Increasing Confidence in the Performance of Ballistic-resistant Shields

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Abstract. ASTM International has published test methods and a specification for ballistic-resistant shields used by law enforcement officers to protect against handgun or rifle rounds. These shields are complex technologies that consist of the main shield body ballistic-resistant materials, a transparent ballistic-resistant viewport, fasteners, joints and seams, edging, appliques (intended to increase localized protection), and more features. Each of these must be tested to verify that the complete shield protects against bullets and also can withstand the conditions of use and storage. The ASTM International standards are intended to verify that ballistic shields meet this purpose. Until now, the standard typically used for assessment of protection afforded by ballistic shields was the National Institute of Justice (NIJ) Standard 0108.01, Ballistic Resistance of Materials, published in 1985. The NIJ standard was developed for materials used to fabricate protective products, not for complete products like shields, and requires limited testing of either a soft armour shoot pack or a hard armour coupon. Additionally, the test threats required in the NIJ standard are not current threats facing U.S. law enforcement; therefore, manufacturers have mixed the requirements of NIJ Standard 0108.01 with test threats from NIJ Standard 0101.06, Ballistic Resistance of Body Armor, leading to confusion, and possibly deception, in the marketplace. To alleviate these issues and develop shield-specific standards, a diverse team of more than forty stakeholders worked together, including shield manufacturers; suppliers; federal, state, and local law enforcement end users; ballistic testing and certification experts; researchers; federal ballistic protection experts; and standards professionals. The new ASTM standards are a tremendous step forward because they are specifically designed for assessing the performance of entire ballistic shields of multiple sizes. The test method specifies detailed testing procedures to assess all aspects of a ballistic shield and requires a minimum number of shots on each area: the shield body, the viewport, fasteners, weak points, and appliques. The specification details pre-conditioning and testing requirements, ballistic performance levels with associated up-to-date test threats, and performance requirements that shields must meet. These two standards form the basis for a new ASTM Verification Program, which includes independent, third-party verification by the Safety Equipment Institute, online listing of verified products, authorization to put the ASTM-verified mark on products, and annual testing requirements to assess continued compliance. This paper will describe the new standards, the new ASTM Verification Program, and the benefits to the U.S. law enforcement community.

1. INTRODUCTION

A ballistic shield is a type of protective equipment intended to protect the user against bullets and provide greater coverage than personal body armour that typically only covers the torso. These shields are complex technologies that consist of the main shield body ballistic-resistant materials, a transparent ballistic-resistant viewport, fasteners, interfaces, joints and seams, edging, appliques (intended to increase localized protection), and more features. See Figure 1 for an example of a shield and its protective components and features. To assess and verify that the complete shield stops bullets and can withstand the conditions of use and storage, each of the shield's protective components and features must be tested.

Ballistic shields for U.S. law enforcement officers have historically been assessed using the National Institute of Justice (NIJ) Standard 0108.01, *Ballistic Resistance of Materials* [1], published in 1985. That NIJ standard was developed for materials used to fabricate protective

Figure 121. Examples of Protective Components and Features
Source: ASTM International

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products, not for complete products like shields. The NIJ standard requires only one test item conditioned at ambient temperature and humidity, at least 30.5 cm by 30.5 cm (12 inch by 12 inch) in size, per ballistic test threat, with a maximum of five shots per test item. Additionally, the test threats required in the NIJ standard are not representative of current threats facing U.S. law enforcement; therefore, manufacturers have mixed the requirements of NIJ Standard 0108.01 [1] with test threats of NIJ Standard 0101.06, *Ballistic Resistance of Body Armor* [2], leading to confusion in the marketplace and inconsistency of testing across products.

To alleviate these issues, a diverse team of stakeholders worked together to develop two ASTM International shield-specific standards and an ASTM Verification Program.

2. RECOGNIZING THE NEED

The need for a ballistic shield standard was recognized by working with the National Association of State Procurement Officials (NASPO) ValuePoint Program, a U.S. national public cooperative purchasing program. One of its public safety contracts is for personal body armour and ballistic-resistant products.[20] When the current ValuePoint contract was written, a requirement was included that ballistic-resistant shields be tested in accordance with NIJ Standard 0108.01 [1]. As previously stated, that standard is intended only for materials used to make finished products and is not appropriate nor sufficient for a shield. However, it was the only performance standard available at the time the contract was put in place. This highlighted the need for a new shield-specific standard.

