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An American National Standard

Standard Specification for Body Protectors Used in Horse Sports and Horseback Riding[1]

This standard is issued under the fixed designation F1937; 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

Horse sports and horseback riding are sports with intrinsic hazards. It is recognized that it is not possible to write a body protector performance standard that will result in products that can protect against injury or death in all accidents. It is also recognized that serious injury or death can result from both low-energy and high-energy impacts, even when body protectors are worn. It is further recognized that protective body protectors must be acceptable to the user and to the regulating associations or agencies requiring their use. Acknowledging these limitations, this specification was developed using resources in medical, scientific, engineering, human factors, and biomedical fields.

This specification incorporates many aspects of other recognized body protector performance standards. This specification draws from work done by others where appropriate for this specification. These standards may be referenced. It should be noted that this specification specifies a laboratory test of a completed body protector's ability to reduce impacts.

1. Scope

1.1 This specification covers minimum performance criteria and describes test methods for body protectors for use in horse sports and horseback riding.

1.2 It is not the intention of this specification to bar from consideration materials of improved quality or performance not known at the time of development of this specification.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

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

1.5 *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]

F1045 Performance Specification for Ice Hockey Helmets

F1446 Test Methods for Equipment and Procedures Used in Evaluating the Performance Characteristics of Protective Headgear

2.2 *BETA Standard:*[3]

BETA 1.24.4.95 Standard for Horse Riders' Body and Shoulder Protectors

2.3 *National Institute of Justice Standard:*[4]

NIJS 0101.03 Ballistic Resistance of Police Body Armor

2.4 *SAE Standard:*[5]

SAE J211 Recommended Practice for Instrumentation for Impact Tests—Requirements for Channel Class 1000

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*In addition to terms defined in Test Methods F1446, the following terms are specific to this specification:

[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 F08.55 on Body Padding.

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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 the British Equestrian Trade Association Ltd., Worthersome Grange, Bramham, Nr. Wetherby, Yorkshire, LS23 6LY.

[4] Available from National Institute of Justice (NIJ), 810 7th St., NW, Washington, DC 20531, http://www.ojp.usdoj.gov/nij.

[5] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

3.1.1 *backing material*—block of non-hardening, oil-based modeling clay in contact with the back of the body protective test specimen during impact deformation testing.[6]

3.1.2 *body protector*—sleeveless garment covering defined areas of the torso and lower back and consisting of one or more layers of material and designed to reduce trauma from blunt impacts and falls.

3.1.3 *bust girth*—maximum horizontal girth measured during normal breathing with the subject standing upright and the tape-measure passed over the scapulae under the armpits and across the breasts: normal underclothing to be worn.

3.1.4 *calibration impact surface*—impact surface shall be a flat modular elastomer programmer (MEP). The MEP is 6.0 in. (152 mm) in diameter, and 1.0 in. (25 mm) thick. It is affixed to the top surface of a flat, 0.25 in. (6.35 mm) thick aluminum plate. The durometer of the MEP is 60 ± 2 Shore A.

3.1.5 *chest girth*—maximum horizontal girth measured during normal breathing with the subject standing upright and the tape-measure passed over the scapulae under the armpits and across the chest.

3.1.6 *deformation*—maximum displacement of the back surface of the body protector, during impact as defined in 9.3.

3.1.7 *depth*—depth of the depression is the distance from the original undisturbed surface of the backing material to the lowest point of the depression.

3.1.8 *impact surface*—flat anvil specified in 6.3.1.2 of Test Methods F1446 shall be used as the impact surface for the shock attenuation test (see Section 6).

3.1.9 *waist girth*—maximum horizontal girth measured during normal breathing with the subject standing upright and the tape-measure passed around the body in the plane of the waist, 2.0 in. (50 mm) above the supra-cristal plane which is at the level of the highest points of the iliac crests. The dimension of 2.0 in. (50 mm) refers to a subject of 70.0 in. (1780 mm) tall and should be scaled pro rata with the height of the actual subject.

3.1.10 *waist to waist over the shoulder length*—maximum length measured from the plane of the waist, as defined above, over the shoulder to the plane of the waist. The tape-measure crosses the shoulder at the mid point between the point of the shoulder and the junction of the shoulder to the neck. Anteriorly the tape-measure passes over the chest (or bust) to a point 3.5 in. (90 mm) lateral to the midline of the body on the plane of the waist. Posteriorly the tape-measure follows the shortest distance to a point 3.5 in. (90 mm) lateral to the midline of the body. The distances of 3.5 in. (90 mm) refer to a subject with a waist girth of 34.0 in. (860 mm) and should be scaled pro rata with the waist girth of the actual subject. Normal underclothing to be worn for the measurement.

