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Standard Guide for ASTM Standards on Playground Surfacing[1]

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1. Scope

1.1 This guide covers standards for selecting and specifying surface systems under and around playground equipment.

1.2 This guide describes how to apply existing ASTM standards to evaluate the impact attenuation, accessibility characteristics and product characteristics when selecting surfacing systems for use under and around playground equipment.

1.3 This guide does not imply that an injury cannot be incurred when the surface system complies with standards referred to in this guide.

1.4 The values stated in inch-pound units are to be regarded as 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 **Warning—**Mercury has been designated by EPA and many state agencies as a hazardous material that can cause central nervous system, kidney, and liver damage. Mercury, or its vapor, may be hazardous to health and corrosive to materials. Caution should be taken when handling mercury and mercury-containing products. See the applicable product Material Safety Data Sheet (MSDS) for details and EPA's website (http://www.epa.gov/mercury/faq.htm) for additional information. Users should be aware that selling mercury or mercury-containing products, or both, in your state may be prohibited by state law.

1.6 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

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

F963 Consumer Safety Specification for Toy Safety

F1292 Specification for Impact Attenuation of Surfacing Materials Within the Use Zone of Playground Equipment

F1487 Consumer Safety Performance Specification for Playground Equipment for Public Use

F1918 Safety Performance Specification for Soft Contained Play Equipment

F1951 Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment

F2075 Specification for Engineered Wood Fiber for Use as a Playground Safety Surface Under and Around Playground Equipment

F2479 Guide for Specification, Purchase, Installation and Maintenance of Poured-In-Place Playground Surfacing

F3012 Specification for Loose-Fill Rubber for Use as a Playground Safety Surface under and around Playground Equipment

2.2 *Canadian Standard:*

CSA Z614 Children's Playspaces and Equipment[3]

2.3 *Government Publications:*

CPSC (US Consumer Product Safety Commission) Handbook for Public Playground Safety, Pub. No. 325[4]

[1] This guide 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.

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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] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON Canada M9W1R3.

[4] Available from the Consumer Product Safety Commission, Washington, DC 20207, website: www.cpsc.gov.

EPA Method 3050B Acid Digestion of Sediments, Sludges, and Soil[5]

EPA Method 3051A Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and oils[5]

EPA Method 6010B [5]

EPA Method 7470A Mercury in Liquid Wastes (Manual Cold-Vapor Technique)[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[6]

US Code of Federal Regulations Part 3, 36 CFR Part 1191 Americans with Disabilities Act Accessibility Guidelines: Play Areas: (Final Rule)

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *acceleration*—the time rate of change of velocity.

3.1.2 *critical height*—the maximum height in full feet for a surfacing system that, when tested in accordance with Specification F1292, no value shall exceed 200 *g* -max or 1000 HIC.

3.1.3 *deceleration*—the time rate of reduction of velocity.

3.1.4 *drop height*—the distance from which the instrumented headform is released to the surface.

3.1.5 *fall height*—the vertical distance between a designated play surface of the play equipment and the protective surfacing beneath it. In the case of swings, the vertical distance from the pivot point for the swinging element to the protective surface beneath it. The playground standard that has relevant jurisdiction should be consulted with relation to specific play structures.

3.1.6 *g*—acceleration due to gravity at the earth's surface at sea level (32 ft/s^2 (9.8 m/s^2)).

3.1.7 *g-max*—the multiple of *g* that represents a maximum deceleration experienced during an initial impact.

3.1.8 *headform*—the striking part of testing apparatus.

3.1.9 *head injury criteria (HIC)*—a measure of impact severity that considers the duration over which the most critical section of the deceleration pulse persists as well as the peak level of deceleration.

3.1.10 *impact attenuation*—the ability of a surface to reduce and dissipate the energy of an impacting body.

3.1.11 *impact velocity*—the velocity of a falling body immediately prior to striking the surface.

3.1.12 *loose fill system*—a surface system consisting of small independent, moveable components such as sand, gravel, wood chips, engineered wood fiber, rubber particles, and like materials.

3.1.13 *surface system*—all materials that contribute to the impact absorption of force to minimize the likelihood of a life threatening head injury under and around a piece of playground equipment.

3.1.14 *theoretical drop height*—equates the measured velocity of the headform to a height that would generate the same velocity if the test were performed at sea level and there was no friction to retard the headform during a drop from that height.