Requiring that shields meet a standard then highlighted the need for a conformity assessment process for determining whether a shield met the standard. Since there was no established conformity assessment program for ballistic shields, the only option was to have an independent technical expert review test reports submitted by manufacturers and provide a recommendation to the ValuePoint contract lead. Reviewing test reports revealed several key points: (1) the NIJ standard was either loosely applied or a blend of multiple standards was used; (2) there was inconsistency of testing across products, and (3) some test reports were for something besides a shield.

This experience prompted discussions with industry, technical experts, researchers, and end users about initiating an effort to write a new shield-specific performance standard and establish a conformity assessment process.

3. IDENTIFYING AND ADDRESSING OFFICER NEEDS AND REQUIREMENTS

The first step in developing the performance standard was to identify the types of shields that are used by U.S. law enforcement officers and to understand their operational needs and requirements. The officers on this project team represented federal law enforcement agencies, local police departments, and sheriff's offices from across the U.S. The team agreed up front to match the new NIJ handgun and rifle threats specified for use with the next version of the NIJ body armour standard (NIJ Standard 0101.07, *Ballistic Resistance of Body Armor*, not yet published). The team additionally chose to add a supplemental shotgun threat as an add-on to either a handgun-rated or rifle-rated shield. The test threats will be discussed in Section 5.

Many configurations of ballistic-resistant shields are available in the marketplace, including hand-held or hand-carried shields, person-portable shields with wheels, fixed or mobile barriers, flexible shields that drape over a surface (e.g., ballistic blanket), and "accordion" shields. Officers typically use hand-held or hand-carried shields and person-portable shields, so the scope of the standards effort was limited to these two configurations. See Figure 2 for examples of shield types.

Officers were asked about issues experienced during use of shields. While no one on the team was aware of a shield failing to stop a bullet during use, ballistic protection was their highest priority. Other concerns were raised about damage caused by use or storage conditions, including delaminating of viewports and edges when stored in vehicles and cracked edges caused by dropping the shield on an edge.

Protective components and features of the shields that needed to be ballistically tested were identified (as shown in Figure 1), and the most appropriate test and performance requirements for each one was discussed at length.

[20] Details on the NASPO ValuePoint Contract may be found here: https://www.naspovaluepoint.org/portfolio/body-armor-and-ballistic-resistant-products/

(a) Hand-held, rigid
Source: United Shield

(b) hand-held, folding
Source: Multi-Threat Shield

(c) person-portable, wheeled
Source: Safariland

Figure 2. Examples of Shields Typically Used by U.S. Law Enforcement Officers

4. IMPROVING TEST METHODS FOR BALLISTIC SHIELDS

A preliminary set of test methods for ballistic shields was published in 2018 as ASTM E3141/E3141M, *Standard Test Method for Ballistic Resistant Shields for Law Enforcement* [3], but these test methods were not developed with limited stakeholder input and were not put into practice. The technical experts on the team evaluated and improved each test method as described below.

Testing of the shield body was improved by adding a second 3-shot cluster with shots at 30 degrees angle of incidence (to complement the initial 3-shot cluster at 0 degrees) because the angled shots better assess the performance of newer ballistic materials. The cluster shot spacing for each type of test threat (i.e., handgun, rifle, shotgun) was specified in detail. No changes were made to the shield body edge shots from the 2018 version.

Details for testing fasteners and perceived weak points were added, with clear specifications for shot placement, angle of incidence, and number required.

The required shots on the viewports were discussed in greater length because the viewport is the most vulnerable component of the shield, especially to certain rifle projectiles, and a failure would likely result in an officer's face being impacted. Figure 3(a) shows an example of a shield viewport shot with handgun projectiles, and Figure 3(b) shows a shield viewport shot with a single 7.62x51mm M80 NATO (M80 ball) rifle projectile[21]. For the handgun shield example, multiple shots were stopped by the viewport; for the rifle shield example, the viewport would not have been able to stop a second shot due to the capabilities of current technology.