4. General Requirements

4.1 *Materials:*

4.1.1 As defined in the ice hockey helmet Performance Specification F1045, all materials used in the fabrication of the body protector shall be known to be suitable for the intended application. All shock attenuation system materials used in the body protector shall not permanently distort during an exposure of at least 4 h to any temperature in the range from 5 ± 4 to 104 ± 4 °F (–15 ± 2 to 40 ± 2 °C), nor shall the material be significantly affected by exposure to ultraviolet radiation, water, dirt, or vibration. All materials shall be rot-resistant.

4.1.2 Materials coming into contact with the wearer's skin shall not be the type known to cause skin irritation or disease, and shall not undergo significant loss of strength, flexibility, or other physical change as a result of contact with perspiration or body oil.

4.1.3 Any material used in the construction of body protectors shall not be adversely affected by ordinary household soap and water, mild household detergent, or cleaners recommended by the manufacturer.

4.2 *Body Protector Assembly:*

4.2.1 Any optional devices fitted to the body protector shall be so designed that they are unlikely to cause any injury to the wearer or other participants during contact.

4.2.2 No rigid projections shall be on the inside of the body protector which could come in contact with the wearer's body.

4.2.3 All external projections shall be smooth and adequately faired to other surfaces.

4.3 *Extent and Form of Protective Material*—The coverage of the body protector listed in Section 5 shall protect the wearer's body to the minimum impact requirements of Section 7. The extent of protection shall include at least all of the designated areas shown in Fig. 1.

4.3.1 The body protector may have reduced thickness over the shoulder. When shoulder protectors are fitted, the body protector shoulder strap may not require any included foam.

4.4 *Attachments*—The components of the fasteners for securing attachments to the body protector shall not reduce the degree of protection afforded the wearer by the protective padding or cushioning material of the body protector.

5. Dimensioning, Sizing, and Body Coverage

5.1 The whole circumference of the torso shall be covered by the body protector.

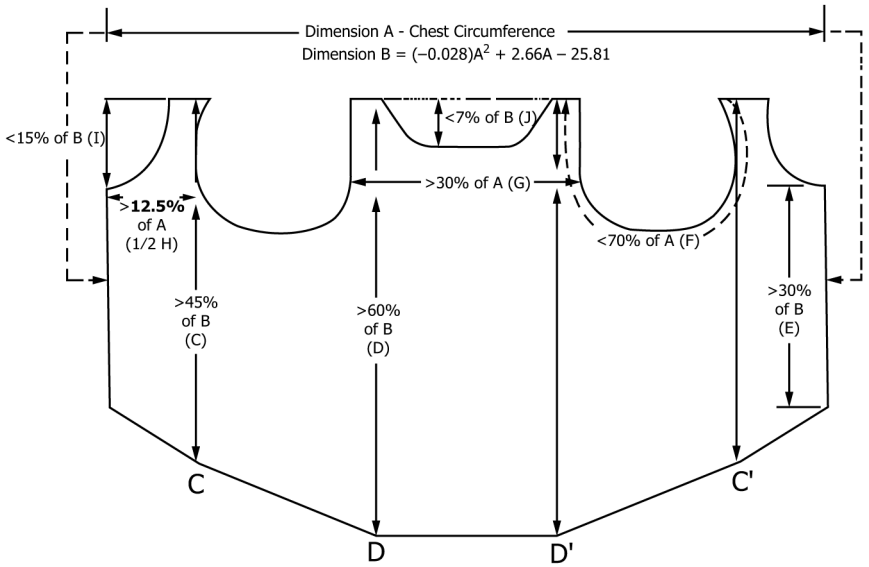
5.2 *Dimensioning*—Body protectors shall have dimensions as shown in Fig. 1. Dimension A is the mid-value of the range of the chest circumferences the manufacturer states the body protector will fit. Dimension B is equal to $B = (-0.028)A^2 + 2.66A - 25.81$.[7] Four vertical reference lines defined in BETA 1.24.4.95 are to be used: C and C' separated by 25 % of Dimension A on the chest, and D and D' separated by 25 % of Dimension A on the back.

5.2.1 The padding shall extend for more than 45 % of Dimension B along the lines C and C' (C in Fig. 1).

5.2.2 The padding shall extend for more than 60 % of Dimension B along the lines D and D' (D in Fig. 1).

[6] A backing material found to be suitable is Roma Plastilina No. 1 modeling clay as defined in NIJS 0101.03.

