S. Department of Commerce
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National Bureau of Standards
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National Bureau of Standards
Certificate of Calibration
Standard Reference Material 1017a
Calibrated Glass Beads

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This Standard Reference Material is intended for use in the evaluation of the effective opening of wire-cloth sieves in the range 100 μm through 310 μm (Test Sieves Nos. 140, 120, 100, 80, 70, 60, and 50). The weight of glass beads in each bottle is about 84 g. While most of the beads are spherical about 8 percent by number range from nearly spherical beads to ellipsoidal beads and a few conglomerates.

The distribution of sizes in this SRM as determined by microscopic measurement is given in Table 1 as the weight percent of glass beads that are smaller than those that have the indicated diameter.

Over 60,000 beads were measured in the course of this calibration. These beads were sampled from 24 bottles that were selected at intervals throughout the bottling process. Repeat measurements were made on 7 of the bottles. Considering the values of percent finer to be exact, the mean of the standard deviations associated with each diameter is 4.6 ± 2.0 μm. This error includes those errors due to the bottling and measuring processes and is to be expected when a given sieve is calibrated with different bottles of this SRM. In addition to this error, the user may impose a sieving error of about ± 3.5 μm, the result of differing ambient conditions. The reproducibility is, of course, dependent upon the sieving method and the care exercised by the operator.

The method that was used in the preparation of these calibrated glass beads (U.S. Patent No. 2,693,706, November 9, 1954) is described in a paper by F. G. Carpenter and V. R. Deitz, Glass Spheres for the Measurement of the Effective Opening of Testing Sieves, J. Research NBS 47, 139 (1951).

The overall coordination and evaluation of data leading to certification of this SRM was performed by R. K. Kirby.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by W. P. Reed.

Washington, D. C. 20234
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J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

Example of Calculation Procedure

An example of data and calculations are shown below. Seven sieves were calibrated at the same time. The original weight of the glass beads was 87.46 g. It may be noted that the sum of the weights shows a loss of 0.11 g. This loss is assumed to be evenly distributed and the sum of the weights is used to evaluate the percentages.

Example of calculation for effective opening

U.S. sieve No.	Weight on sieve	Weight percent		Opening of sieve	
		On sieve	Finer than sieve	Effective[a]	Nominal
50	7.81 g	8.94	91.1	304 μm	300 μm
60	11.24	12.87	78.2	250	250
70	9.79	11.21	67.0	219	212
80	19.29	22.09	44.9	180	180
100	12.86	14.72	30.2	150	150
120	8.54	9.77	20.4	127	125
140	11.32	12.96	7.4	105	106
Pan	6.50	7.44			
	87.35				

[a] Determined by interpolation between values given in the calibration table.

Foreign Material and Dirt

If the sieves are not cleaned sufficiently before the calibration, some foreign material will be found among the glass beads. If possible, this foreign material must be removed by hand. A dirty appearance of the glass beads indicates that they have picked up a small amount of dust. The weight of the dust is usually so small that only a negligible error is introduced.

If the sieves to be calibrated have been used they may be cleaned thoroughly with a sturdy brush, not too stiff, soap and water or solvents. Under no circumstance should a sharp object be used to dislodge particles that are stuck in the meshes.

Loss of Weight with Use

Experience has shown that there is a loss in weight of the beads with use. How great a loss can be tolerated without introducing large errors in the calibration is difficult to state. However, a quick check of the accuracy of the beads can be made by "cross-calibrating" a single sieve with the questionable beads and new or relatively little used beads. A variation significantly greater than ± 5 μm would indicate that the accuracy of the questionable beads has suffered from a loss of weight. If an SRM is ruined by either repeated use or accident, the only recourse is to purchase a new SRM from the National Bureau of Standards.

Directions for Using Calibrated Glass Beads for the Evaluation of the Effective Opening of Sieves

The Calibration Process

The aperture size of a sieve can be determined as the average size of the openings in the sieve. However, the purpose of a sieve is to measure the size of particles, and therefore, it is the effective opening that must be determined. This is done by using particles of known size. Thus the effective opening is determined by the size of calibrated glass beads that will just pass through the sieve. This in turn permits the measurement of the particle size of an unknown material that will also just pass through the sieve.

The openings of a sieve are not all the same size, and particles that are coarser than the average opening can pass through the larger holes. Thus, the effective opening is generally larger than the average opening. In addition, the separation achieved by a sieve is not sharp. A few particles capable of passing the sieve are always retained. The number of particles retained or passed depends upon the manner and time of shaking, and any measurement of the effective opening must take these variables into account. To a large extent, the glass bead method of calibration automatically includes these effects because the sieves are shaken in the same manner when calibrated as when measuring an unknown material.

The sieve openings are essentially square in shape and particles of irregular shape can pass through even though one of the dimensions of the particle is considerably larger than the diameter of the opening. This is especially true for needlelike shapes. The average diameter of such irregular particles that pass a sieve cannot be considered equal to the effective opening of the sieve as measured by the diameter of spheres that just pass.

For the application of the calibrated glass beads to sieve analysis, see Carpenter, F. G., and Deitz, V. R., Methods of Sieve Analysis with Particular Reference to Bone Char, J. Research NBS 45, 328 (1950).

Calibration Procedure

To evaluate the effective opening of testing sieves with glass beads, the entire standard is placed on the top sieve. The sieves are then shaken in a shaking device, or by hand, in exactly the same manner as that to be followed in routine analysis.

After the shaking has been completed the stack of sieves is disassembled, and the beads are removed from each sieve and placed into a suitable weighing bottle. Experience has shown that loss of beads is very likely to occur during this operation. Therefore, the whole operation should be carried out over a large piece of paper to permit recovery of any beads that may accidently be spilled. Such loss can also be minimized by the use of a funnel large enough to completely contain the sieve. The stem of the funnel should be fitted snugly into the mouth of the weighing bottle so that no beads can bounce out. The sieve is inverted into the top of the funnel and all of the glass beads are removed with a stiff brush.

Each of the sieve fractions is weighed to the nearest 0.01 g. After weighing, all beads are returned to the original container and kept for reuse. The weight percent retained on each sieve is calculated from the weights of the sieve fractions. The percent passing through each sieve is determined by subtracting the percentage on the coarsest sieve from 100 percent, the percentage on the next sieve from that result, and so on. The effective size of the sieve opening is determined by interpolation between the nearest values given in the calibration table.

Table 1

Cumulative Size Distribution by Weight

Weight percent finer	Diameter (Effective sieve opening)	Weight percent finer	Diameter (Effective sieve opening)	Weight percent finer	Diameter (Effective sieve opening)
%	μm	%	μm	%	μm
1	82	34	163	67	219
2	88	35	165	68	222
3	92			69	226
4	94	36	167	70	229
5	97	37	169		
		38	170	71	232
6	100	39	172	72	235
7	104	40	173	73	238
8	107			74	240
9	110	41	175	75	243
10	112	42	176		
		43	178	76	245
11	114	44	179	77	247
12	116	45	180	78	250
13	118			79	252
14	119	46	181	80	256
15	120	47	182		
		48	184	81	259
16	122	49	185	82	263
17	123	50	186	83	269
18	124			84	274
19	125	51	187	85	279
20	127	52	189		
		53	190	86	283
21	128	54	191	87	287
22	130	55	193	88	291
23	131			89	295
24	133	56	194	90	299
25	135	57	196		
		58	197	91	303
26	137	59	199	92	308
27	140	60	201	93	312
28	143			94	316
29	146	61	203	95	320
30	150	62	205		
		63	207	96	324
31	153	64	210	97	328
32	157	65	213	98	333
33	160			99	341
		66	216		