



Designation: E3107 – 17

Standard Test Method for Resistance to Penetration and Backface Deformation for Ballistic-resistant Torso Body Armor and Shoot Packs¹

This standard is issued under the fixed designation E3107; 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 addresses resistance to ballistic penetration and to backface deformation (BFD) for ballistic-resistant torso body armor and shoot packs.

1.2 This test method is intended for testing of soft body armor, hard armor plates, in conjunction with armor, and shoot packs mounted on a clay block as the backing assembly.

NOTE 1—This test method does not apply to ballistic helmets, inserts, trauma packs, trauma plates, or accessories.

1.3 The test method does not specify performance criteria or usage of the test results.

1.4 This test method does not address conditioning of test items.

1.5 It is anticipated that this test method will be referenced by certifiers, purchasers, or other users in order to meet their specific needs.

1.5.1 Purchasers and other users will specify the ballistic test threats to be used. Within this test method, the reference defining the ballistic test threats is called the “test threats document.”

1.5.2 In this test method, “other standards and specifications” and “unless specified elsewhere” refer to documents (for example, military standards, purchase specifications) that require the use of this test method. Purchasers and other users are responsible for the “other standards and specifications” and for specifying any requirements that supersede those of this test method.

1.6 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

1.7 *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 and health practices and determine the applicability of regulatory limitations prior to use.

1.8 *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

[E3004 Specification for Preparation and Verification of Clay Blocks Used in Ballistic-Resistance Testing of Torso Body Armor](#)

[E3005 Terminology for Body Armor](#)

[E3062 Specification for Indoor Ballistic Test Ranges for Small Arms and Fragmentation Testing of Ballistic-resistant Items](#)

[E3068 Test Method for Contact Measurement of Backface Deformation in Clay Backing During Body Armor Testing](#)

[E3086 Practice for Creating Appliques for Use in Testing of Nonplanar Soft Body Armor Designed for Females](#)

2.2 *ISO Standard:*³

[ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories](#)

2.3 *NIJ Standard:*⁴

[NIJ Standard-0101.06 Ballistic Resistance of Body Armor](#)

3. Terminology

3.1 For terms not defined in this test method, the following definitions of Terminology [E3005](#) apply: accessories, angle of incidence, backface deformation, backing assembly, backing material, backing fixture, body armor, complete penetration, fair hit, hard armor, obliquity, partial penetration, plates, shoot

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 International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁴ Available from National Institute of Justice (NIJ), 810 7th St., NW, Washington, DC 20531, <http://nij.gov>.

¹ This test method is under the jurisdiction of ASTM Committee [E54](#) on Homeland Security Applications and is the direct responsibility of Subcommittee [E54.04](#) on Personal Protective Equipment (PPE).

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pack, shot-to-edge distance, shot-to-shot distance, soft body armor, stop, strike face, test item, unfair hit, witness panel, and yaw.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *applique, n*—a three-dimensional item made from backing material that is shaped and sized for testing or conditioning a nonplanar test item.

3.2.1.1 *Discussion*—Some appliques are designed for the purpose of filling the entire space behind a nonplanar test item; other appliques are designed to assess features of a nonplanar test item.

3.2.2 *striking device, n*—device used on a clay block to establish an appropriate, flat surface on the clay backing material with respect to the backing fixture edges. **E3004**

3.2.3 *test series, n*—the set of all shots necessary to obtain the required number of fair hits on a single test item or the set of all shots necessary over multiple test items to generate ballistic response data.

3.2.4 *warmer round, n*—a projectile fired from a receiver or firearm, prior to testing, to warm the test barrel.

4. Summary of Test Method

4.1 This test method specifies the methods for assessing penetration resistance and backface deformation for ballistic-resistant torso soft body armor, hard armor plates, in conjunction with armor, and shoot packs.

4.2 A number of individual test items, each mounted on a clay block, is impacted one at a time with a number of test threats. The type and velocity of the test threats are specified in the test threats document, and the quantity and shot pattern are specified in other standards and specifications.

5. Significance and Use

5.1 U.S. Department of Defense and U.S. Department of Justice standards and specifications require assessing the penetration resistance and backface deformation of ballistic-resistant body armor.

5.2 This test method may be used by private-sector and government laboratories, manufacturers, research and development organizations, and others assessing the ballistic resistance of body armor or performing research and development of new materials.

