Designation: ~~F3012 – 14~~ F3012 – 22

Standard Specification for Loose-Fill Rubber for Use as a Playground Safety Surface under and around Playground Equipment[1]

This standard is issued under the fixed designation F3012; 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.

INTRODUCTION

Recycled rubber used in loose-fill applications is found in a wide variety of products, including landscaping mulch, equestrian surfacing, artificial turf in-fill, and resilient playground surfacing. The goal of this specification is to provide test methods and performance requirements for loose-fill rubber playground-surfacing products. It is intended to complement existing ASTM International standards for determining the shock attenuation and accessibility of a playground surface. This specification will assist playground designers and specifiers, owner/operators, and playground-surfacing suppliers in evaluating loose-fill rubber products for playground use.

1. Scope

1.1 This specification establishes test methods and performance requirements for particle size distribution, extractable hazardous metal content, total lead content, tramp metal content, and sharp tramp metal content for loose-fill rubber that is intended to be used as a playground surface.

1.2 This specification does not contain test methods or performance requirements for the accessibility of loose-fill rubber playground surfacing. The specification also does not establish test methods or performance requirements to characterize the release of organic chemicals from loose-fill rubber intended to be used as a playground surface. Appendix X1 and Appendix X2 contain additional information on these topics.

1.3 If loose-fill rubber which meets the requirements of this standard is to be installed in the use zone of playground equipment, it must also comply with Specification F1292.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

---

[1] This specification is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.63 on Playground Surfacing Systems.

Current edition approved ~~May 1, 2014~~Feb. 1, 2022. Published ~~May 2014~~February 2022. Originally approved in 2014. Last previous edition approved in 2014 as F3012 – 14. DOI: ~~10.1520/F3012-14.~~10.1520/F3012-22.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
D1193 Specification for Reagent Water
E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves
E1613 Test Method for Determination of Lead by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES), Flame Atomic Absorption Spectrometry (FAAS), or Graphite Furnace Atomic Absorption Spectrometry (GFAAS) Techniques (Withdrawn 2021)[3]
F963 Consumer Safety Specification for Toy Safety
F1292 Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment

2.2 *U.S. EPA Standards and Methods:*[4]

EPA Method 3050B Acid Digestion of Sediments, Sludges and Soils; SW 846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
EPA Method 3051A Microwave Assisted Acid Digestion of Sediments, Sludges and Soils; SW 846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
EPA Method 6010B Inductively Coupled Plasma-Atomic Emission Spectrometry; SW 846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
EPA Method 7470A Mercury in Liquid Waste (Manual Cold-Vapor Technique); SW 846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods

2.3 *Federal Standards:*[5]

16 CFR 1500.48 Technical Requirements for Determining a Sharp Point in Toys and Other Articles Intended for Use by Children Under 8 Years of Age

3. Terminology

3.1 *Definitions:*

3.1.1 *hazardous metal, n*—metal that could have the potential to cause harm to humans

3.1.2 *organic chemical, n*—chemical compound containing carbon and hydrogen.

3.1.3 *particle size distribution, n*—list of values that defines the relative amounts of particles present in a mixture.

3.1.4 *sieve analysis, n*—procedure used to determine the particle size distribution of a granular material.

3.1.5 *tramp metal, n*—unwanted metal that finds its way into loose-fill rubber, generally steel.

3.1.6 *use zone, n*—area beneath and immediately adjacent to a play structure or playground equipment that is designated for unrestricted circulation around the equipment and on whose surface it is predicted that a user would land when falling from or exiting the equipment.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *buffing, rubber, n*—elongated rubber strand.

3.2.1.1 *Discussion*—

The approximate dimensions (0.039 to 0.375 inches thick (1 to 9.5 mm), 0.039 to 0.50 in. (1 to 12.7 mm) wide, 0.079 to 3.0 in. (2 to 76.2 mm) long) of buffings used in loose-fill rubber playground surfacing differ from those of buffings used in poured-in-place rubber playground surfacing.

3.2.2 *loose-fill rubber, n*—rubber particles in the form of nuggets or buffings.

---

[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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from the U.S. EPA, Office of Resource Conservation and Recovery, (5305P), 1200 Pennsylvania Ave., N.W., Washington, DC 20460.

[5] *Code of Federal Regulations*, available from U.S. Government Printing Office, Washington, DC 20402.

3.2.3 *nugget, rubber, n*—rubber granule, irregular in shape, with maximum dimension of approximately ⅜ to ⅞ in. (9.5 to 22.2 mm).

4. Performance Requiremetns

4.1 Loose-fill rubber represented as complying with this specification shall meet all applicable requirements specified herein. Anyone representing compliance with this specification shall keep such records as are necessary to document any claim that the requirements within this specification have been met.

4.2 *Sieve Analysis:*

4.2.1 *Nuggets*—When a sample of loose-fill rubber in the form of nuggets is tested in accordance with Section 7, the minimum and maximum passing through the two sieves shall be as in Table 1.

4.2.2 *Buffings*—When a sample of loose-fill rubber in the form of buffings is tested in accordance with Section 7, the minimum and maximum passing through four sieves shall be as in Table 2.

4.3 *Hazardous Metal Content*—When the sample is analyzed using the procedure described in Section 8 (including the correction for statistical errors as described in 8.4.6), the maximum content of hazardous metals shall not exceed the concentrations shown in Table 3.

4.4 *Tramp Metal Content*—When tested in accordance with the procedure described in Section 9, there shall be no tramp metal particles with any dimension of 0.50 in. (12.7 mm) or greater or rubber particles which contain exposed metal that has any dimension of 0.50 in. (12.7 mm) or greater.

4.5 *Sharp Tramp Metal Content*—When tested in accordance with the procedure described in Section 9, there shall be no tramp metal particles with any dimension of 0.20 in. (5 mm) or greater which are determined to have sharp points; or rubber particles that contain exposed metal which has any dimension of 0.20 in. (5 mm) or greater which is determined to have sharp points.

4.6 *Total Metal Content*—When tested in accordance with the procedure outlined in Section 9, the total exposed metal content, ferrous and non-ferrous, shall not exceed 0.1 % as measured by weight.

4.7 *Total Lead Content*—When tested according to the procedure described in Section 10, total lead content shall not exceed 100 ppm.

4.8 The tests required to determine compliance with the foregoing performance requirements shall be conducted not more than ~~three~~five years before the date of the installation of the loose-fill rubber playground surface.

5. Sampling

5.1 Five 3-yd^3 (2.3-m^3) sample piles of loose-fill rubber are required. A smaller sample of loose-fill rubber is taken from these sample piles using the procedure in 5.2 and 5.3.

NOTE 1—The standard container size for bulk recycled loose-fill rubber is 3 yd^3 (2.3 m^3).

5.2 Eight 2-dry qt (2.2-L) samples are drawn from each 3-yd^3 (2.3-m^3) sample pile, taking two 2-dry qt (2.2-L) samples from each quadrant of the pile, digging 1 to 2 ft (0.3 to 0.6 m) into the pile. Each of the two probes (in each quadrant) shall be in different locations (in vertical and horizontal directions) in the quadrant.

TABLE 1 Sample of Loose-Fill Rubber in the Form of Nuggets Tested in Accordance with Section 7

Sieve Size	Minimum %	Maximum %
⅞ in.	99	100
No. 4	0	5

TABLE 2 Sample of Loose-Fill Rubber in Form of Buffings Tested in Accordance with Section 7

Sieve Size	Minimum %	Maximum %
1 in.	99	100
No. 5	0	45
No. 8	0	15
No. 16	0	5

5.3 Combine and thoroughly mix the 40 2-dry qt (2.2-L) samples to achieve a homogenous blend. The resultant 20-dry gal (88-L) blended sample will be used to provide samples for the sieve analysis, hazardous metal content testing, tramp metal testing and total lead content testing.

