



# Standard Terminology Relating to Impact Testing of Sports Surfaces and Equipment<sup>1</sup>

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## 1. Scope

1.1 This terminology covers terms related to impact test methods and impact attenuation specifications of sports equipment and surfaces.

1.2 This terminology is appropriate for use in the development of standards that describe gravity-driven impact test methods or specify impact attenuation performance criteria and which fall under the jurisdiction of ASTM Committee F08 on Sports Equipment and Facilities.

1.3 This terminology defines common terms that are applicable to many sports-related impact tests including those used in the context of sports surfaces, athletic footwear, protective equipment and padding. The use of a common terminology will promote greater consistency among standards and reduce the risk of misinterpretation.

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

## 2. Terminology

### 2.1 Definitions:

**acceleration**,  $n$ —rate of change of velocity with time.

DISCUSSION—Acceleration is a vector quantity, having both magnitude and direction. Acceleration magnitude is expressed in units of  $m/s^2$  ( $ft/s^2$ ) and direction is defined relative to a Cartesian coordinate system or other spatial reference frame.

**assisted impact test**,  $n$ —an impact test in which the missile is accelerated by means other than gravity alone, for example, by an actuator.

**drop height** ( $h$ ),  $n$ —height from which a missile is dropped during a gravity-driven impact test, measured as the vertical distance between the lowest point of the elevated missile and its first point of contact with the impacted surface or anvil.

*theoretical drop height*,  $n$ —drop height ( $h$ ) that, under standard conditions, would result in an impact velocity equal to a missile's measured impact velocity ( $V_0$ ).

DISCUSSION—The “standard conditions” assume standard gravity and that friction and air resistance do not affect the fall of the missile. In a free-fall impact test the actual drop height will approximate the theoretical drop height. In a guided impact test, the theoretical drop height will be less than the actual drop height, due to the effects of friction in the guidance mechanism.

**g**,  $n$ —(pronounced “gee”) a unit of acceleration equal to standard gravity. Missile accelerations expressed in ‘g’ units are the ratio of the missile acceleration to standard gravity and are hence dimensionless.

DISCUSSION—The symbol  $g$  is properly written in lowercase and italic, to distinguish it from the symbol  $G$  (uppercase, used to indicate the gravitational constant) and  $g$  (not italicized) which is an abbreviation of the gram unit.

**g-max**,  $n$ —maximum acceleration magnitude recorded during a single impact, expressed in ‘g’ units.

*average g-max*,  $n$ —arithmetic average of a specified set of g-max values.

**gravity-driven impact test**,  $n$ —an impact test in which the missile is accelerated by gravity alone, during a period of free-fall.

**head injury criterion (HIC)**,  $n$ —weighted impulse criterion calculated from a head impact acceleration-time profile and used to quantify head impact severity. The HIC calculation results in a severity index that is weighted by both impact acceleration magnitude and by the time for which high magnitude accelerations persist.

DISCUSSION—HIC scores can only be directly referenced to the head injury risk data on which the criterion is based if the impact acceleration-time profile is recorded using a human head or a biofidelic headform. HIC scores determined using rigid missiles and headforms tend to over estimate head injury risk.

**headform**,  $n$ —missile with mass and geometry approximating those of the human head.

*biofidelic headform*,  $n$ —headform with elastic properties approximating those of the human head.

*rigid headform*,  $n$ —headform fabricated from very stiff materials (for example, steel or aluminum) such that its deformation during an impact is negligible.

<sup>1</sup> This terminology is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.80 on Common Terminology, Methods and Laboratory Practices.

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**impact attenuation, *n***—reduction of loads produced in the course of an impact by means of a cushioning system or device, relative to a load criterion or to the loads produced by a reference system.

DISCUSSION—Load measures used to quantify impact magnitude include force, acceleration, stress and pressure and their time derivatives.

**impact energy, *n***—the kinetic energy of a missile at the instant of initial contact with the target.

DISCUSSION—In a gravity-driven test, impact energy is equal to the potential energy of the missile at the theoretical drop height. See also **total energy input**.

**missile, *n***—in a gravity-driven impact test, the object mass that falls under gravity to produce an impact.

**reference plane, *n***—plane parallel to the surface or normal to the path of the missile and from which missile displacement is measured.

**rigid surface, *n***—a reference surface (for example, a concrete surface covered by a steel plate) used as the basis for measuring force reduction.

*shock absorption, *n**—see **shock attenuation**.

**shock attenuation, *n***—impact attenuation where the measure of load is the peak magnitude of acceleration produced by an impact. (See **impact attenuation**.)

**standard gravity, *n***—nominal value of the acceleration due to gravity at sea level having an international standard value of exactly 9.80665 m/s<sup>-2</sup> (approximately 32.174 ft/s<sup>-2</sup>).

**time to g-max, *n***—elapsed time from the onset of impact until the time at which g-max occurs.

DISCUSSION—Depending on the application, the “onset of impact” may be defined as the time at which the missile intersects a zero reference plane or as the time at which a measured deceleration of the missile exceeds a small threshold value.

**total energy input, *n***—the total energy transferred to the target, up to the point of maximum target displacement, the sum of the impact energy and the additional potential energy transferred during target displacement.

### 3. Keywords

3.1 athletic equipment; athletic field; impact; impact testing; playground equipment; playground surfaces; sports; sports equipment; sports field; sports surfaces

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