3.1.15 *unitary system*—a surface system consisting of one or more components bound together, such as foam composites, urethane/rubber systems such as prefabricated blocks, tiles, or mats or as poured in place, and like materials.

4. Significance and Use

4.1 This guide is to be used to assist the playground owner/operator, specifier, designer, etc., in determining the properties that can be considered with regard to the protective surfacing in the playground. It is the intent to outline the requirements associated with design, installation, and maintenance of the surface. This is not a technical document and technical information must be found in the various standards.

5. Background and Rationale

5.1 Since 1986, ASTM has been involved in the ongoing development and publishing of a standard specification for the impact attenuation of the surface systems installed under and around playground equipment. This is the work of the F08.63 subcommittee on playground surfaces. This subcommittee consists of a broad spectrum of members including testing laboratory personnel, scientists, engineers, manufacturers, safety experts, and owner/operators of playgrounds.

5.2 In 1986, Subcommittee F08.63 was given the responsibility to respond to the need for a standard for the impact-attenuating surface under and around playground equipment. Specification F1292 was first published in 1991. Since then, the specification has been revised five times in '93, '94, '95, '96, and '99.

5.3 In 1998, the subcommittee published a provisional standard specification (PS 83) for determination of accessibility for wheelchair access of surface systems under and around playground equipment. The standard was elevated to a full standard (see Specification F1951) in 1999.

6. Factors to Consider in the Selection and Specification of Surface Systems

6.1 *Types of Material*—Every surface system is unique in material, formulation, composition, and source of raw materials and should be tested to confirm conformance with the ASTM specifications as identified within this guide (Specifications F1292, F1951, and F2075).

7. Impact Attenuation

7.1 The initial work of Subcommittee F08.63 was especially important since injuries sustained from falls to the surface were determined to be 60 % of all playground injuries.

7.2 There are two measurements considered in the guide. The first is the *g*-max and the second is the HIC or Head Injury

[5] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

[6] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

Criteria. It should be recognized that serious injuries (for example, long bone injuries and so forth) might occur even though the playground surfacing system meets the requirements of Specification F1292. Lower values of *g*-max and HIC signify better performance for impact absorption.

7.3 *The g-max*—The *g*-max is the measurement of the peak deceleration of an instrumented metal headform when it impacts the surface. When the object falls from the same height onto a hard surface such as concrete, the impact duration will be very short and therefore the peak deceleration (*g*-max) will be high, but an impact on a resilient surface that yields and deforms with the force, results in a longer impact and a lower peak deceleration (*g*-max).

7.4 *Head Injury Criteria (HIC)*—A measure of impact severity that considers the duration over which the most critical section of the deceleration pulse persists as well as the peak level of the deceleration.

7.5 *Critical Height*—The maximum height from which the instrumented metal headform, upon impact, yields either a *g*-max that does not exceed 200 g's or HIC exceeding 1000, when tested in accordance with the procedure described in Specification F1292. The United States Consumer Product Safety Commission states that "critical height—the fall height below which a life-threatening head injury would not be expected to occur."

7.5.1 The surfacing material used under and around a particular piece of playground equipment should have a critical height value of at least the height of the highest designated play surface on the equipment.

7.5.2 The CPSC Handbook for Public Playground Safety (see 2.3), Specification F1487 for play structures, as well as other national standards (see Section 2), provide fall heights for various pieces of playground equipment.

7.6 *Testing:*

7.6.1 *Laboratory Testing (Three Temperatures)*—Specification F1292 recognizes that children play in climates with diverse temperature ranges. For this reason, the materials that are used under playground equipment are required to be tested in a laboratory at the temperatures of 30°F, 72°F, and 120°F (–1°C, 23°C, and 49°C) to determine the height from which the *g*-max does not exceed 200 or the HIC does not exceed 1000. The determination of this height is the critical height. When selecting an appropriate playground surface system, the owner, specifier, or purchaser, or a combination thereof, of the playground should ensure that the critical height meets or exceeds the fall height.

7.6.2 *Minimum Performance Standards*—Specification F1292 states that the pass/fail measurements for the specification are minimums.