[7] This formula represents the mathematically calculated anthropometric mean for the waist to waist over the shoulder length for chest sizes 21 to 48.



NOTE 1—Protective material can be removed from the body protector.

FIG. 1 Diagrammatic Representation of the Protective Material in a Body Protector Flattened Out for Measurement

5.2.3 The padding shall extend for a length greater than 30 % of Dimension B in the center front (E in Fig. 1).

5.2.4 The circumference of the armhole shall be less than 70 % of Dimension A (F in Fig. 1).

5.2.5 The minimum width of the padding across the back between the arm holes shall be more than 30 % of Dimension A (G in Fig. 1).

5.2.6 The minimum width of padding across the chest between the armholes shall be more than 25 % of Dimension A (H in Fig. 1).

5.2.7 The maximum depth of the front neck opening shall be less than 15 % of Dimension B (I in Fig. 1).

5.2.8 The maximum depth of the back neck opening shall be less than 7 % of Dimension B (J in Fig. 1).

5.2.9 Padding over the top of the shoulder may be reduced to 50 % of its normal thickness in an area not extending more than 2.0 in. (50 mm) along the over-shoulder dimension line from the top of the shoulder, to the front and to the rear.

5.3 *Sizing*—Body protectors and shoulder protectors shall be marked a size. The size is to be determined by three dimensions of the persons the protector will fit. The dimensions are chest girth, waist girth, and waist to waist over the shoulder length.

6. Apparatus

6.1 *Shock Attenuation Test*—The apparatus for the shock attenuation test shall consist of the following:

6.1.1 *Guide Assembly*—The spherical impactor shall be attached to the free fall drop assembly carriage by an adjustable mounting that will allow impacts to be delivered to any point of the body protector. The carriage shall be free to slide on vertical guides. If wires are used they must be placed under at least 190 lbf (845 N) tension. The guide assembly shall not weigh more than 2.4 lb (1100 g). The total weight of the guide assembly and spherical impactor shall be 11.0 ± 0.25 lb (5000 ± 100 g).

6.1.2 *Recording Equipment*—The recording equipment shall meet the following criteria:

6.1.2.1 *Acceleration Transducer*—A linear accelerometer is mounted at the center of gravity of the spherical impactor and carriage assembly with the sensitive axis aligned to within 5° of the vertical when the spherical impactor is in the impact position. This transducer shall be capable of withstanding a shock of 1000 g without damage and shall have a frequency response (variation ±1.5 %) over the range from 5 to 900 Hz.

6.1.2.2 *Impact Recording*—The impact shall be recorded on single- or dual-trace storage oscilloscope with 0.1 mV to 20 V deflection factor, 1 to 5 ms sweep speed-division and 500 kHz bandwidth, or any digital system meeting or exceeding these requirements.

6.1.2.3 *Signal Filtering*—Acceleration data channel and filtering shall comply with SAE J211, CFC 1000.

6.1.3 *System Accuracy*—The impact recording system shall be capable of measuring shocks up to 500 g peak acceleration with an accuracy of ±5 %.

6.2 *Penetration and Deformation Test*—The apparatus for the penetration and deformation test shall consist of the following:

6.2.1 *Backing Material*—The backing material shall be in the form of a single block at least 4.0 in. (102 mm) thick and of sufficient length and width (approximately 10.0 by 10.0 in. (254 by 254 mm)) to completely back the body protector to be tested.

6.2.2 *Backing Material Box*—A box measuring at least 11.0 by 11.0 by 4.5 in. (279 by 279 by 114-mm) with at least a 10.0 by 10.0 by 4.0 in. (254 by 254 by 102 mm) square opening shall be used to hold the backing material during product test.

7. Performance Requirements

7.1 *General*—Body protectors shall be capable of meeting the requirements in this performance specification throughout

their full range of adjustment. They shall be capable of meeting these requirements at any temperature between 5 and 104 °F (–15 and 40 °C).

7.2 The velocity of any impact shall be 10.33 ft/s ± 2 % (3.15 m/s ± 2 %).

7.3 The peak acceleration of any impact shall not exceed 300 g, when test in accordance to 9.2 and 9.3.

7.4 When tested according to 9.3, post impact deformation is limited to a depth of 1.0 in. (25 mm).

7.5 When tested according to 9.4, blocks of padding in the body protector must prevent the bars from coming into effective contact with each other (with only fabric or a zip or other non-protective material between them).

7.6 When tested according to 9.5, the force to separate any closures shall not be less than 11 lbf (50 N). This requirement shall be met at 73 °F (23 °C).

8. Sampling

8.1 Submit at least one specimen body protector for each size of a protector model. At least five specimens of the protector model must be submitted for impact testing. If protector models are produced exclusively for children, the largest size should be supplied.