5.3 It is intended that this test method be referenced by other standards, specifications, or test methods.

6. Test Equipment and Apparatus

6.1 Test threats shall be specified in a separate test threats document.

6.2 The ballistic test range shall meet the requirements of Specification **E3062**.

6.3 The method of measuring yaw shall be with yaw cards, flash radiography, high-speed video, or photography. Yaw shall be measured by the system to an accuracy of 1°.

6.4 Clay blocks shall be used as backing assemblies behind test items and shall meet the requirements of Specification **E3004**.

6.5 For measuring BFD, the measurement method shall be specified in other standards and specifications.

6.6 Measurement of BFD may be performed using contact or non-contact measurement instruments, and other standards and specifications will specify which method to use.

6.6.1 When the contact method for BFD measurement is used, the equipment shall be as specified in Test Method **E3068**.

7. Hazards

7.1 The ballistic tests described in this test method have inherent hazards. Adequate safeguards for personnel and property shall be employed when conducting these tests.

8. Sampling and Test Items

8.1 The test items shall be individual soft armor panels, hard armor plates, in conjunction with systems, or shoot packs.

8.2 Test item details, including quantity, size, and conditioning, shall be specified in other standards and specifications.

NOTE 2—The supplier is responsible for providing a sufficient number of test items to accomplish the required testing. It is recommended that spare test items be provided.

8.3 When the use of a spare test item is required, details about selecting the appropriate spare item shall be specified in other standards and specifications.

9. Test Requirements

9.1 The intended angle of incidence, obliquity, or other shot direction details, if any, for all shots shall be specified in other standards and specifications.

NOTE 3—Typical angles of incidence are 0°, 30°, and 45°, with most testing at angles of incidence being 0°.

9.2 When warmer rounds are necessary, a number of test threats shall be fired through the projectile firing system.

NOTE 4—Examples of when warmer rounds may be necessary include, but are not limited to, at the start of a new day of testing and upon reconfiguration of the test range.

9.3 Unless specified elsewhere, each ballistic impact shall meet the requirements listed below to be considered a fair hit. See **Annex A1** for flowchart showing the decision logic for determination of fair hit.

9.3.1 The test threat shall impact the test item at an angle of incidence or obliquity within 5° from the intended angle.

9.3.2 The test threat shall have yaw verified to be ≤5° using a yaw card, flash radiography, high speed video, or photography. Yaw shall be checked for every test threat shot.

9.3.2.1 The yaw measurement equipment shall be positioned perpendicular to the projectile line of flight. The yaw measurement equipment shall be securely mounted and anchored to maintain its required position and alignment.

9.3.2.2 When photographic means are used to assess the projectile yaw angle, the measurement shall be made as close as practical to the strike face of the test item but not more than 305 mm (12 in.) from the front of the strike face.

9.3.2.3 When yaw cards are used to assess the projectile yaw angle, the cards shall be positioned between 51 and 305 mm (2 and 12 in.) from the front of the strike face of the test item.

9.3.3 The test threat shall impact the test item no closer to the edge of the test item than the minimum shot-to-edge distance. The measurement for shot-to-edge distance shall be taken from the center of the projectile impact to the nearest edge of the ballistic material in the test item. When not specified elsewhere, the minimum shot-to-edge distance shall be 51 mm (2 in.).

9.3.4 For intended edge shots, the test threat shall impact the test item no further than the maximum shot-to-edge distance.

9.3.5 The test threat shall impact the test item no closer to a prior impact than the minimum shot-to-shot distance. The measurement for shot-to-shot distance shall be taken from the center of one projectile impact to the center of another. When the minimum shot-to-shot distance is not specified, the minimum shot-to-shot distance shall be 51 mm (2 in.).

NOTE 5—When assessing whether a particular impact location meets the minimum shot-to-shot distance requirements, the shot-to-shot distances should be measured from that impact location to all prior impact locations.

9.3.6 For grouped shots, the test threat impacts shall be within the specified spacing or pattern.

9.3.7 The test threat shall impact the clay block no closer than 106 mm (4.2 in.) from the inside edge of the clay block frame.

9.3.8 The test threat velocity shall conform to the requirements given in the test threats document. If no specification is given, the test threat velocity shall be within ± 9.1 m/s (± 30 ft/s) of the required velocity.

9.3.9 The method for determination of a shot outcome as a complete penetration shall be specified in other standards and specifications.

10. Mounting and Positioning of Soft Armor Test Items on a Clay Block

10.1 The testing of nonplanar soft armor test items intended for females requires the use of appliques as specified in Practice **E3086**, unless specified elsewhere.

NOTE 6—Appliques that may be needed for testing nonplanar soft armor test items other than those intended for females shall be specified in other standards and specifications. Testing of planar soft armor test items does not require the use of appliques.

10.2 The test item shall be positioned on a clay block such that the entire test item is supported. When the test item exceeds the size of the clay block, install backing fixture extensions coplanar with the backing material surface to allow the test item to be fully supported.

10.3 The test item, and its applique(s) for nonplanar test items, shall be held in contact with the clay block and secured using approximately 50 mm (2.0 in.) wide elastic straps, held closed by hook-and-loop fasteners. Two vertical and three horizontal straps shall be positioned such that they do not interfere with the impact points on the test item. **Fig. 1** shows examples of strapping arrangements.

10.4 The clay block shall be positioned to achieve proper bullet impact location and angle (for example, angle of incidence, obliquity) of the test threat. For any shots requiring a nonzero angle of incidence, the clay block shall be rotated to achieve the appropriate angle.

10.5 Between test threat impacts, the test item shall be manipulated by hand so that any wrinkles or bunching in the test item (caused by a previous shot) are smoothed out. No effort shall be made to recover any bullets trapped in the test item until the test series is complete.

NOTE 7—Manipulation of a bullet is allowed if the bullet will interfere with subsequent shots. The test item may be removed if necessary to smooth it out.

10.5.1 The test item shall be repositioned on the backing material such that the test item is supported by smooth backing material for a distance of no less than 76 mm (3.0 in.) in all directions around the next shot location.

NOTE 8—Instructions related to striking the backing material between shots shall be specified by other standards and specifications.

11. Ballistic Test Procedure for Soft Armor Test Items

11.1 A complete test series for the assessment of penetration resistance and backface deformation consists of individual ballistic tests being conducted on a number of individual test items, of specified size(s), as specified in other standards and specifications.

11.2 Unless specified in other standards or specifications, the shot placement, pattern, and angles of incidence shall be as specified below and as shown in **Fig. 2**.

11.2.1 All test items shall be marked with the maximum number of fair hit locations prior to taking any shots.

11.2.2 Shots 1, 2, and 3 shall meet the shot-to-edge distance requirements but shall not be located more than the shot-to-edge distance plus 19 mm (0.75 in.) from the edge of the test item. The placement of shots 1, 2, and 3 is not restricted to the locations shown in **Fig. 2**.