7.6.3 *Field Testing*—Specification F1292 allows for the performance testing of the playground surface in the field. Both the *g*-max must not exceed 200 and the HIC must not exceed 1000 (the same as the laboratory test). The fall height is determined by the appropriate playground equipment standard (for example, in the United States, Specification F1487, in Canada, CSA Z614), however, the purchaser may specify a higher drop height consistent with the specification at the time of purchase. The specification requires that the drops take place at a minimum of three locations for each play structure or functionally linked play structures in a playground site and shall include those areas that may exhibit less than optimal impact characteristics. These areas may be high traffic or compressed areas as well as areas containing seams, partitions, corners and fasteners, or anchors. The equipment operator shall be trained in the proper orientation of the test instrument by a competent agency.

7.6.3.1 A failure for impact attenuation of the field test will be where the average of the last two of three drops at the exact same location and drop height using the procedure in the standard from the drop height specified by the purchaser for the surface produces a *g*-max greater than 200 or a HIC greater than 1000. These tests can be carried out at any ambient temperature. If the surface fails, the guide requires the owner/operator of the playground to repair or replace the failed surface with a surface that will comply with the standard or take the applicable part of the playground (play structure and surface) out of service until the surface can be brought into compliance.

7.6.4 The guide allows for the surface material to be tested in a laboratory to simulate wet and frozen conditions.

8. Wheelchair Work Measure for Accessible Surfacing Systems

8.1 In 1996, it was determined that there was a need for a performance standard to determine the suitability of surfacing for persons with disabilities. The result was Specification F1951.

8.2 *Laboratory Testing*—The tests for determining accessibility for surfacing materials are performed on a prepared test bed of the material being tested. Testing is performed with the sample temperature in the range of 40 to 100°F. A rider, weighing 165 + 11 – 4.4 lb, propels a wheelchair in a straight line, as well as turning 90°, on the sample surface. Five trials are run for each test, with the high and low values discarded, and an average is taken from the remaining three. For loose fill systems, the sample is prepared each time the test is performed. The work per foot required to navigate on the surface shall not exceed the work per foot required to navigate a 7.1 ± 0.2 % grade on a hard, smooth surface. The owner/operator of the loose fill surface material that meets Specification F1951 must understand that maintenance such as smoothing and filling of depressions as a result of traffic and active play will be required.

8.2.1 *Minimum Performance Standards*—Specification F1951 states that the pass/fail measurements for the standard are minimums. A requirement of Specification F1951 is that the surface must also meet the requirements of Specification F1292.

9. Criteria for Engineered Wood Fiber

9.1 In 2001, Subcommittee F08.63 approved and ASTM subsequently published a new specification, Specification F2075 that describes the technical requirements for engineered wood fiber. There are a number of tests performed on the

subject material and the owner/operator should request test certificates. This specification ensures the quality of product.

9.2 *Laboratory Testing*—The testing for this guide is performed in the laboratory for particle size and distribution, heavy metals, and tramp metal, and at the manufacturing facility.

9.2.1 *Sieve Analysis*—Testing is done by passing the material through a specified number of sieves to determine % of each particle size in the sample of the engineered wood fiber. The specification states the acceptable values.

9.2.2 *Hazardous Metals*—Heavy metals, such as, but not limited to, lead and mercury, are extracted from a sample of engineered wood fiber in a hydrochloric acid solution and analyzed for the presence of heavy metals. The specification states the acceptable levels of various chemical elements. (Acceptable levels were determined by reference to Specification F963.)

9.2.3 *Tramp Metal*—Samples of engineered wood fiber are tested for the presence of ferrous metal by using a rare earth magnetic probe. The sample pile is probed 112 times. The number of tramp metal pieces ½ in. or greater in size may not exceed 0 for every 50 cubic yards analyzed.

9.2.4 *Minimum Performance Standards*—Specification F2075 states that the pass/fail measurements for the specification are minimums. A requirement of Specification F2075 is that the surface must also meet the requirements of both Specifications F1292 and F1951.

10. Standard Guide for Poured-In-Place Surface Systems

10.1 In January 2007, ASTM published Guide F2479, which is under the responsibility of subcommittee F08.63, to help with better understanding of poured-in-place surfaces. This standard describes various considerations, potential problems and a selection of solutions that should result in surfaces with extended functional longevity.

10.2 *Terminology*—There is a long list of terms and a discussion of the actual use and importance of the terms in relation to the topic. This vocabulary will add to the clear communication between the various users of the standard.

10.3 *Description of Poured-In-Place Surface Systems*—There is a section that specifically describes the type of surface system that is covered in the guide and limits the discussion to this type of surfacing. Poured-in-place includes those types of surfaces that consist of rubber materials bonded with a polymer binder and installed in one or more layers and mixed and poured at the installation site.

