Designation: ~~E3141/E3141M – 22a~~ E3141/E3141M – 23

Standard Test Method for Ballistic Resistant Shields for Law Enforcement[1]

This standard is issued under the fixed designation E3141/E3141M; 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

This test method for the ballistic resistance of shields has been prepared after consideration of the features of ballistic-resistant shields and of potential vulnerabilities. Specifically, the tests have been designed to target the face of the shield, the viewports, the handle support structures, and lights or any other attachments to the body of the shield. This test method addresses ballistic resistance of shields used by law enforcement and corrections.

This test method is to be used in conjunction with documents created by other concerned parties that establish performance levels through the specification of threats and other requirements.

1. Scope

1.1 This test method[2] applies to personal protective ballistic-resistant shields.

1.2 The intent of this test method is to evaluate the ballistic resistance of shield products for law enforcement.

1.3 Certifiers, purchasers, and other users of this test method will specify the ballistic test threats to be used. Within this test method, the reference defining the ballistic test threats will be called the "test threats document."

1.4 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. Certifiers, purchasers, and other users are responsible for the "other standards and specifications" and for specifying any requirements that supersede those of this test method.

1.5 *Units*—Values stated in either the International System of Units (metric) or U.S. Customary units (inch-pound) are to be regarded separately as standard. The values stated in each system may not be exact equivalents. Tests conducted using either system maintain repeatability and reproducibility of the test method and results are comparable.

1.6 *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.*

1.7 *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.*

---

[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 Public Safety Equipment.

Current edition approved ~~June 1, 2022~~March 1, 2023. Published ~~June 2022~~March 2023. Originally approved in 2018. Last previous edition approved in 2022 as ~~E3141/E3141M – 22.~~E3141/E3141M – 22a. DOI: ~~10.1520/E3141_E3141M-22A.~~10.1520/E3141_E3141M-23.

[2] This test method is subject to revision as indicated by changes to threats experienced by law enforcement practitioners and subject to review at least every five years.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E3005 Terminology for Body Armor

E3062/E3062M Specification for Indoor Ballistic Test Ranges for Small Arms and Fragmentation Testing of Ballistic-resistant Items

E3078/E3078M Practice for Conditioning of Hard Armor Test Items

E3112/E3112M Test Method for Ballistic-resistant Products and Shoot Packs

2.2 *U.S. Department of Defense Standard:*[4]

MIL-STD-810G Environmental Engineering Considerations and Laboratory Tests

2.3 *ISO Standard:*[5]

ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

3. Terminology

3.1 For terms not defined in this test method, the following definitions of Terminology E3005 apply: *angle of incidence, complete penetration* (see 3.2.2), *shot-to-edge distance, shot-to-shot distance, strike face, test item, witness panel*, and *yaw*.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *ballistic layup, n*—the layering of ballistic materials through the thickness of the ballistic-resistant item under consideration.

3.2.1.1 *Discussion*—

Ballistic materials are typically recorded from strike face to body side.

3.2.2 *complete penetration*—for purposes of this test method, definition 4 from Terminology E3005 applies: the result of a test threat impact if a hole is created through the witness panel.

3.2.3 *fastener, n*—hardware device that mechanically joins or affixes two or more objects together; for helmets, shields, and other protective products, a fastener passes into or through the protective material and includes such devices as bolts, anchors, screws, and rivets.

3.2.3.1 *Discussion*—

A primary example of this is a bolt that joins a handle or light to the body of the shield.

3.2.4 *in conjunction with armor applique, n*—an armor applique that is designed to provide a specific level of ballistic protection only when layered with a specified model(s) of ballistic-resistant shield, helmet, or other protective product.

3.2.5 *opaque, adj*—not able to be seen through; not transparent.

3.2.5.1 *Discussion*—

Functionally, non-opaque, transparent shield components act as viewports.

3.2.6 *spall, n*—particles of material from either the test item or the impacting projectile that are broken off as a result of the ballistic impact.

3.2.6.1 *Discussion*—

For the purposes of this test method, spall includes secondary projectiles such as bolts or other fastenings that may be propelled toward the witness panel as a result of a test threat impact.

3.2.7 *strike face, n*—the surface of an armor panel or plate intended to face the incoming threat (Terminology E3005).

3.2.7.1 *Discussion*—

For purposes of this test method, the term strike face refers to the surface of the test item intended to face the incoming threat.

---

[3] 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.

[4] Available from U.S. Army Test and Evaluation Command, https://www.atec.army.mil/publications/mil-std-810g/mil-std-810g.pdf.

[5] 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. Test Items

4.1 *Test Item Requirements:*

4.1.1 In this test method, a test item is a fully assembled product.

4.1.2 Additional test item requirements, such as size and quantity, shall be specified in other standards and specifications.