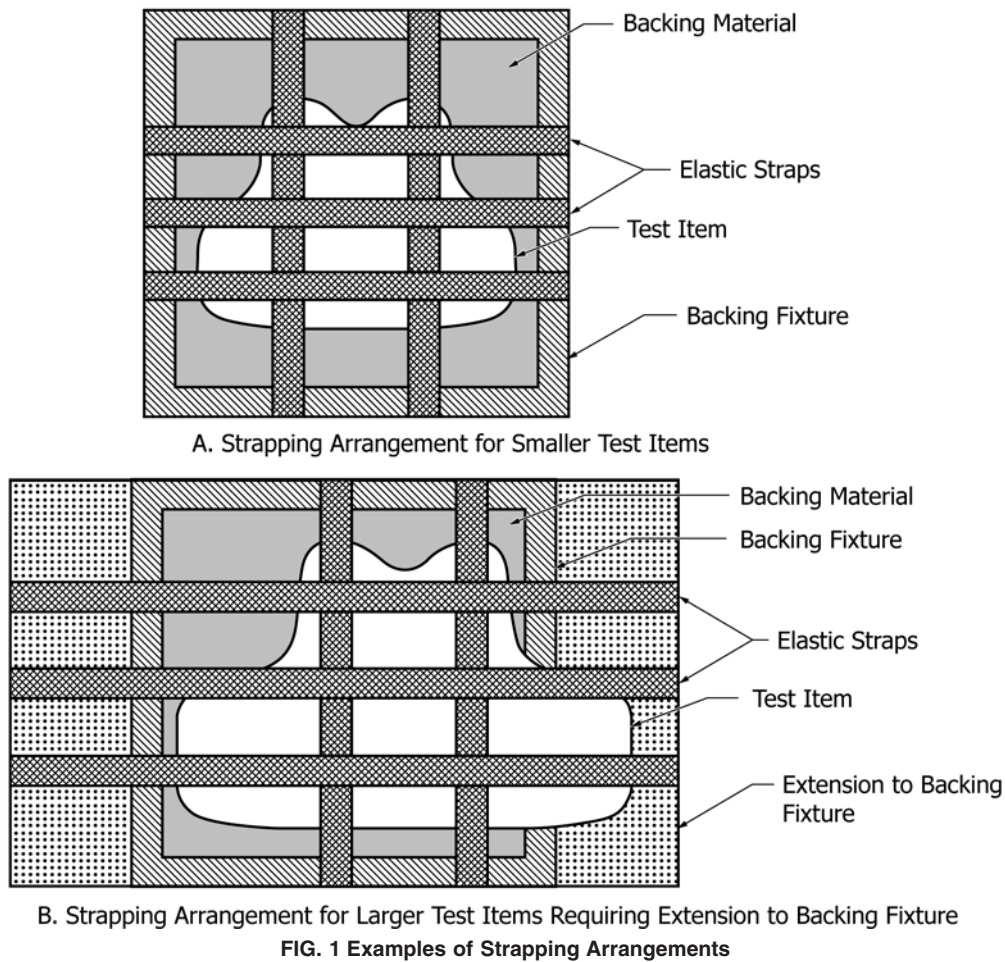
11.2.3 Shots 4, 5, and 6 shall meet the minimum shot-to-shot distance requirements and shall be located within a 100 mm (3.94 in.) diameter circle. For test items with sufficient area, the locations of shots 4, 5, and 6 shall be arbitrarily moved to different areas on different test items within the test series. Unless specified in other standards and specifications, when the test item is too small to allow all six shots with the required spacing, an additional test item may be used for shots 4, 5, and 6.

11.2.4 Shots 1, 2, 3, and 6 shall be taken at 0° angle of incidence.

11.2.5 Shots 4 and 5 shall be taken at 30° and 45° angle of incidence, with the angular rotation of the backing assembly in the same direction for both shots on an individual test item.

11.2.5.1 The order of angles shall be alternated between test items. For example, on the first test item, if shot 4 is taken at 30°, then shot 5 shall be taken at 45°; then, on test item 2, shot 4 shall be taken at 45°, and shot 5 shall be taken at 30°. This shall continue until the test series is complete.

11.3 The steps below shall be followed for each test series:



11.3.1 Mount and position the test item on the clay block as specified in Section 10 of this test method.

11.3.2 Fire the test threat at the test item.

11.3.3 Verify that the shot was a fair hit (per Section 9 of this test method), taking the following steps:

11.3.3.1 The velocity shall be checked to determine whether it was within the specified range.

11.3.3.2 The difference between the velocity readings from each independent instrument shall be compared as specified in Specification E3062.

11.3.3.3 The shot spacing shall be assessed to determine if shot-to-edge, shot-to-shot, and shot-to-clay block edge were within specified requirements.

11.3.3.4 When not specified elsewhere, if the shot is determined to be unfair, another shot shall be taken on that test item in a location that meets shot spacing requirements. If there is not sufficient room on the test item for another shot, all required shots shall be repeated on a spare test item. The spare test item shall be of the same size, if available.

11.3.4 Determine whether the shot outcome is a partial or complete penetration.

11.3.5 When required, measure the BFD for partial penetrations.

11.3.6 Reposition and smooth the test item as specified in Section 10 of this test method.

11.3.7 Repeat relevant steps until all required shots on the test item are complete.

11.3.8 Repeat relevant steps until the test series is complete.

12. Mounting and Positioning of Hard Armor Test Items on a Clay Block

12.1 The test item shall be positioned on a clay block such that the entire test item is supported.

12.2 The testing of nonplanar hard armor test items requires the use of appliques between the test item and the clay block.

NOTE 9—Testing of planar hard armor test items does not require the use of appliques.

12.3 A clay applique shall be created for each individual test item and shall meet the following requirements:

12.3.1 The applique shall conform to the wear face of the test item and create a planar surface for the test item to contact the surface of the clay block.