9. Test Method

9.1 *Impact Sites*—Each body protector shall be impacted at two sites. The center of any impact must not be less than 4.0 in. (102 mm) from any edge, and at least 4.0 in. (102 mm) from any prior impact center.

9.2 *Shock Attenuation Test*—Prior to each test, position the body protector on a support platform so that only the material that would be between the torso of the wearer and any hazard is subjected to the impact. (To effectively test an area of closure it may be necessary to separate, cut, or slit part of the body protector away from the test area.)

9.2.1 The spherical impactor as described in 3.1.8 is dropped from a theoretical drop height of 1.66 ft (0.5 m) to obtain a velocity of 10.33 ft/s ± 2 % (3.15 m/s ± 2 %).

9.2.2 The impact velocity shall be measured within the last 1.0 in. (25 mm) of travel before impact with the protector.

9.3 *Penetration and Deformation Test*—Condition the backing material according to Section 10. Place the body protector on the backing material box so that only the material that would be between the torso of the wearer and any hazard is subjected to the impact. (To effectively test an area of closure it may be necessary to separate, cut, or slit part of the body protector away from the test area.)

9.3.1 Backing material is used to fill the square opening in the backing material box so that it is flush with the surface of the box. The spherical impactor as described in 3.1.8 is dropped from a theoretical drop height of 1.66 ft (0.5 m) to obtain a velocity of 10.33 ft/s ± 2 % (3.15 m/s ± 2 %).

9.3.2 The center of any impact on the backing material must not be less than 5.0 in. (127 mm) from any wall of the backing material box, and at least 8.0 in. (203 mm) from any prior impact center.

9.3.3 The impact velocity shall be measured within the last 1.0 in. (25 mm) of travel before impact with the protector.

9.4 *Padding Separation Test*—The inside of the protector to be tested is placed on a metal bar with a cross Section of 0.6 ± 0.04 in. (15 ± 1 mm), a length of 1.8 ± 0.08-in. (45 ± 2-mm), with rounded corners (approximately 0.02-in. (0.5-mm) radius) which stands 2.8 ± 0.04-in. (70 ± 1-mm) up from a bench surface. The protector is allowed to drape naturally over the bar and be supported by the bench. A similar metal bar of mass 5.5 ± 0.25 lb (2550 ± 50 g) is placed in a groove between blocks of padding on the outer surface of the protector above the fixed block and gently rocked from side to side.

9.5 *Closures*—Test body protector closures using a spring balance or force gage. Clamp the device (spring balance or force gauge with accuracy of ±5 %) to the surface or to a free edge of the body protector, or hook around an edge while the protector is worn by a suitable subject or dummy. Gently apply the test force and measure the result. Test all closures at right angles to the line of the closure. The lower edge of the body protector is tested by being pulled up the body at four points in turn.

10. Preparation of Backing Material

10.1 The protector backing material shall be conditioned for at least 3 h at a temperature between 59 and 95 °F (15 and 30 °C), and shall be worked thoroughly to eliminate any voids. Its consistency shall be such that a depression of 1.0 ± 0.1 in. (25 ± 3 mm) in depth is obtained when a 2.2 ± 0.02 lb (1000 ± 10 g) cylindrical steel mass, 1.75 ± 0.02 in. (44.5 ± 0.5 mm) in diameter and having a hemispherical striking end, is dropped from a height of 6.5 ± 0.07 ft (2 ± 0.02 m) onto one of its square faces as described in NIJS 0101.03. Three drop tests shall be made, and the center of each impact site shall be at least 3.0 in. (75 mm) from a previous impact site and from any edge. A guide tube or other means may be used as required to assure that the striking end of the cylindrical mass impacts the backing material squarely. The backing material may be maintained at any temperature in the above range that will give it the required consistency when conducting the tests described in 9.3.

11. System Check

11.1 The system instrumentation shall be checked before and after each series of tests by dropping the spherical impactor (see 3.1.4) onto the MEP (see 3.1.4) at an impact velocity of 17.85 ft/s ± 2 % (5.44 m/s ± 2 %). The peak acceleration obtained during this impact should be 389 ± 8 g. Three such impacts, at intervals 75 ± 15 s, shall be performed before and after each series of tests. If the peak acceleration obtained in the pretest impacts differs by more than 5 % from the peak acceleration obtained in the post-test impacts, recalibration of the instruments and transducers is required and all data obtained during that series of body protector test should be discarded.

12. Conditioning

12.1 Prior to testing, condition each body protector in one of the following ways: