

National Bureau of Standards

Certificate of Calibration

Standard Reference Material 1003a

Calibrated Glass Spheres

(8 to 58 micrometers)

(In cooperation with the American Society for Testing and Materials)

This Standard Reference Material (SRM) is intended for use in calibrating equipment and in evaluating methods for measuring particle size in the 8 to 58 micrometer range. SRM 1003a consists of 25 grams of glass spheres.

The values given for the distribution of sphere diameters according to count are based on microscopic measurements of nearly 8000 individual spheres taken from 10 randomly selected bottles. Less than one percent of the "spheres" were observed to be nonspherical.

The certified values given in Table 1 represent the cumulative distribution according to count. The calculated values which represent the cumulative distribution according to volume, also given in Table 1, are not certified. The uncertainties of the certified values are expressed as the standard deviation of the mean of the ten samples at each diameter.

Table 1. Cumulative Size Distributions

<u>Diameter</u>	<u>Percent of Spheres with Diameters</u>		
	<u>Less Than the Size Indicated</u>		
	<u>Count</u>	<u>Uncertainties</u>	<u>Volume</u>
4 μm	0.00	± 0.00	0.0
6	0.47	± 0.12	0.00
8	1.50	± 0.16	0.02
10	3.40	± 0.23	0.08
12	6.87	± 0.37	0.29
14	12.01	± 0.61	0.80
16	18.84	± 0.89	1.84
18	27.17	± 1.10	3.69
20	36.43	± 1.25	6.57
22	45.67	± 1.39	10.44
24	54.34	± 1.50	15.21
26	62.06	± 1.57	20.67
28	68.84	± 1.59	26.71
30	74.74	± 1.58	33.21
32	79.78	± 1.52	40.00
34	83.99	± 1.42	46.84
36	87.50	± 1.25	53.64
38	90.32	± 1.08	60.09
40	92.58	± 0.87	66.15
42	94.41	± 0.67	71.87
44	95.80	± 0.51	76.86
46	96.95	± 0.38	81.57
48	97.80	± 0.27	85.58
50	98.48	± 0.19	89.13
52	98.98	± 0.13	92.24
54	99.38	± 0.08	94.87
56	99.64	± 0.04	96.96
58	99.85	± 0.02	98.53
60	99.95	± 0.01	99.52
62	99.98	± 0.00	99.86
64	100.00	± 0.00	100.00

The various measures of the central tendencies of the two distributions are given below.

Table 2. Non-Certified Values of the Mode, Median, and Mean of the Size Distributions

	<u>By Count</u>	<u>By Volume</u>
Mode, Linear Class Size	20.0 μm	31.1 μm
Mode, Logarithmic Class Size	22.9	37.5
Median	23.0	33.7
Mean	24.5	35.6

The density of the glass spheres is $2.414 \text{ g}\cdot\text{cm}^{-3}$ as determined by the classical volume displacement method using 25-mL pycnometers and xylene as the displacement fluid. This value is not certified, but is given for the benefit of those wishing to use Stoke's law calculations.

Before sampling this SRM, the spheres should be thoroughly mixed in the bottle using a mechanical device or a manual technique that consists of a combination of shaking and rolling. Samples should be taken from a number of places in the bottle.

Previous experience has shown that a reaction can occur between the surfaces of glass spheres subjected to moisture that can make them difficult to disperse. Once opened the bottle should be stored in a dry atmosphere; e.g., a desiccator.

The glass spheres used for this SRM were provided by Potters Industries of Hasbrook Heights, New Jersey. The microscopic measurements were made by R.C. Obbink, ASTM/NBS Research Associate. The data reduction was performed by R.K. Kirby of NBS Measurement Services. The density was determined by W.F. Koch of the NBS Center for Analytical Chemistry.

J.R. Thompson of the Alcoa Technical Center in Pennsylvania provided valuable assistance in determining that the homogeneity of this SRM was satisfactory by making many measurements with a Leeds & Northrop Microtrac and a modified Coulter Counter. Measurements were also made by S.D. Duke of Duke Scientific Corp., Palo Alto, California, L.D. Carver of the Hiac Corp., Montclair, California, and F. Kosel of Marco Scientific, Sunnyvale, California.

The technical and support aspects involved in the certification and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by L.J. Kieffer and R.K. Kirby.

The following results are given for information only:

Table 3. Results Obtained by Cooperating Laboratories with Commercial Equipment

<u>Method/Instrumentation^a</u>	<u>Laboratory</u>	<u>Vol. Mean Diameter</u>	<u>Distribution Sigma (s.d.)</u>
Air Sedimentation	Alcoa	38.1 μm	1.22 μm
Electronic Sensing Zone	Alcoa	36.0	1.25
Granulometre	Marco	35.8	1.28
Hiac PA-720	Hiac	36.8	1.28
Hiac PA-720	Hiac	36.9	1.36
Microtrac (L&N)	Alcoa	36.6	1.45
X-ray Sedimentation	Duke	36.5	1.38
Electronic Sensing Zone	Duke	32.2	1.29

^aReference to specific instrumentation by its commercial name does not constitute an endorsement by either the National Bureau of Standards or the American Society for Testing and Materials.