12.3.2 The applique shall be formed such that it completely fills the space between the test item and the clay block surface. The applique shall be the minimum thickness required to completely fill the space without preventing contact between the test item edges (or corners) and the surface of the clay block (for example, a multi-curve plate should have at least

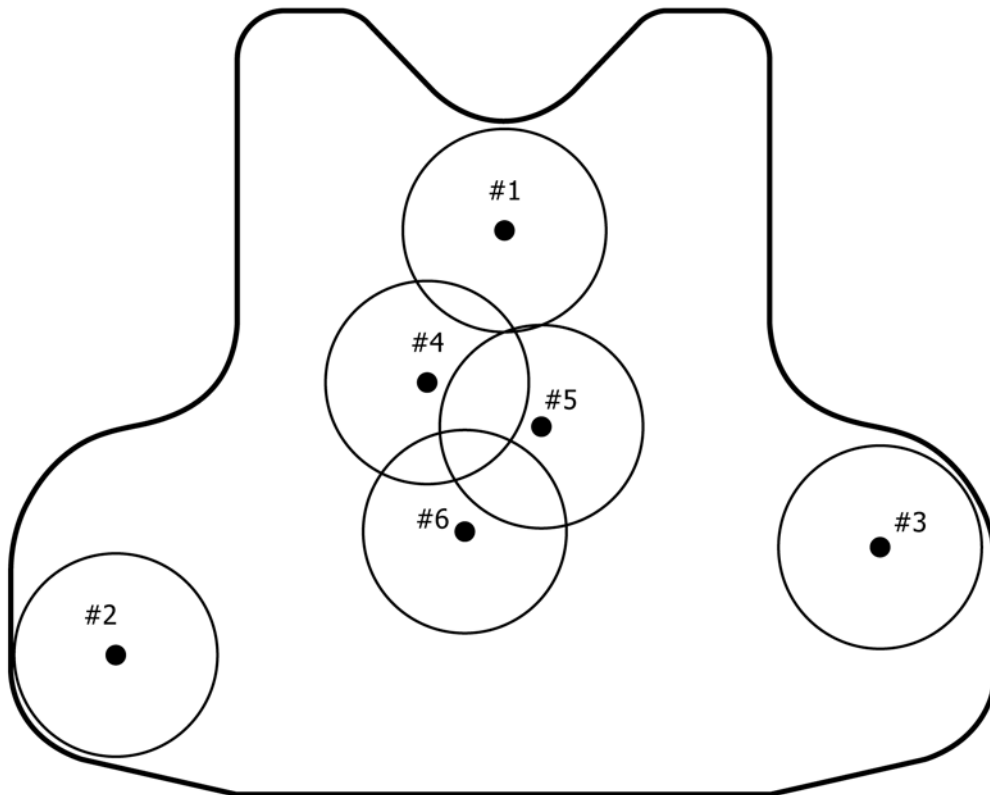


FIG. 2 Example of Soft Armor Test Item Shot Position and Pattern

four points of contact between its edges and the surface of the clay block). See Fig. 3 for an example of a test item with applique installed.

NOTE 10—A mold is necessary to create an appropriate applique sized for a specific test item, and it is possible that the hard armor could serve as the mold. Other standards and specifications may provide guidance for creating the mold and the applique and for conditioning the applique prior to use. Some testing requires that the hard armor be tested with soft armor or a shoot pack (that is, in conjunction with armor). In those cases, the hard armor shall be placed appropriately in contact with the soft armor or a shoot pack (placed on the front or inserted).

12.3.3 The applique shall be installed on the clay block prior to testing as described below.

12.3.3.1 Hand form conditioned clay into a long, thin strip. Place the strip around the perimeter of the applique at the interface with the clay block, and press the clay strip into the interface to ensure that the applique remains adhered to the clay block during testing.

12.3.3.2 Care is required to ensure that the shape of the applique is not significantly changed during affixing it to the clay block.

12.4 The test item shall be positioned on a clay block (with or without an applique installed, as appropriate) such that the entire test item is supported, as shown in Fig. 3.

