



Standard Test Method for Impact Attenuation of Playing Surface Systems, Other Protective Sport Systems, and Materials Used for Athletics, Recreation and Play¹

This standard is issued under the fixed designation F355; 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 This test method measures the impact attenuation of surface systems and materials, specifically the peak impact acceleration (“impact shock”) and calculates the Head Injury Criteria produced under prescribed impact conditions.

1.2 This test method is applicable to surface systems intended to provide impact attenuation, made of naturally occurring or synthetic materials.

1.3 This test method is applicable to impact attenuating mats and padding used in sports facilities, including, but not limited to: stadium wall padding, gymnastic mats, wrestling mats, turf playing systems, pole vault landing systems, and playground protective surfacing.

1.4 This test method is used to measure the impact attenuation of materials and components used as protective padding on trampoline frames, goal posts, etc., provided the material or component can be tested separately from the equipment to which it is attached.

1.5 Without modifications, this test method shall not be used to test materials and components that are attached to structures or equipment or finished products, unless the impact attenuation of the whole system is of interest.

1.6 While it is widely believed that lower values for impact attenuation can reduce the severity of impact-related injuries, the relationships between the results of this test method and specific injury risk are within automotive testing data.

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

1.8 *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 appro-*

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

1.9 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

D5874 Test Methods for Determination of the Impact Value (IV) of a Soil

E105 Guide for Probability Sampling of Materials

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F1702 Test Method for Measuring Impact-Attenuation Characteristics of Natural Playing Surface Systems Using a Lightweight Portable Apparatus

F2650 Terminology Relating to Impact Testing of Sports Surfaces and Equipment

2.2 SAE Standard:

SAE J211/1 Instrumentation for Impact Tests - Part 1 - Electronic Instrumentation (rev. July 2007)³

3. Terminology

3.1 Definitions of terms related to impact testing of sports surfaces equipment are found in Terminology **F2650**, except as noted.

3.2 Definitions:

¹ This test method is under the jurisdiction of ASTM Committee **F08** on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee **F08.52** on Miscellaneous Playing Surfaces.

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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 SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

3.2.1 *drop height, n*—height from which the missile is dropped during an impact test, measured as the vertical distance between the lowest point of the elevated missile and surface under test.

3.2.2 *head injury criterion (HIC), n*—a specific integral of the acceleration-time history of an impact, used to determine relative risk of head injury. See [Appendix X1](#).

3.2.3 *HIC interval, n*—the time interval within the acceleration-time history of an impact over which the HIC integral is evaluated.

3.2.4 *impact, n*—contact caused by a moving object (for example, an impact test missile) striking another object (for example, a surface) and during which one or both bodies are subject to high accelerations.

3.2.5 *impact test, n*—a procedure in which the impact attenuation of a playground surface or surfacing materials is determined by measuring the acceleration of a missile dropped onto the surface.

3.2.6 *free-fall impact test, n*—an impact test in which the trajectory of the missile is not restrained by rails, wires, or mechanisms or structures of any type.

3.2.7 *impact test results, n*—one or more measured or calculated values from one or more impact tests used to define the impact attenuation of a playground surface or surfacing materials.

3.2.8 *impact test site, n*—point on the surface of an installed playground surface that is selected as the target of an impact test.

3.2.9 *impact velocity, n*—the velocity (V_0) of a falling body (for example, a missile) at the instant of impact.

3.2.10 *missile, n*—a rigid object of specified mass and dimensions; used to impart an impact to a surface.

3.2.11 *impact test system, n*—a device or system for performing an impact test in which an instrumented missile is used to impact the surface or surfacing materials as specified in the appropriate specification or test procedure.

3.2.12 *missile reference plane, n*—the plane of the flat circular face of the hemispherical missile.

3.2.13 *reference drop height, n*—a specification of the drop height of an impact test.

3.2.14 *reference MEP pad, n*—a modular elastomer programmer pad with consistent and known impact attenuation properties that is used to verify proper functioning of the impact test equipment.

3.3 Definitions of Terms Related to the Measurement of Acceleration Used in Annexes:

3.3.1 *accelerometer, n*—a transducer for measuring acceleration.

3.3.1.1 *sensor, n*—alternative term for accelerometer.

3.3.1.2 *transducer, n*—the first device in data channel, used to convert a physical quantity to be measured into a second quantity (such as an electrical voltage) which is processed by the remainder of the channel.

3.3.1.3 *triaxial accelerometer, n*—a transducer or combination of transducers used for measuring the three vector components of acceleration in three dimensions, relative to three orthogonal spatial axes.

3.3.2 *accelerometer data channel, n*—all of the instrumentation used to communicate information about the physical quantity of acceleration from its origin to the point of presentation.

3.3.2.1 *Discussion*—The data channel includes all transducers, signal conditioners, amplifiers, filters, digitizers, recording devices, cables and interconnectors through which the information passes and also includes the analytical software or procedures that affect the frequency, amplitude, or timing of the data.

3.3.3 *Z axis, n*—axis of motion (fall) perpendicular to a horizontal surface.

3.3.4 *Y axis, n*—one of two axes forming a plane parallel to a horizontal surface.

3.3.5 *X axis, n*—one of two axes forming a plane parallel to a horizontal surface.

4. Summary of Test Method

4.1 A test specimen or installed surface system is impacted at a specified velocity or from a specified height with a specific missile of given mass and geometry as stipulated in a specification or test method. An accelerometer mounted in the missile is used to record the acceleration-time history of the impact. The peak acceleration and duration are used as a measure of impact severity.

4.2 This test method defines two missiles for use in playing surface impact tests:

4.2.1 *Missile A* has a cylindrical impacting surface, with specified mass and geometry and a circular, flat, metal impacting surface. This missile is used with a friction free guidance tube.

4.2.2 *Missile E* has a hemispherical impacting surface of specified mass and geometry and is used with a support structure and without a guidance system (“free-fall”).

4.2.3 Both missiles shall be fitted with triaxial accelerometers.

4.2.4 The specific masses and geometries of the missiles are detailed in [Annex A1](#).

5. Significance and Use

5.1 The results of this method quantify the impact attenuation of playing surface and system specimens under the specific test conditions, either within a laboratory or the location the surface system is installed for use.

5.2 The test method measures the outcome of impacts performed under specific conditions. It does not quantify the intrinsic material properties of the tested specimens.

5.3 Test results from different specimens obtained under the same conditions (that is, the same missile mass and geometry, drop height, etc.) are used to compare impact attenuation under those conditions.