6. Summary of Test Methods

6.1 Particle size distribution is achieved using Test Method C136, which provides a test method for determining particle size distribution by passing a sample of known mass through a series of sieves of progressively smaller openings.

6.2 Loose-fill rubber hazardous metal content is determined using a procedure contained in Specification F963. This procedure simulates the situation in which loose-fill rubber remains in the digestive tract for 4 h after swallowing by extracting soluble hazardous metals from the loose-fill rubber sample with an acidic solution. The resultant solution is then analyzed for mercury content using EPA Method 7470A. The content of the balance of the hazardous metals is analyzed using EPA Method 6010B.

6.3 The presence of tramp ~~metal~~ metal, both ferrous and non-ferrous, in the loose-fill rubber is determined by visual inspection as well as by collecting any ferrous tramp metal particles from the loose-fill rubber sample using a Ceramic Grade 8 hand magnet. Tramp metal is tested for sharpness according to the procedure in 16 CFR 1500.48.

6.4 Total lead content of the loose-fill rubber sample is determined by strong acid digestion using EPA Method 3050B or 3051A, followed by instrumental analysis of the resultant digestate using one of the test methods specified in ASTM E1613.

TEST METHODS

7. Sieve Analysis Test Method

7.1 *Significance and Use*—This test method is used to determine the particle size distribution of loose-fill rubber to insure that the material tested has a particle size distribution that is appropriate for use as a playground surface. The specified particle size distribution is one that provides sufficient porosity for drainage and limits compaction to allow for proper resilience.

7.2 *Apparatus:*

7.2.1 *Balances*—Balances or scales used in testing fine or coarse aggregate shall be readable and accurate to the greater of 0.018 oz (0.5 g) or 0.1 % of test load at any point within the range of use.

7.2.2 *Sieves:*

7.2.2.1 The sieve cloth shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. The sieve cloth and standard sieve frames shall conform to the requirements of Specification E11. Nonstandard sieve frames shall conform to the requirements of Specification E11, as applicable.

7.2.2.2 Sieve sizes required are: for nuggets; ⅞ in. and No. 4 (3⁄16-in. (4.8-mm)) sieves, and for buffings; one in., No. 5, No. 8, and No. 16 sieves; mounted on a standard frame 8 in. (20 cm) in diameter and 2 in. (5 cm) high.

7.2.3 *Sieve Shaker*—A mechanical sieving device, if used, shall create motion of the sieves to cause the particles to bounce, tumble, or otherwise turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion of adequacy of sieving described in this test procedure is met in a reasonable time period.

TABLE 3 Maximum Allowable Soluble Concentration in mg/L

Antimony (Sb)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Lead (Pb)	Mercury (Hg)	Selenium (Se)
60	25	1000	75	60	90	60	500

7.2.4 *Oven*—The oven used for drying the sample shall be of a size capable of accommodating a 1-dry gal (4.4-L) sample and be capable of maintaining a uniform temperature of 140 ± 9°F (60 ± 5°C).

7.3 *Sample Preparation:*

7.3.1 From the 20-dry gal (88-L) sample of loose-fill rubber, measure a 1-dry gal (4.4-L) sample for drying followed by sieve testing.

7.3.2 Oven dry the 1-dry gal (4.4-L) test sample to a constant weight using an oven temperature of 140 ± 9°F (60 ± –12.7°C). (A constant moisture level is necessary to prevent weight changes because of changing moisture levels in the sample.)

7.4 *Procedure:*

7.4.1 Nest the sieves in order of decreasing size of opening from top to bottom and place the sample on the top sieve.

7.4.2 Agitate the sieve by hand or mechanical apparatus for a sufficient period, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving described in 7.4.5.

7.4.3 Limit the quantity of material on the sieve so that all particles have the opportunity to reach sieve openings a number of times during the sieving operation.

