Designation: E 688 – 94 (Reapproved 1999)

Standard Test Methods for Waste Glass as a Raw Material for Glass Manufacturing[1]

This standard is issued under the fixed designation E 688; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods give the various tests for assessing the compliance of glass recovered from wastes for use as a raw material for glass manufacturing.

1.2 The test methods combine visual examinations with both chemical and physical tests. A flow chart of the testing sequence is included in this test method (see Fig. 1).

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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.* For hazard statements, see 5.3, and Section 6.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

C 169 Test Methods for Chemical Analysis of Soda-Lime and Borosilicate Glass

C 566 Test Method for Total Moisture Content of Aggregate by Drying

C 702 Practice for Reducing Samples of Aggregate to Testing Size

C 729 Test Method for Density of Glass by the Sink-Float Comparator

D 1068 Test Methods for Iron in Water

D 1193 Specification for Reagent Water

D 2576 Test Method for Metals in Water and Waste Water by Atomic Absorption Spectrophotometry[3]

D 4129 Test Method for Total and Organic Carbon in Water by High Temperature Oxidation and by Coulometric Detection

E 11 Specification for Wire-Cloth Sieves for Testing Purposes

E 105 Practice for Probability Sampling of Materials

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process

3. Significance and Use

3.1 These test methods provide a means for determining whether waste glass is suitable for use as a raw material for glass manufacturing.

4. Apparatus

4.1 The following various items of equipment required may be purchased from most laboratory supply houses:

4.1.1 *Aspirator*.

4.1.2 *Balance*.

4.1.3 *Burner*, Fisher (Meker) type.

4.1.4 *Crucible*, porcelain or other ceramic.

4.1.5 *Crucible*, platinum.

4.1.6 *Flask*, filtering, with side tube, 2000-ml.

4.1.7 *Funnel*, Büchner, approximately 171 mm in diameter.

4.1.8 *Funnel*, approximately 150 mm in diameter, filtering.

4.1.9 *Furnace*, 540°C or 1000°F.

4.1.10 *Clamps*, tubing, screw compressor.

4.1.11 *Magnet*, C-shaped, Alnico.

4.1.12 *Magnifier*, 5×, 10×.

4.1.13 *Oven*, 110°C or 230°F.

4.1.14 *Scales*, triple-beam.

4.1.15 *Sieves, U.S. Standard Series*—50 mm (2 in.), 6.3 mm (¼ in.), 1.18 mm (No. 16), 850 µm (No. 20), 425 µm (No. 40), 250 µm (No. 60), 106 µm (No. 140), conforming to Specification E 11.

4.1.16 *Sink-Float Standard*, sp gr 2.65.

4.1.17 *Triangle*, platinum.

4.1.18 *Tubing*, vinyl.[4]

4.1.19 Other ancillary laboratory equipment.

5. Reagents and Materials

5.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that

[1] These test methods are under the jurisdiction of ASTM Committee D34 on Waste Management and are the direct responsibility of Subcommittee D34.03.03 on Industrial Recovery and Reuse.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Discontinued—See *1980 Annual Book of ASTM Standards*, Part 31.

[4] Tygon plastic tubing, available from Norton Co., Plastics and Synthetics Div., Dept TR2, 12 East Ave., Tallmadge, OH 44278, or equivalent, has been found suitable for this purpose.

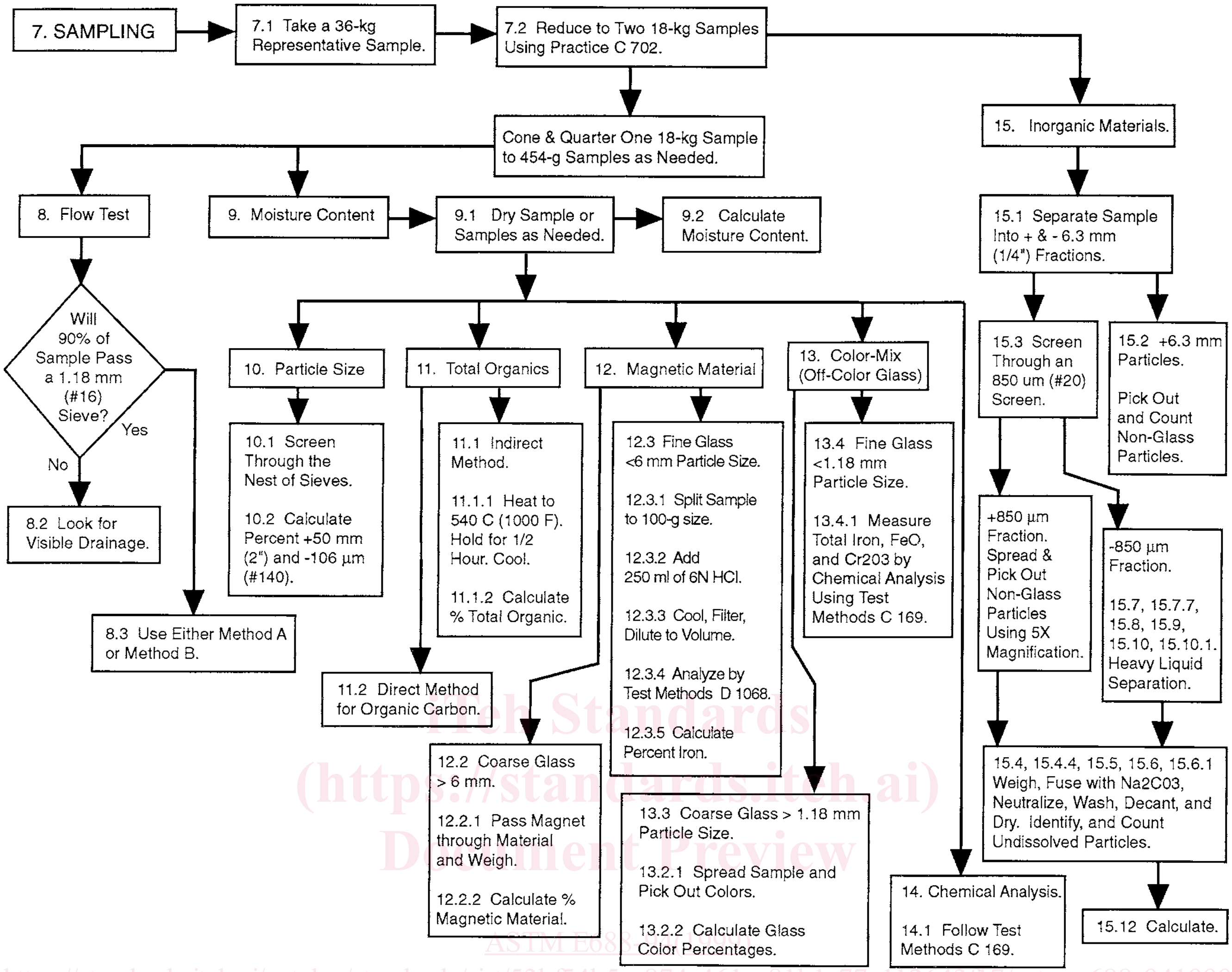
7. SAMPLING
7.1 Take a 36-kg Representative Sample.
7.2 Reduce to Two 18-kg Samples Using Practice C 702.
Cone & Quarter One 18-kg Sample to 454-g Samples as Needed.
15. Inorganic Materials.
8. Flow Test
9. Moisture Content
9.1 Dry Sample or Samples as Needed.
9.2 Calculate Moisture Content.
15.1 Separate Sample Into + & - 6.3 mm (1/4") Fractions.
Will 90% of Sample Pass a 1.18 mm (#16) Sieve?
Yes
No
10. Particle Size
11. Total Organics
12. Magnetic Material
13. Color-Mix (Off-Color Glass)
15.3 Screen Through an 850 um (#20) Screen.
15.2 +6.3 mm Particles.
Pick Out and Count Non-Glass Particles.
10.1 Screen Through the Nest of Sieves.
10.2 Calculate Percent +50 mm (2") and -106 µm (#140).
11.1 Indirect Method.
11.1.1 Heat to 540 C (1000 F). Hold for 1/2 Hour. Cool.
11.1.2 Calculate % Total Organic.
12.3 Fine Glass <6 mm Particle Size.
12.3.1 Split Sample to 100-g size.
12.3.2 Add 250 ml of 6N HCl.
12.3.3 Cool, Filter, Dilute to Volume.
12.3.4 Analyze by Test Methods D 1068.
12.3.5 Calculate Percent Iron.
13.4 Fine Glass <1.18 mm Particle Size.
13.4.1 Measure Total Iron, FeO, and Cr203 by Chemical Analysis Using Test Methods C 169.
+850 µm Fraction. Spread & Pick Out Non-Glass Particles Using 5X Magnification.
-850 µm Fraction.
15.7, 15.7.7, 15.8, 15.9, 15.10, 15.10.1. Heavy Liquid Separation.
8.2 Look for Visible Drainage.
8.3 Use Either Method A or Method B.
11.2 Direct Method for Organic Carbon.
12.2 Coarse Glass > 6 mm.
12.2.1 Pass Magnet through Material and Weigh.
12.2.2 Calculate % Magnetic Material.
13.3 Coarse Glass > 1.18 mm Particle Size.
13.2.1 Spread Sample and Pick Out Colors.
13.2.2 Calculate Glass Color Percentages.
14. Chemical Analysis.
14.1 Follow Test Methods C 169.
15.4, 15.4.4, 15.5, 15.6, 15.6.1 Weigh, Fuse with Na2C03, Neutralize, Wash, Decant, and Dry. Identify, and Count Undissolved Particles.
15.12 Calculate.

FIG. 1 Simplified Testing Flow Chart

all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available.[5] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

5.2 *Purity of Water*— Unless otherwise indicated, references to water shall be understood to mean reagent water, Type II, as defined in Specification D 1193.

5.3 *Warning: Acetone (see 15.5)*—This substance is highly flammable (Class B) and must not be used in the vicinity of open flames or other ignition sources. Vapors should not be inhaled, since they can cause skin and membrane irritation.

5.4 *Ethyl Alcohol*, denatured.

5.5 *Hydrochloric Acid (3 N and 6 N) (see 12.3.2/15.11)*—Prepare 3 *N* acid by diluting 1 part of concentrated hydrochloric acid (HCl, sp gr 1.19) with 3 parts of water. Prepare 6 *N* acid by diluting 1 part of concentrated HCl with 1 part of water.

NOTE 1—**Caution:** These materials are corrosive and injurious to the skin as well as irritating to the eyes and mucous membranes.

5.6 *Potassium Hydroxide, Saturated Solution*—Add 100 g of potassium hydroxide (KOH) slowly, while stirring, to 100 ml water. Store this solution in a polyethylene bottle. This solution is corrosive and injurious to the skin.

5.7 *Sodium Carbonate (Na_2CO_3).*

5.8 *sym-Tetrabromoethane (Acetylene Tetrabromide) (sp gr 2.964)*—This substance has a threshold limit value (8 h time-weighted average exposure) of 1 ppm and a short time exposure limit (15 min) of 1.25 ppm. It must be used in a hood or under conditions of ensured ventilation.

6. Hazards

6.1 The analyst should be aware of good laboratory practices. Adequate ventilation is necessary, particularly for handling sym-tetrabromoethane and the density liquids used in

[5] *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmaceutical Convention, Inc. (USPC), Rockville, MD.

15.7.1-15.10.1. The flammability of acetone must be considered when it is used in 15.5.

6.2 Due to the origins of glass samples in municipal wastes destined for disposal, common sense dictates that some precautions should be observed when conducting tests on the samples. Recommended hygienic practices include using gloves when handling waste glass and washing hands before eating or smoking.

7. Sampling

7.1 *Gross Sample*— Take a grab sample weighing 36 kg (80 lb) in such a manner that it will be representative of the lot as described in Practices E 105 and E 122.

7.2 *Test Sample Preparation*—Reduce the gross sample to two samples, each weighing 18 kg (40 lb) by a method as described in Practice C 702. Use one sample for testing for inorganic material. Reduce the other sample by coning and quartering to produce at least seven samples, each weighing 454 g (1 lb), to be used for the remaining tests described in Sections 8-14.

7.3 *Sample Preservation*—Store the gross sample and subsequent samples in such a manner as to prevent not only the loss of contaminants but to prevent further contamination, until the necessary tests can be performed. It is recommended that samples be stored in sealed plastic bags (75 µm or 3 mil) or other airtight containers in order to avoid gain or loss of moisture.