4.2 Inspect all test items for defects, including wrinkles, blisters, cracks or fabric tears, fraying, crazing, or chipped or sharp corners and edges. Document all defects in the test report.

4.3 Inspect all test items for variations in size, appearance, materials, and manner of construction compared to other submitted test items. Document all observed variances in the test report.

4.4 *Examination of Test Item Subcomponents*—This section provides guidelines for identifying regions of identical construction and regions of unique construction.

4.4.1 *Ballistic Layup*—Evaluate the shield to identify regions of identical construction. Regions are considered identical if they have identical layups of ballistic materials through the thickness of the shield. Each region of the ballistic shield that is not identical is considered to be unique.

4.4.2 *Viewport Mounting System*—If the shield design incorporates a viewport, examine the mounting system to identify identically constructed corners. Such corners may be rounded or squared. Two corners are considered to be identically constructed if the design is visually observed to be identical in form and function. Any corners that are not found to be identically constructed are considered to be unique. Evaluate the viewport mounting system to identify identically constructed edges. Edges are considered identical if the design is visually observed to be identical in form and function exclusive of edge length. Any edges that are not found to be identically constructed are considered to be unique.

4.4.3 *Fasteners*—Examine all fasteners to determine their form and function. Fasteners are considered to be identical if they match in form and function. Any fasteners that are not found to be identical are considered to be unique.

4.4.4 *Weak Points*—Examine the test item and information provided by the manufacturer to identify weak points.

5. Test Requirements

5.1 *Test Range Configuration*—The test range shall meet Specification E3062/E3062M under normal circumstances. If a shield's performance is to be evaluated against a specific threat where it is not practical to meet the specifications described in Specification E3062/E3062M, then thoroughly document the configuration that is utilized in the testing of the shield in the test report with respect to the type of test threat used and the means of propelling the test threat downrange.

5.2 A separate test threats document will specify test threats utilized in testing.

5.3 *Fair-hit Requirements*—Table 1 lists default fair-hit requirements which are applicable when other standards, specifications, or test methods do not otherwise specify such requirements. See Table 1.

5.3.1 Measure the shot-to-edge distance from the center of the projectile impact to the nearest edge of the strike face of the ballistic shield. In situations where the edge of the shield has a rounded profile, the edge is defined as the ultimate edge of the shield when viewed from the strike face. Measure the shot-to-shot distances from center of one projectile impact to the center of another.

NOTE 1—When assessing whether a particular impact location meets the minimum shot-to-shot distance requirements, the shot-to-shot distances are

TABLE 1 Fair-hit Requirements

Minimum Shot-to-edge distance	51 mm [2.0 in.]
Minimum Shot-to-shot distance	51 mm [2.0 in.]
Yaw	≤5.0° test threat line of flight
Velocity Tolerance	±9.1 m/s [30 ft/s]

measured from that impact location to all prior impact locations. There is no requirement to record acceptable shot-to-shot distances or physically measure distances that are obviously greater than the minimum shot-to-shot distance.

5.3.2 *Tolerance*—The center point of each impact shall lie within a 10 mm [0.39 in.] radius circle of its intended point of impact.

5.4 *Cluster Shot Requirements:*

5.4.1 *Cluster for Handgun-rated and Rifle-rated Shields*—A cluster consists of three shots that shall meet the fair hit requirements and strike within a 100.0 mm [3.94 in.] diameter circle. The manufacturer may choose to decrease the spacing between shots in the cluster. The spacing used for the test shall be documented.

5.4.2 *Cluster for Shotgun-rated Shields*—A cluster consists of three shots that shall meet the fair hit requirements and strike within a 152.0 mm [6.0 in.] diameter circle. The manufacturer may choose to decrease the spacing between shots in the cluster. The spacing used for the test shall be documented.

5.4.3 *Adjacent Clusters on Handgun-rated Shields*—The spacing between adjacent clusters shall be 76.0 mm ± 6.0 mm [3.0 in. ± 0.25 in.] from center-to-center of the closest shots between the clusters. The manufacturer may choose to decrease the spacing between adjacent clusters. The spacing used for the test shall be documented.

5.4.4 *Adjacent Clusters on Rifle-rated Shields*—The spacing between adjacent clusters shall be 203.0 mm ± 6.0 mm [8.0 in. ± 0.25 in.] from center-to-center of the closest shots between the clusters. The manufacturer may choose to decrease the spacing between adjacent clusters. The spacing used for the test shall be documented.

5.4.5 *Adjacent Clusters on Shotgun-rated Shields*—The spacing between adjacent clusters shall be 203.0 mm ± 6.0 mm [8.0 in. ± 0.25 in.] from center-to-center of the closest shots between the clusters. The manufacturer may choose to decrease the spacing between adjacent clusters. The spacing used for the test shall be documented.

