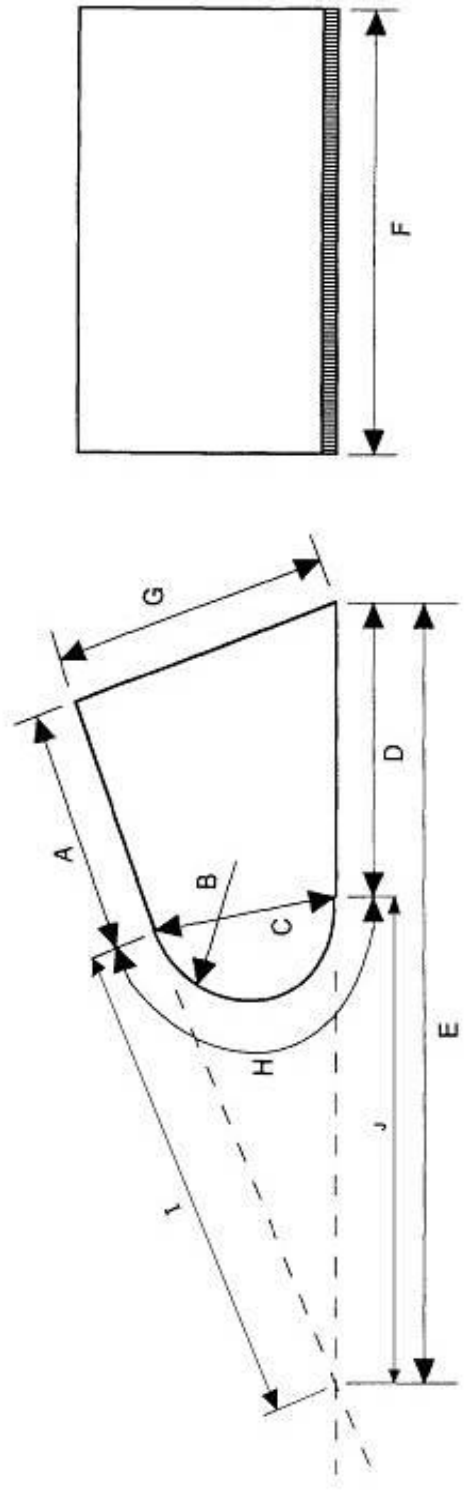
The following procedures may be used to find the various dimensions shown above, as shown in Figure 1:

(a) Lay the bucket on a flat surface so that side of length D is in contact with the surface over its whole length.

(b) TO FIND LENGTH E: With a string line or long straight object, find the apex of the triangle, as defined by the extensions of sides A and D in Figure 1, by laying the string or object along the side length A until it just touches the ground. With a string line, anchor the end at the front of the bucket and gradually lower the free end until the string just touches the side A; extend the string till it just touches the ground. This locates the apex from which length E can be measured.

(c) Radius B may be approximated using a flexible or rigid measure. For example: Using a compass, prepare templates which are segments of circles of known radius, increasing in 5 mm increments. Comparing these with the curvature of the measure should enable the value of B to be determined with sufficient accuracy.

FIGURE 4/8/0A – 1



Schematic Diagram of a Typical Measure

~ End of Document ~