10.4 *Issues Related to Installation and Technique*—A critical factor in the initial and long-term success of the poured-in-place surface is the ability of the crew to consistently install and correct for changes that can occur during the installation and detrimentally affect the outcome. A well trained crew will be able to respond to the environmental changes at the site of installation that could lead to a premature failure.

10.5 *Issues Related to Environment During Installation and Curing Period*—The chemical components of the poured-in-place system are affected by both temperature and humidity. Initially binders must be selected that will perform well in the general conditions of the installation as to temperature and humidity. There are other considerations of the changes in temperature, ground or air, and humidity during the installation and during the initial 48 to 72 h following the installation.

10.6 *Maintenance of the Poured-In-Place Surface System*—Every poured-in-place surface system will require some form of maintenance. This could be the regular cleaning of the surface to removal of snow or ice with the surface becomes contaminated and is expected to function for play. Other maintenance could involve rejuvenation and professional care. Failure to perform the required maintenance could result in a premature failure of the system.

10.7 *Repair of the Poured-In-Place Surface System*—Should a poured-in-place surface need some form of repair, it is important that the owner/operator have detailed information on what repairs they can perform with untrained personnel and what repairs will require specialized labor before it would need to be replaced.

10.8 *Warranties*—Any warranty which is provided should clearly state the terms of the warranty and what is covered by the warranty, including, if appropriate, compliance with any ASTM standards.

10.9 *Documentation*—There are consideration and recommendations for the documents that should be collected at the time of installation and during the life of the playground.

10.10 *Compliance to Standards*—When used as an impact attenuating surface under or around playground equipment the surface must comply with Specification F1292.

11. Loose-Fill Rubber

11.1 In 2014 ASTM published Specification F3012. This standard defines the technical requirements for loose-fill rubber mulch used in and around playground equipment including performance requirements for size, hazardous metal content, tramp metal content, sharp metal content and lead content.

11.2 *Sampling*—The sampling method as defined in the standard is designed to generate a random sample from 15 yd^3 of material. The standard defines the sampling process.

11.3 *Testing*—Testing for this standard is performed in a laboratory and during the manufacturing process.

11.4 *Size*—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. Loose fill rubber is manufactured in two general shapes: Nuggets and buffings. The specification states the acceptable values for each shape of loose fill rubber.

11.5 *Hazardous Metal Content*—Loose-fill rubber hazardous metal content is determined using a procedure contained in Specification F963 and tests for hazardous metals including, but not limited to, arsenic, lead, and mercury. 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. The pass/fail criteria is defined in the standard.

11.6 *Tramp Metal Content*—The presence of tramp metal 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 hand magnet as specified in the standard. Tramp metal is tested for sharpness according to the procedure in 16 CFR 1500.48. Pass/fail criteria for tramp metal required not exposed metal greater than 0.50 in. (12.7 mm) and no sharp metal greater than 0.20 in. (5 mm) in length.

11.7 *Lead Content*—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 Test Method E1613. Pass/Fail Criteria is specified in the standard.

12. Records

12.1 For compliance to Specifications F1292, F1951, or F2075, the owner/operator must obtain and inspect a copy of the test certificate/report and satisfy themselves that the tested product and proposed product for installation are one and the same. The owner/operator may elect to perform field-testing following installation and on an ongoing basis of the surface system to ensure the surface system meets the specifications claimed by the manufacturer/supplier with respect to Specification F1292.

12.1.1 A requirement of Specification F1487:

12.1.1.1 Section 9.1 requires that there be an obstacle free surface in the use zone that conforms to Specification F1292.

12.1.1.2 Section 11.2.2 requires that the owner/operator shall install protective surfacing that conforms to Specification F1292.

12.1.1.3 Section 13.2.1 states that the owner/operator shall maintain the protective surfacing within the use zone for each play structure in accordance with Specification F1292 appropriate for the fall height of each structure.

12.1.2 The accessibility requirement of Specification F1487:

12.1.2.1 Section 10.1.2 states that an accessible route shall conform to Specifications F1292 and F1951.

12.1.2.2 Section 11.2.2 states that the owner/operator install the protective surface to conform with Specification F1951 where applicable.

12.1.2.3 Section 13.2.1 states that the owner/operator shall maintain the applicable surface to Specification F1951.

13. Keywords

13.1 accessibility; *g*-max; HIC; impact attenuation; playground; shock attenuation; surface system; wood fiber