8. Flow Test[6]

8.1 This test is used to ensure that the sample of glass shows no drainage, is noncaking, and free flowing.

8.2 If the sample is 90 % larger than will pass through a 1.18-mm (No. 16) sieve, the requirements will be met if the sample shows no drainage of water.

8.3 *Method A*—If the sample contains in excess of 10 % through a 1.18-mm (No. 16) sieve, screen a sample through the 1.18-mm sieve, 454 g (1 lb) of this material must flow out of the funnel as follows: Fit a powder funnel having a uniform internal stem diameter of 18 mm, a stem length of 30 mm, and a top of 80 mm, in a rack, and close off the bottom by the palm of a hand. Pour the sample to be tested into the funnel until the funnel is full. When the hand over the opening is removed, glass meeting the requirements will flow out of the funnel. One or two light taps on the funnel may be used to begin or aid flow. If the glass fails to flow out of the specified funnel and both producers and users agree, a second funnel test (Method B) may be performed; this test will measure the flow properties of a somewhat more sticky glass.

8.4 *Method B*—Use the same procedure as in Method A except that the dimensions of the second funnel shall be: stem internal diameter, 38 mm; stem length, 48 mm; top diameter, 170 mm.

9. Moisture Content

9.1 *Procedure*—Dry five 454-g (1-lb) test samples (see 7.2) to constant weight in accordance with Test Method C 566. Drying time may be in the order of 2 h at 110°C (230°F). Record the dry weight of at least one sample for use in 9.2. Use the remaining dry samples for testing according to Sections 10-14.

9.2 *Calculation*— Calculate the moisture content as follows:

$$\text{Moisture, \%} = \frac{(\text{original weight} - \text{dry weight}) \times 100}{\text{original weight}} \quad (1)$$

10. Particle Size

10.1 *Procedure*—Screen a sample from 9.1 on a 50-mm (2-in.) sieve. Weigh the material remaining on the sieve. Screen the material passing the sieve on a 106-µm (No. 140) sieve. An intervening sieve, such as a 212 µm (No. 70) may be used merely to reduce the amount presented to the test sieve. Weigh material passing through the 106-µm sieve. Shake all sieves mechanically for 10 min or by hand to achieve equivalent results. Other intervening screen sizes may be utilized.

10.2 *Calculations*— Calculate the percent of plus 50-mm and minus 106-µm material as follows:

$$\text{Plus 50-mm material, \%} = (A/W) \times 100 \quad (2)$$

$$\text{Minus 106-µm material, \%} = (B/W) \times 100 \quad (3)$$

where:

A = weight of material on 50-mm sieve,
B = weight of material through 106-µm sieve, and
W = dry weight of sample.

11. Total Organics (Paper, Plastic, and Other Combustibles)

11.1 *Indirect Method*:

11.1.1 *Procedure*—Using a sample from 9.1, place the sample in an uncovered ceramic crucible(s) and heat to 540°C (1000°F). Maintain this temperature for ½ h or until all flame and smoke have ceased.

NOTE 2—**Caution:** Overheating can cause the glass particles to fuse together. Allow the sample to cool to room temperature, weigh, and calculate the percent total organics. Reserve the sample or use an alternative dry sample for subsequent tests.

11.1.2 *Calculation*— Calculate the percent total organics as follows:

$$\text{Total organics, \%} = 100 - \frac{\text{weight after ignition} \times 100}{\text{dry weight of sample}} \quad (4)$$

11.2 *Direct Method for Organic Carbon*—Organic carbon can only be inferred from the method in 11.1. Organic carbon can be determined directly by the method in this section.

11.2.1 *Procedure*—Organic carbon can be determined directly by an instrumental method such as coulometrics.[7] Test Method D 4129 uses this instrumentation for total and organic

[6] More detailed testing procedures and the effect of compaction are discussed by Carson, J. W., in *International Journal of Powder Metallurgy and Powder Technology*, vol. 11, 1975, pp. 233–239.

[7] Model 5010 Coulometer, available from Coulometrics Inc., a subsidiary of UIC Inc., P.O. Box 563, Joliet, IL 60434.