



# Standard Test Method for Apparent Density of Free-Flowing Metal Powders Using the Hall Flowmeter Funnel<sup>1</sup>

This standard is issued under the fixed designation B 212; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This test method describes a procedure for determining the apparent density of free-flowing metal powders and is suitable for only those powders that will flow unaided through the specified Hall flowmeter funnel.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

B 215 Practices for Sampling Finished Lots of Metal Powders<sup>2</sup>

B 243 Terminology of Powder Metallurgy<sup>2</sup>

B 873 Test Method for Measuring the Volume of Apparent Density Cup Used in Test Methods B 212, B 329, B 417<sup>2</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, see Terminology B 243.

## 4. Summary of Test Method

4.1 A volume of powder is permitted to flow into a container of definite volume under controlled conditions. The mass of powder per unit volume is determined and reported as apparent density, Hall.

## 5. Significance and Use

5.1 This test method provides a guide for evaluation of the apparent density physical characteristic of powders. The density measured bears a relationship to the mass of powder that will fill a fixed volume press cavity when parts are being made. The degree of correlation between the results of this test and

the quality of powders in use will vary with each particular application.

## 6. Apparatus

6.1 *Powder Flowmeter Funnel*<sup>3</sup>—A Hall flowmeter funnel (Fig. 1) having a calibrated orifice.

6.2 *Density Cup*<sup>3</sup>—A cylindrical brass cup (Fig. 2) having a capacity of 25 cm<sup>3</sup>. The actual cup volume shall be determined according to Test Method B 873.

6.3 *Stand*<sup>3</sup>—A stand (Fig. 1) to support the Hall flowmeter funnel concentric with the density cup so that the bottom of the Hall flowmeter funnel orifice is approximately 25 mm (1 in.) above the top of the density cup when the apparatus is assembled as shown in Fig. 1.

6.4 *Base*—A level, vibration-free base to support the powder flowmeter.

6.5 *Balance*, having a capacity of at least 200 g and a sensitivity of 0.01 g.

## 7. Test Specimen

7.1 The test specimen shall consist of a volume of approximately 30 to 40 cm<sup>3</sup> of metal powder obtained in accordance with Practices B 215.

7.2 The test specimen shall be tested as sampled. Note, however, that temperature, moisture, oils, stearic acid, stearates, waxes, and so forth, may alter the characteristics of the powder.

## 8. Procedure

8.1 Weigh the empty density cup to the nearest 0.1 g or, alternatively, place the empty density cup on the balance and tare the balance to zero.

8.2 Carefully load the test specimen into the flowmeter funnel and permit it to run into the density cup through the discharge orifice. Take care not to move the density cup.

8.3 When the powder completely fills and overflows the periphery of the density cup, rotate the funnel approximately

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.05.

<sup>3</sup> The sole source of supply of the apparatus known to the committee at this time is Accu Powder International, LLC, 901 Lehigh Ave., Union, NJ 07083-7632. If you are aware of alternate suppliers, please provide this information to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committees, which you may attend.

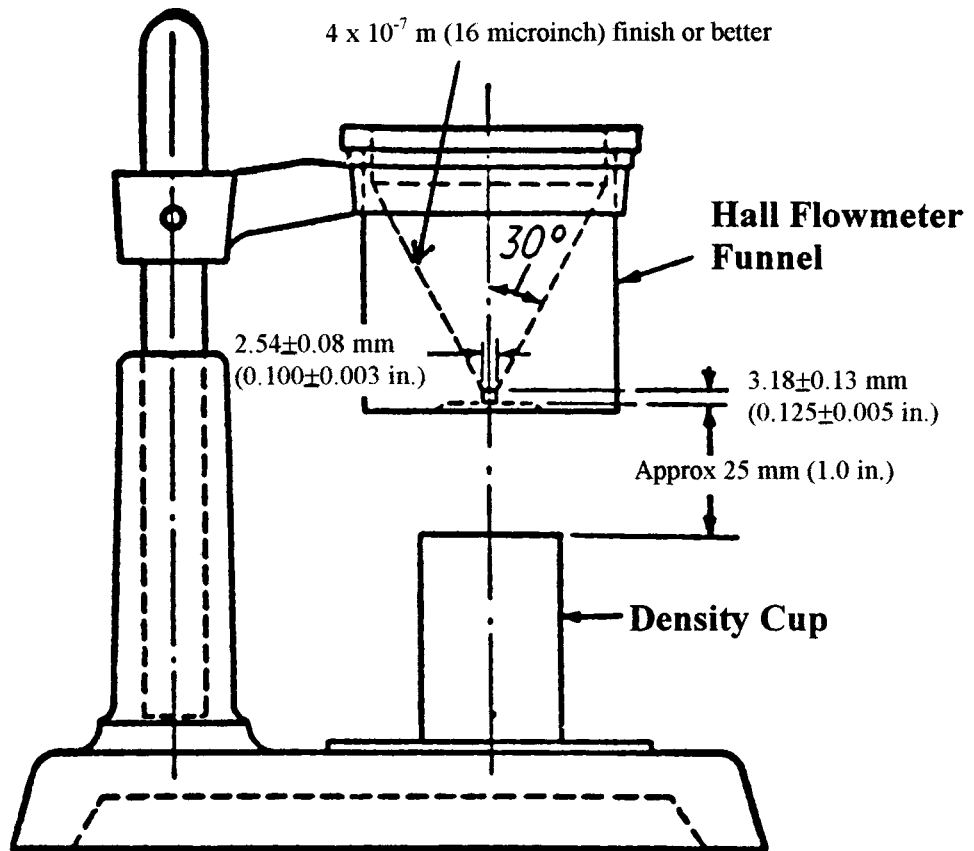


FIG. 1 Flowmeter Apparatus — Hall Funnel

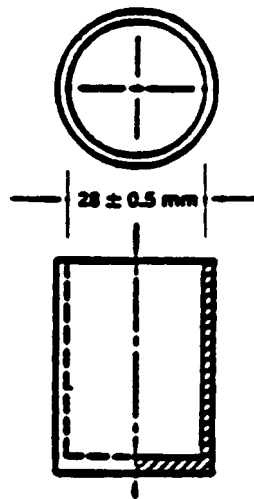


FIG. 2 Density Cup ( $25 \pm 0.03 \text{ cm}^3$ )

90° in a horizontal plane so that the remaining powder falls away from the cup.

8.4 Using a nonmagnetic spatula with the blade held perpendicular to the top of the cup, level off the powder flush with the top of the density cup. Take care to avoid jarring the apparatus at any time.

8.5 After the leveling operation, tap the density cup lightly on the side to settle the powder to avoid spilling in transfer.

8.6 Transfer the filled density cup to the balance and weigh to the nearest 0.1 g to determine the mass,  $M$ , of powder.

## 9. Calculation

9.1 Calculate the apparent density as follows:

$$\text{Apparent density, g/cm}^3 = M/V \quad (1)$$

where:

$M$  = mass of powder in the density cup in grams and

$V$  = volume of the density cup,  $\text{cm}^3$ .

## 10. Report

10.1 Report the results as apparent density, Hall to the nearest 0.01 g/cm<sup>3</sup>.

## 11. Precision and Bias

11.1 *Precision*—The precision of this test method as determined by the statistical examination of the interlaboratory test results is as follows:

11.1.1 *Repeatability*  $r = 1.5\%$ —Duplicate analyses of unlubricated or lubricated metal powders by the same operator and same apparatus should not differ by more than 1.5 % at the 95 % confidence level.

11.1.2 *Reproducibility*  $R = 3\%$  (unlubricated and lubricated iron powder),  $R = 5\%$  (lubricated brass and bronze powders). The difference between two single and independent

results obtained by different operators working in different laboratories on lubricated and unlubricated iron powders should not differ by more than 3 % at the 95 % confidence level. Analyses of lubricated brass and bronze metal powders should not differ by more than 5 % at the 95 % confidence level.

11.2 *Bias*—Since there is no accepted reference material for determining the bias for the procedure in Test Method B 212 for measuring apparent density, Hall, bias has not been determined.

## 12. Keywords

12.1 apparent density; Hall flowmeter funnel; metal powders

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