U. S. Department of Commerce
Frederick B. Dent
Secretary

National Bureau of Standards
Richard W. Roberts, Director

National Bureau of Standards
Certificate of Calibration
Standard Reference Material 1018a
Calibrated Glass Beads

R. K. Kirby

This Standard Reference Material is intended for use in the evaluation of the effective opening of wire-cloth sieves in the range 225 μm through 780 μm (Test Sieve Nos. 60, 50, 45, 40, 35, 30, and 25). The weight of glass beads in each bottle is about 74 g. While most of the beads are spherical about 6 percent by number range from nearly spherical beads to elliposidal beads and fused beads.

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 18,000 beads were measured in the course of this calibration. These beads were sampled from 10 bottles that were selected at intervals throughout the bottling process. The beads in these bottles were also carefully compared by sieving with the beads from 20 other bottles, also selected at random. These intercomparisons show no significant difference between beads from all 30 bottles. Considering the values of percent finer to be exact, the standard deviation associated with each test sieve is: No. 60, 2.1 μm; No. 50, 2.5 μm; No. 45, 2.9 μm; No. 40, 2.7 μm; No. 35, 3.8 μm; No. 30, 3.3 μm; and No. 25, 4.5 μm. It was assumed that the effective opening would be within the permissible variation of average opening as specified in the ASTM Standard Specification for Wire-Cloth Sieves, E11-70. 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 ± 2 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. Res. 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
May 16, 1973

J. Paul Cali, Chief
Office of Standard Reference Materials

(over)

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 irregualr 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. Res. NBS 45, 328 (1950).

Calibration Procedure

To evaluate the effective opening of testing sieves with this SRM all of the glass beads are 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	200	34	349	67	581
2	207	35	354	68	583
3	212			69	585
4	217	36	360	70	588
5	221	37	367		
		38	375	71	590
6	225	39	385	72	592
7	229	40	396	73	595
8	233			74	598
9	236	41	408	75	602
10	239	42	420		
		43	432	76	606
11	242	44	444	77	611
12	245	45	454	78	617
13	249			79	627
14	253	46	462	80	646
15	257	47	469		
		48	475	81	680
16	262	49	480	82	692
17	267	50	486	83	700
18	274			84	706
19	281	51	493	85	712
20	289	52	500		
		53	507	86	717
21	296	54	515	87	723
22	302	55	523	88	729
23	307			89	736
24	312	56	531	90	743
25	316	57	539		
		58	546	91	750
26	320	59	552	92	759
27	323	60	557	93	769
28	326			94	779
29	329	61	561	95	791
30	332	62	565		
		63	569	96	803
31	336	64	572	97	817
32	340	65	575	98	832
33	344			99	849
		66	578		

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 73.91 g. It may be noted that the sum of the weights shows a loss of 0.02 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
25	8.43 g	11.41	88.6	733 μm	710 μm
30	7.76	10.50	78.1	618	600
35	18.63	25.21	52.9	506	500
40	7.86	10.64	42.2	422	425
45	4.63	6.27	36.0	360	355
50	10.48	14.18	21.8	301	300
60	5.99	8.11	13.7	252	250
Pan	10.11	13.68			
	73.89				

[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 of 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, the variation of the accuracy of the "working sample" can be monitored by periodically calibrating a set of sieves with it and one or two others that are kept in reserve. 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.