5.5 *Testing Sequence and Distribution of Shots*—Other standards and specifications specify details such as conditioning procedures prior to ballistic testing and distribution of shots across test items.

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.

5.6 *Multi-panel Shields Requirements:*

5.6.1 The shield shall be tested in the intended-use configuration.

5.6.2 For joints (that is, seams, overlaps, folds, hinges, or bends) between panels, the joint shall be shot with the shield at both its minimum and maximum deployment angles. Angled shots shall be taken to exploit the weakness.

5.6.2.1 The shot may be taken at any angle between 0° and 45° relative to any strike face to exploit perceived weakness.

5.6.2.2 The choice of the shot angle to use shall be made by the testing laboratory. Users of this standard may specify additional shot angles. Angled shots and the rationale shall be documented in the test report.

5.6.3 If the panels have identical ballistic layup and construction, only one of the panels is required to be tested.

5.6.4 If the panels have different ballistic layup and construction, each panel of the shield shall be tested independently.

5.7 *In Conjunction With (ICW) Armor Applique Requirements:*

5.7.1 The base shield shall be tested and have its performance verified prior to subsequently testing the ICW armor applique installed on the shield.

5.7.2 The shield shall be conditioned and tested as a system with the ICW armor applique installed, and the applique shall be impacted with the required test threat(s).

5.7.3 The ICW armor applique shall remain attached to the shield for the entire test series. If the ICW armor applique detaches, that shall be considered a failure.

5.7.4 At least one shot shall be placed on the applique. The manufacturer may specify additional shots to be placed on the ICW armor applique. The number of shots taken on the ICW armor applique shall be documented in the test report.

5.7.5 Any exposed fastener used to attach the applique that is outside the perimeter of the applique and requires a penetration of the base shield shall be shot with the applique test threat. The requirements for fastener shots shall apply.

5.7.6 Given that ICW armor appliques may have additional material around the edges for durability, the manufacturer shall identify the boundary of the ballistic protective material (that is, protective edge) on the applique test samples.

5.7.7 The ballistic layup and thickness shall be consistent across the ICW armor applique. This requirement applies to all appliques, including mosaic appliques.

5.7.8 The minimum shot-to-edge distance shall be 1 in. [25.4 mm] from the protective edge of the ICW armor applique.

5.8 *Test Equipment:*

5.8.1 *Test Item Mounting*—Mount the test item on a test item mounting system in accordance with the manufacturer's guidance regarding usage. If a shield is intended to be held by the handles, then test the shield using a mounting system that holds the shield by the handles. If a shield is intended to be used while its base sits on the ground and does not rely on handles to keep it aloft then test the shield in this configuration using an appropriate support.

NOTE 3—An example test item mounting system is presented in Appendix X1. The example system is not mandatory, and other similar test item mounting systems may be used.

5.8.2 *Witness Panel*—All ballistic resistance tests utilize a witness panel to determine if a complete penetration has occurred. Witness panels shall:

5.8.2.1 Meet the specifications listed in Table 2.

5.8.2.2 Be rigidly affixed 15 cm ± 2.5 cm [6 in. ± 1 in.] behind the intended point of impact of the test threat as measured from the side opposite the strike face along the intended shot line.

5.8.2.3 Have its geometric center positioned along the intended test threat flight line to within a 2.54 cm [1.0 in.] accuracy unless restricted by the test item features, the test configuration, or the test item mounting system.

5.8.2.4 Be oriented parallel to the plane normal to the surface of the test item at the intended point of impact.

5.8.2.5 Be sufficiently large to allow any test threat that completely penetrates or ejected spall to strike it. At the distance listed above, the dimensions shall be not less than 35.0 cm by 35.0 cm [13.75 in. by 13.75 in.] unless the test item mounting system or shield components necessitate a smaller witness panel be used.

5.9 *Determination of Shot Result*—After each shot or cluster of shots, examine the witness panel for penetration by the projectile or spall. This is done by holding the witness panel between the eye and a light source of at least 800 lumens.

TABLE 2 Witness Panel Specifications

Operational Use	Aluminum Alloy	Description	Nominal Thickness[A] mm	Nominal Thickness[A] mil
Opaque components of the shield	2024–T3, 2024–T4, or 5052	Sheet	0.5 ± 0.08	20 ± 3
Translucent or transparent components or areas intended to be operationally positioned in front of a user's face	Any Al alloy[B]	Heavy-duty foil	0.024 ± 0.004	0.95 ± 0.15

[A] Nominal thickness refers to an approximate dimension by which a material is generally called or sold but which may differ from the actual dimension.
[B] Any alloy of Aluminum found in an Aluminum foil is acceptable.