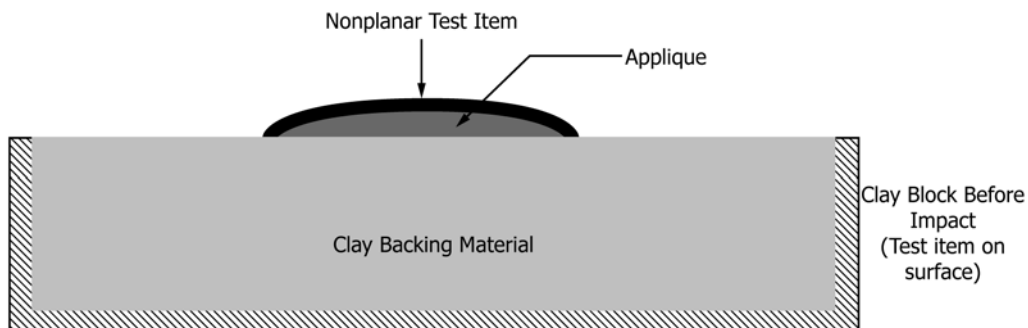


FIG. 3 Test Item with Applique Installed

12.5 The test item shall be held in contact with the clay block and secured using approximately 50 mm (2.0 in.) wide elastic straps, held closed by a hook-and-loop fasteners. Vertical and horizontal straps shall be positioned such that they do not interfere with the impact points on the test item.

12.6 The clay block shall be positioned to achieve proper bullet impact location and angle (for example, angle of incidence, obliquity) of the test threat. For any shots requiring a nonzero angle of incidence, the clay block shall be rotated to achieve the appropriate angle.

12.7 Between test threat impacts, any soft armor or shoot pack shall be manipulated by hand so that any wrinkles or bunching in the test item (caused by a previous shot) are smoothed out. No effort shall be made to recover any bullets trapped in the test item until the test series is complete.

NOTE 11—Manipulation of a bullet is allowed if the bullet will interfere with subsequent shots. The test item may be removed to smooth out the soft armor or shoot pack.

13. Ballistic Test Procedure for Hard Armor Test Items

13.1 A complete test series for the assessment of penetration resistance and backface deformation consists of individual ballistic tests being conducted on a number of individual test items, of specified size(s), as specified in other standards and specifications.

13.2 The shot number, placement, pattern, and angles of incidence shall be as specified in other standards and specifications.

13.3 The steps below shall be followed for each test series:

13.3.1 Mount and position test item on clay block as specified in Section 12 of this test method.

13.3.2 Fire the test threat at the test item.

13.3.3 Verify that the shot was a fair hit (per Section 9 of this test method), taking the following steps:

13.3.3.1 The velocity shall be checked to determine whether it was within the specified range.

13.3.3.2 The difference between the velocity readings from each independent instrument shall be compared as specified in Specification E3062.

13.3.3.3 The shot spacing shall be assessed to determine if shot-to-edge, shot-to-shot, and shot-to-clay block edge were within specified requirements.

13.3.3.4 In the event of an unfair hit, other standards and specifications shall be consulted for guidance.

13.3.4 When required, measure the BFD for partial penetrations.

13.3.5 Reposition and smooth the soft armor or shoot pack (when applicable) as specified in Section 12 of this test

method. The hard armor test item shall be returned to its original location on the clay block.

13.3.6 Repeat relevant steps until all required shots on the test item are complete.

13.4 Repeat relevant steps until the test series is complete.

14. Test Report

14.1 A test report shall be produced and shall meet the requirements of ISO/IEC 17025, and at least the following shall be included:

14.1.1 Standard or specification calling for the use of this test method,

14.1.2 Identification of the test threats document,

14.1.3 Test item information: detailed description of test items, number of test items, details of any conditioning prior to ballistic testing,

14.1.4 Test item mounting procedure from this test method,

14.1.5 Ballistic test procedure from this test method,

14.1.6 Identification and description of test threat,

14.1.7 Description of projectile firing system,

14.1.8 Number of shots per test item and per test series,

14.1.9 Shot pattern, and

14.1.10 For each shot:

14.1.10.1 Shot number and location,

14.1.10.2 Angle of incidence or angle of obliquity, or both,

14.1.10.3 Velocity of test threat,

14.1.10.4 Shot result, as partial penetration or complete penetration,

14.1.10.5 Fair hit or unfair hit and the cause of any unfair hit,

14.1.10.6 BFD measurement for partial penetrations (when required), and

14.1.10.7 Any other information necessary to describe the interaction of the test item and the threat.

14.2 Additional information and observations may be included in the test report.

15. Precision and Bias

15.1 No information is presented about either the precision or bias of this test method since the test results are nonquantitative. The only quantitative test result noted in this test method is the BFD measurement, and that is addressed in Test Method E3068.

16. Keywords

16.1 backface; backface deformation; body armor; hard armor; penetration-backface deformation; soft armor; soft body armor

A1. FLOWCHART SHOWING DECISION LOGIC FOR DETERMINATION OF FAIR HIT

A1.1 See [Fig. A1.1](#).

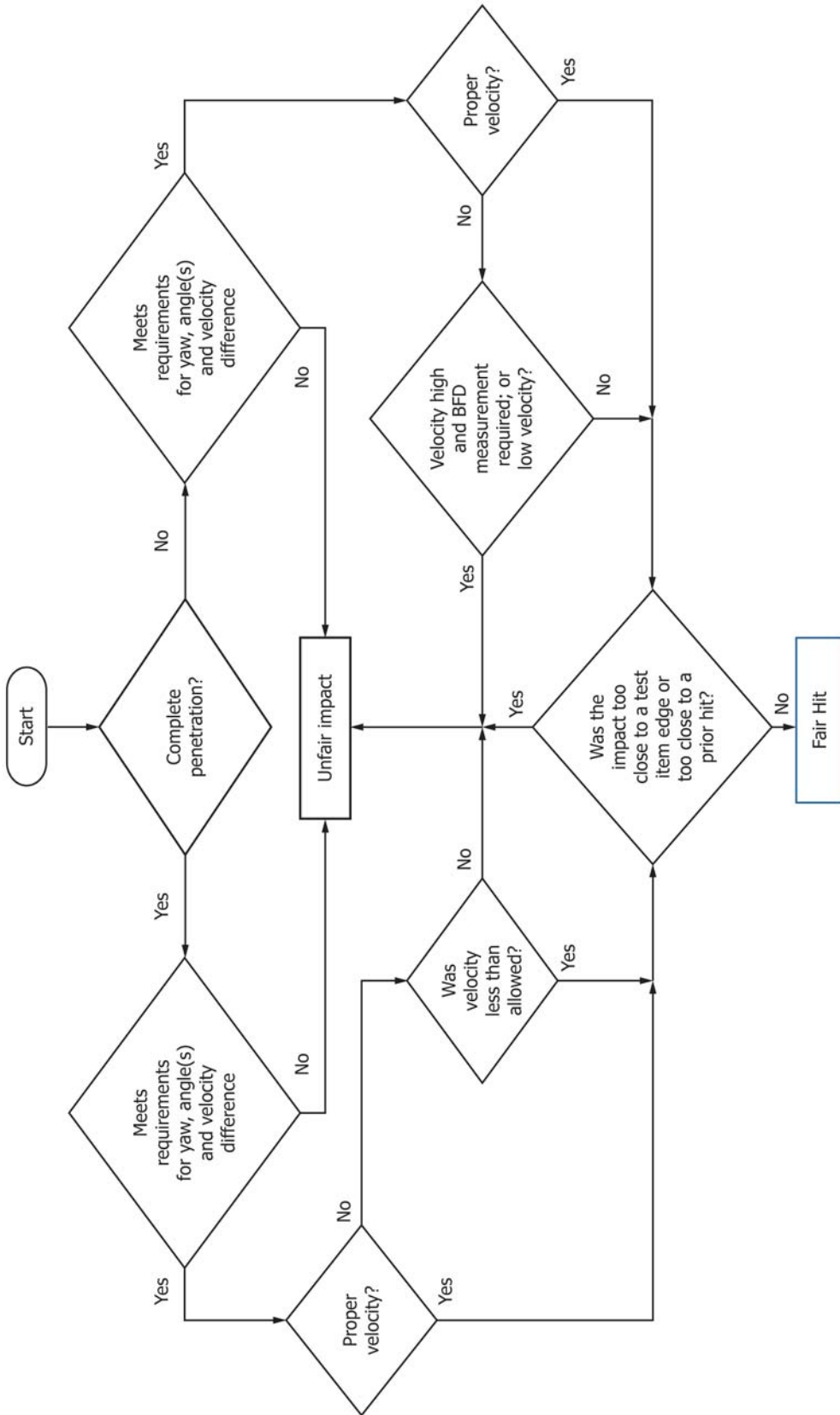


FIG. A1.1 Decision Logic for Determination of Fair Hits (see 9.3)

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