7.4.4 Prevent an overload of material on the individual sieve by one of the following methods:

7.4.4.1 Insert an additional sieve with an opening size intermediate between the sieve that is overloaded and the sieve immediately above that sieve in the original set of sieves.

7.4.4.2 Split the sample into two or more portions, sieving each portion individually. Combine the masses of the general portions retained on a specific sieve before calculating the percentage of the sample on the sieve.

7.4.5 Continue sieving for a sufficient period and in such a manner that, after completion, not more than one mass percent of the residue on any individual sieve will pass that sieve during 1 min of continuous hand sieving as follows: hold the individual sieve provided with a snug-fitting pan and cover in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at a rate of about 150 times per minute, turning the sieve about one sixth of a revolution at intervals of about 25 strokes. In determining the sufficiency of sieving for sizes larger than the No. 16 sieve, limit the material on the sieve to a single set of particles. If the size of the mounted testing sieves makes the described sieving motion impractical, use 8-in. (20-cm) diameter sieves to verify the sufficiency of sieving.

7.4.6 Hand sieve larger particles by determining the smallest sieve opening through which each particle will pass. Start the test on the smallest sieve to be used. Rotate the particles, if necessary, to determine whether they will pass through a particular opening; however, do not force particles to pass through an opening. Hand manipulation shall not include forcing of the particles; however, natural breakdown of particles that are semi-attached through this practice is not necessarily detrimental.

7.4.7 Determine the mass of the size increment on a scale or balance (which conforms to the requirements specified in 7.2.1) to the nearest 0.1 % of the total original dry sample mass. The total mass of the material after sieving shall be within ±0.3 % of the dry mass of the original sample. If this is not the case, the results shall not be used for acceptance purposes.

7.5 *Calculations*—Calculate percentages passing the sieve size to the nearest 0.1 % of the dry mass of the original sample.

7.6 *Report:*

7.6.1 *Nuggets:*

7.6.1.1 The percentage of material that did not pass the ⅞ in. sieve after hand manipulation is subtracted from 100 % and reported as the percent passing the ⅞ in. sieve.

7.6.1.2 The percentage of material that did not pass the No. 4 sieve after hand manipulation is added to the percentage of material that did not pass the ⅞ in. sieve. The sum is subtracted from 100 %. The resulting value is reported as the percent passing the No. 4 sieve.

7.6.2 *Buffings:*

7.6.2.1 The percentage of material that did not pass the 1 in. sieve after hand manipulation is subtracted from 100 % and reported as the percent passing the 1 in. sieve.

7.6.2.2 The percentage of material that did not pass the No. 5 sieve after hand manipulation is added to the percentage of material that did not pass the 1 in. sieve. The sum is subtracted from 100 % and reported as the percent passing the No. 5 sieve.

7.6.2.3 The percentage of material that did not pass the No. 8 sieve is added to the percentage of material that did not pass the 1 in. and No. 5 sieves. This sum is subtracted from 100 %. The resulting value is reported as the percent passing the No. 8 sieve.

7.6.2.4 The percentage of material that did not pass the No. 16 sieve is added to the percentage of material that did not pass the 1 in., No. 5 and No. 8 sieves. This sum is subtracted from 100 %. The resulting value is reported as the percent passing the No. 16 sieve.

7.7 *Precision and Bias*—The precision and bias of this test method for determining particle size distribution are as specified in Test Method C136.

8. Hazardous Metal Test Method

8.1 *Significance and Use*—This test method is based on Section 8.3 of Specification F963, which specifies a test procedure to determine the amount of hazardous metals that have the potential to be present in toys and handled or ingested by children. Since it is also possible for children on a playground to handle and ingest loose-fill rubber particles, it is necessary to determine the level of these hazardous metals in loose-fill rubber intended for use as a playground-surfacing material. The limits for hazardous metals used in this specification are based on those specified in Specification F963, adjusted with a statistical error correction factor as specified in Specification F963.

8.2 *Apparatus:*

8.2.1 *pH Meter,* accurate to 0.2 pH units.