6. Conditioning Procedures

6.1 *Controlled Ambient Conditioning:*

6.1.1 Expose test items to controlled ambient conditions of 20 °C ± 5.5 °C [68 °F ± 10 °F] and 50 % ± 20 % relative humidity (RH) for at least 24 h.

6.2 *Temperature Extremes Procedure (see Practice E3078/E3078M):*

6.2.1 Tests shall be performed in accordance with constant temperature exposure procedures of MIL-STD-810G, Method 501.5, Procedure I (high temperature) and Method 502.5, Procedure I (low temperature).

6.2.2 One set of test items shall be subjected to high temperature and another set shall be subjected to low temperature. Ramping of temperature is prohibited.

6.2.3 The starting temperature shall be controlled ambient.

6.2.4 One set of test items shall be heated in a chamber operating at 71.1 °C ± 3.0 °C [155 °F ± 5 °F] for a minimum of 6 h, not to exceed 24 h.

6.2.5 One set of test items shall be cooled in a chamber operating at -51.1 °C ± 3.0 °C [-60 °F ± 5 °F] for a minimum of 6 h, not to exceed 24 h.

6.3 *Temperature Shock Procedure (see Practice E3078/E3078M):*

6.3.1 Tests shall be performed in accordance with MIL-STD-810G, Method 503.5, Procedure I-A, with the following modifications:

6.3.1.1 The extreme temperatures shall be T1: –31.7 °C ± 3.0 °C [–25 °F ± 5 °F] and T2: 48.9 °C ± 3.0 °C [120 °F ± 5 °F].

6.3.1.2 Test items shall be subjected to temperature conditioning steps as follows: *(1)* controlled ambient, *(2)* T1, *(3)* T2, and *(4)* controlled ambient. Transfer of test items from one condition to another shall be accomplished in less than one minute. Ramping of temperature is prohibited.

6.3.1.3 The test items shall be subjected to T1 and T2 for a minimum of 2 h, not to exceed 2 h and 15 min.

6.4 *Conditioning by Submersion in Plain Water (see Test Method E3112/E3112M):*

NOTE 4—This conditioning is not intended to cause corrosion or simulate artificial aging.

6.4.1 *Equipment:*

6.4.1.1 A water bath shall be used that is sufficiently sized to allow at least one test item to be submersed at least 50 mm below the surface of the water, and the test item edges and seals shall not contact the surfaces of the tank or be significantly obstructed by any weight used to keep the test item submersed.

6.4.1.2 The water in the bath shall be clean and shall be either potable tap or demineralized water. The water shall be replaced anytime there are visible impurities in the water. The water temperature shall be 21 °C +3 °C/–6 °C [70 °F +5 °F/–10 °F].

6.4.2 *Procedure:*

6.4.2.1 Weigh the test item.

6.4.2.2 Place the test item in the water bath for 30 min (+5 min/–0 min). For test items that are buoyant, attach weights to keep the test item under water.

6.4.2.3 Remove the test item from the water.

6.4.2.4 Wipe each test item dry and weigh it.

6.4.2.5 Document any change in weight.

7. Ballistic Resistance Test Procedures

7.1 The following sections designate shot locations for test item(s) within a test sequence. Each major section is considered a separate test, allowing the tests to be conducted on separate test items. A manufacturer or other entity submitting shields for testing may allow additional shots to be placed onto a test item that has received one or more shots. However, if a test is carried out on a test item that was used in a previous test, the result is considered a valid test result provided it meets all of the fair-hit requirements. Table 3 provides a summary of the shots required in this section.

TABLE 3 Summary of Required Shots

Shield Component	Shot Description	Total Number of Shots Required for Handgun Shields	Total Number of Shots Required for Rifle and Shotgun Shields
Viewport	Shot in center, 0°	2 shots	1 shot
Viewport	Shot in corner, 0°	2 shots per unique corner	0 shots
Viewport	0° shot on unique edge	1 shot per unique edge	1 shot per unique edge
Viewport-Body Interface	45° angled shot at interface	1 shot at interface	1 shot at interface
Viewport-Body Interface	0° shot at interface	1 shot at interface	1 shot at interface
Body	3-shot cluster shot at 0°	2 clusters per unique construction type	2 clusters per unique construction type
Body	3-shot cluster shot at 30°, with all shots in same direction	2 clusters per unique construction type	2 clusters per unique construction type
Body	Edge shot	4 shots	4 shots
Fasteners	Fastener head shot, 0°	2 shots per unique fastener	2 shots per unique fastener
Fasteners	Fastener proximity shot, 0°	2 shots per unique fastener	2 shots per unique fastener
Fasteners	Fastener shank shot, 45°	2 shots per unique fastener	2 shots per unique fastener
Weak Points	Shot on/near perceived weak points, 0°	1 shot per unique weak point	1 shot per unique weak point