



Standard Test Method for Impact Attenuation Properties of Body Padding and Protective Wear for the Sport of Fencing¹

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1. Scope

1.1 This test method covers a comparative measurement method for impact absorption properties for body padding and protective wear (apparel) for the sport of fencing. The apparel includes fencing mask bibs, underarm protectors or plastrons, padded vests, uniform jackets, knickers or trousers, gloves, and other protection worn to protect against impacts from the fencing weapon's tip (for example, touches) for foil, saber, or épée. The scope of this test method excludes measurement or performance for perforation resistance of the blade, whether in tact or broken.

NOTE 1—This is a simple test method to discriminate between qualities of different padding materials or systems under an impact that simulates the delivery of a fencing touch. It does not purport to measure quantitative impact energy absorption values at thrust sites. Until in-field data become available, this standard allows manufacturers to intercompare padding systems, fabrics, materials, or composites for protective fencing wear for integrity, robustness, and impact attenuation.

1.2 *This standard does not purport to address all of the safety problems associated with fencing padding and will not prevent all injuries due to blades impacting fencers. It is the responsibility of the users of the protective padding to establish appropriate safety practices, including maintaining safe fencing distances and care and inspection of the protective wear as well as the blade. Specifically, this standard does not address degradation of the protective padding with use and laundering, or performance of the padding for puncture resistance by thrusts involving in-tact or broken blades. It should be recalled that the sport derives from duelling and is inherently not free of risk of injury or death.*

2. Referenced Documents

2.1 ASTM Standards:

E 105 Practice for Probability Sampling of Materials²

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

¹ This test method is under the jurisdiction of ASTM Committee F-8 on Sports Equipment and Facilities and is the direct responsibility of Subcommittee F08.13 on Fencing.

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² Annual Book of ASTM Standards, Vol 14.02.

3.1.1 *acceleration (deceleration)*—the instantaneous time rate of change of velocity, either positive (acceleration) or negative (deceleration).

3.1.2 *anvil*—the impacting surface upon which the test specimen or representative sample is placed.

3.1.3 *attenuation factor*—the ratio, $G_{max}(av)$ of the sample divided by $G_{max}(av)$ of the modular elastomer pad (MEP).

3.1.4 *bib*—the protective covering for the neck area of a fencer, attached to the lower front and sides of the fencing mask.

3.1.5 *fencing jacket*—a protective garment that is worn over other protective wear such as the underarm protector, breast protectors, and other optional protection. It is the garment that receives the opponent's touches to the upper body and full torso.

3.1.6 *g*—the acceleration of matter due to gravity at the surface of the earth.

3.1.7 *G*—the ratio of the magnitude of missile deceleration during impact to the acceleration of gravity, *g*. Hence, *G* values are dimensionless.

3.1.8 G_{max} —the maximum value of *G* encountered during impact.

3.1.9 $G_{max}(av)$ —the arithmetic average of the set of G_{max} values as stipulated in this test method.

3.1.10 *glove*—the protective garment for the hand holding the weapon.

3.1.11 *impact attenuation*—the deceleration of an object upon impact on an object, measured in units of *g*.

3.1.12 *knickers or trousers*—a protective garment that covers the lower half of the torso and the legs to below the knees. The fencing knickers or trousers area must pass a puncture test established by the FIE.

3.1.13 *missile*—the impacting device that is used to drop onto the test specimen placed on the anvil.

3.1.14 *modular elastomer pad*³ (MEP)—6 in. (152 mm) diameter, 1 in. (25 mm) thick, 60 ± 5 durometer (Shore A) impact surface.

3.1.15 *padding or protective wear*—the equipment or garments worn by fencers or coaches to reduce the impact of the incoming tip of the foil, saber, or épée blade in the sport of fencing. The U.S. Fencing Association issues specifications for

³ The MEP impact surface required for this test (Model #9000-122) is available from U.S. Testing Co., Inc., of 1415 Park Avenue, Hoboken, NJ 07030.

fencing equipment and wear in its rule book⁴, but not for padding performance.

3.1.16 *padding system*—protective wear intended to absorb or deflect, or both, a portion of the energy imparted by impacts on it. A padding system can consist of several dissimilar layers.

3.1.17 *robustness or integrity*—resilience of the protective padding to impacts by visual inspection for signs of permanent deformation, stretching, or rupture.

3.1.18 *tip*—the far end of the weapon's blade with which the opponent is touched and scores are registered.

3.1.19 *touches*—the delivery of a point (all three weapons) or a cut (saber) to the opponent.

3.1.20 *underarm protector or plastron*—a sleeve worn on the arm holding the weapon (foil, saber, épée), under the fencing jacket. This protector is multi-layered and does not have a seam where the fencing jacket has its seam.

3.1.21 *weapon*—the fencing equipment that is used for delivering the touches to the opponent. The weapon is either a foil, a saber, or an épée, each with different scoring rules, but with similar mechanical functions in connection with the impact attenuation property requirements addressed in this test method. Dimensions of fencing weapons are described in the U.S. Fencing Association rule book.⁴

4. Summary of Test Method

4.1 General:

4.1.1 *Purpose*—The purpose of this test method is to allow for comparative testing of padding systems. This is not an absolute test of energy absorption of the padding system but allows manufacturers to choose the better from among choices for padding systems, by comparing G_{max} values as well as visual inspection for identical tests done on different padding systems.

4.1.2 *Approach*—A test specimen is impacted with a missile of specified configuration from a specified height yielding a known velocity at impact. A transducer can be mounted on the missile to monitor the acceleration-time history of the impact that is recorded with the aid of an oscilloscope or other recording device. This is necessary to analyze the impact attenuation but is not necessary for studying the relative robustness or integrity among a set of samples studies under identical test parameters in the test region of padding system distortion, deformation, or failure.

5. Significance and Use

5.1 Dynamic data obtained by this test method are indicative of the impact attenuation properties and provide information regarding relative performance of protective wear used by fencers exposed to weapon blade thrusts. This test method addresses all four types of protective wear.

6. Classification

6.1 Types of Protective Wear or Padding Systems:

6.1.1 *Type I*—Fully flexible garments such as sleeves for the arm away from the opponent and the lower body (trouser knees, knee socks).

6.1.2 *Type II*—Somewhat flexible padding systems such as for jackets, underarm protectors, and optional padded under-jackets or vests. This type of padding typically covers areas of the armed arm and the upper and lower half of the torso, especially the side exposed to the incoming touches (right side for right-handed fencers, left side for left-handed fencers).

6.1.3 *Type III*—Semi-rigid padding systems for mask bibs, backs of fencing gloves, and masters' jackets or plastrons.

6.1.4 *Type IV*—Fully rigid, inflexible surfaces upon impact by forces of 800 N or more.

7. Apparatus

7.1 *Configuration*—Guided free-fall drop test apparatus is described that tests the padding system on a MEP anvil secured onto a rigid substrate with a missile at a given impact velocity determined by the drop height. The missile can be guided by either a monorail or a guide wire for best quantitative reproducibility. A guiding pipe can also be used, provided the inside is smooth and the fit does not add significant friction (less than 2 % energy absorption). The anvil mass should be at least 100 times that of the missile. The test machine and missile shall have sufficient rigidity to eliminate undesirable vibrations in the apparatus that might cause added forces at the time of impact and reflected on any data recording. The apparatus optionally can monitor and record quantitatively the acceleration versus time graph on an oscilloscope.

7.1.1 Configurations:

7.1.1.1 Configuration A for flat padding systems, such as bibs or jacket surfaces that can rest flat on the test area. A flat modular elastomer pad (MEP) is used as anvil.

7.1.1.2 Configuration B for curved protection, such as a breast protector, using a curved, raised MEP so that the sample rests fully on the MEP.

7.2 *Missile*—The missile shall consist of an 8.00 ± 0.05 lb (3.64 ± 0.02 kg) steel cylinder with a foil tip or épée tip mounted at the bottom, as specified in Fig. 1. The foil (or épée) tip measuring approximately 2.9 (foil) to 3.0 (épée) cm long (including the button at the end), protrudes at the bottom of the flat cylinder, preventing the cylinder from making contact with the test specimen upon impact. (The accelerometer is fastened at the collar to within 5° of the vertical axis of the missile. The foil tip will give a more severe impact test because its diameter is one millimeter smaller than that of the épée tip.)

7.3 Recording Equipment:

7.3.1 *Acceleration Time*—The selection of the specific acceleration-time recording equipment, including transducers and recorders, is optional. However, the recording system shall have a frequency response adequate to measure the peak acceleration value to an accuracy of ± 5 %. The total system, detection and recording, shall be capable of measuring impulses up to 500 g at frequencies of 2 to 1000 Hz to an accuracy of ± 5 %.

7.3.2 *Impact Velocities*—The dynamic test equipment must have a means of recording these velocities of the missile to an accuracy of ± 5 %, within 2.54 cm of the point of impact. Any method that does not physically interfere with the impact to give erroneous data is acceptable.

7.3.3 *Displacement Time*—It is optional, but desirable, that the displacement-time history also be recorded. Any method

⁴ *Fencing Rules*, United States Fencing Association, Inc., One Olympic Plaza, Colorado Springs, CO, 1991.