8.2.2 *Membrane Filter,* having a pore size of 0.45 µm.

8.2.3 *Centrifuge,* capable of achieving 5000 ± 500 rpm.

8.2.4 *Container* of gross volume between 1.6 and 5.0 times that of the volume of the hydrochloric acid extractant (see 8.4.2).

8.3 *Reagents:*

8.3.1 *Purity of Reagents*—Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.[6] Other grades are permitted, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening of the accuracy of the determination.

[6] *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.D., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (UPSC), Rockville, MD.

8.3.2 *Hydrochloric Acid Solution,* 0.08 mol/L.

8.3.3 *Hydrochloric Acid Solution,* 2.0 mol/L.

8.3.4 *Purity of Water*—Unless otherwise indicated, reference to water shall be understood to mean reagent water as defined by Type 3 of Specification D1193.

8.4 *Procedure:*

8.4.1 From the 20-dry gal (88-L) sample of loose-fill rubber, measure a 1-dry gal (4.4-L) sample. Select a 0.106-oz (3.1-mL) test sample from the 1-dry gal (4.4-L) sample of material for testing.

8.4.2 Mix the 0.106-oz (3.1-mL) test sample with 50 times its mass of an aqueous solution of 0.08-mol/L hydrochloric acid at 98.6 ± 3.6°F (37 ± 2°C). Shake for 1 min.

8.4.3 Measure the pH of the mixture. If the pH is greater than 1.5, add drop-wise while shaking an aqueous solution of 2 mol/L (7.3 %) hydrochloric acid until the pH is between 1.0 and 1.5. Protect the mixture from light. Continuously shake the mixture for 1 h. Then allow the mixture to stand for 1 h at a temperature of 98.6 ± 3.6°F (37 ± 2°C).

NOTE 2—It has been shown that the extraction of soluble cadmium can increase two to five times when extraction is conducted in the light rather than in the dark.

8.4.4 Without delay, separate the solids from the mixture by filtering through a membrane filter with a pore size of 0.45 µm. If necessary, centrifuge at 5000 ± 500 rpm (523.5 ± 52.4 rad/s) for no longer than 10 min. Analyze the solution using EPA Methods 7470A and 6010B to determine the presence of the elements identified in 4.3.

8.4.5 If it is not possible to analyze the sample within one working day, stabilize by the addition of hydrochloric acid (HCl) so that the solution is approximately 1 mol/L of HCl; then proceed with EPA Methods 7470A and 6010B.

8.4.6 The analytical results as determined in 8.4.4 and 8.4.5 shall be adjusted by subtracting the analytical correction factor in Table 4 as shown in the examples in 8.4.7. This is necessary to make statistical correction for interlaboratory error.

8.4.7 *Example of Calculations Using* Table 4*:*

8.4.7.1 *Example 1*—The analytical result for lead is 120 mg/L; the correction factor from Table 2 is 30 % (0.30). Adjusted analytical results = 120 – (120 × 0.30) = 120 – 36 = 84 mg/L.

8.4.7.2 *Example 2*—The analytical result for arsenic is 90 mg/L; the correction factor from Table 2 is 60 % (0.60). Adjusted analytical results = 90 – (90 × 0.60) = 90 – 54 = 36 mg/L.

8.5 *Report*—Report the analytical results for the elements listed in Table 3, adjusted for statistical correction following the procedure discussed in 8.4.6.

8.6 *Pass/Fail Criteria*—When analyzed using the procedure in this section the maximum content of hazardous metals shall not exceed the concentrations shown in Table 3.

8.7 *Precision and Bias*—No information is presented about either the precision or bias of the test method in Section 8 for measuring hazardous metal content since the test result is non-quantitative.

TABLE 4 Analytical Correction

Element	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Cadmium (Cd)	Chromium (Cr)	Lead (Pb)	Mercury (Hg)	Selenium (Se)
Correction, %	60	60	30	30	30	30	50	60