The 2018 test method had specified shots for the viewport corner, edge, and center with no mention of the interface between the shield body and viewport. The requirements for the shots in the corner,

(a) Handgun-rated shield with multiple shots

(b) Rifle-rated shield with one M80 shot

Figure 3. Examples of Viewport Ballistic Testing

[21] Figures 3(a) and 3(b) were provided by the U.S. Drug Enforcement Administration

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edge, and center were specified in greater detail in the 2022 version, and interface shots were added at 0-degree and 45-degree angles of incidence with specificity regarding direction of each shot for each type of interface (i.e., protruding, overlapping, protruding and overlapping, flush, and recessed).

A summary of required shots, excerpted from ASTM E3141/E3141M [3], is shown in Figure 4. It can be seen that the shots required for a handgun or a rifle shield are the same, except for the number of viewport shots for a rifle shield is reduced, recognizing the limitations of current viewport technology.

The team discussed the increasingly common use of in-conjunction with (ICW) armour appliques that may be applied to a shield to enhance ballistic protection in a localized area. Test requirements were added to shoot the applique, at the claimed protection level, as well as any exposed hardware attaching the applique to the shield.

Shield Component	Shot Description	Total Number of Shots Required for Handgun Shields	Total Number of Shots Required for Rifle 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

Figure 4. Summary of Required Shots from ASTM E3141/E3141M

5. DEVELOPING THE BALLISTIC SHIELD SPECIFICATION

In addition to ballistic testing requirements, the team agreed to the need to develop a specification to identify the ballistic test threats and define performance requirements and testing details supplemental to the test methods of ASTM E3141/E3141M.

As previously mentioned, the team chose to match the protection categories and associated test threats as defined by NIJ, and the list, excerpted from ASTM E3347/E3347M, *Specification for Ballistic-Resistant Shields Used by Law Enforcement Officer* [4], is as shown in Figure 5.

Each protective component and feature of the shield was considered, and the team determined which test procedures should be applied and what the performance requirements should be. For all ballistic testing, the performance requirement is no complete penetration.

To assess a shield's ability to withstand storage and use conditions that could degrade ballistic performance, the team discussed potential conditioning procedures that could be included as a pre-cursor to ballistic testing. Thermal shock, submersion in water, extreme temperature exposure, and dropping on an edge were chosen as the most relevant procedures. In order to reduce the number of shield samples required for testing, the team elected to perform the conditioning as a sequence of procedures: controlled ambient, thermal shock, controlled ambient, submersion, and extreme temperature (cold for one sequence, hot for another).

ASTM Shield Ballistic Protection Level	Test Threat	Test Threat Reference Velocity
ASTM-Shield-HG2	T1: Handgun, 9 mm Luger FMJ RN 124 grains	448 ± 9.1 m/s [1470 ± 30 ft/s]
	T2: Handgun, .44 MAG JHP 240 grains	436 ± 9.1 m/s [1430 ± 30 ft/s]
ASTM-Shield-RF1	T3: Rifle, 7.62 × 51 mm M80 Ball NATO FMJ Steel Jacket, 147 +0/-3 grains (U.S. military supply or rounds meeting NATO specifications)	847 ± 9.1 m/s [2780 ± 30 ft/s]
	T4: Rifle, 7.62 × 39 mm, MSC Ball Ammunition Type 56 from Factory 31, 123 grains	732 ± 9.1 m/s [2400 ± 30 ft/s]
	T5: Rifle, 5.56 mm M193, 56 +0/-2 grains (U.S. military supply or rounds meeting NATO specifications)	990 ± 9.1 m/s [3250 ± 30 ft/s]
ASTM-Shield-RF2	T3, T4, T5 (See above)	T3, T4, T5 (See above)
	T6: Rifle, 5.56 mm M855 BT, 61.8 ± 1.5 grains (U.S. military supply or rounds meeting NATO specifications)	950 ± 9.1 m/s [3115 ± 30 ft/s]
ASTM-Shield-RF3	T7: Armor-piercing rifle, 30.06 M2 AP, 165.7 +0/-7 grains (U.S. military supply or rounds meeting NATO specifications)	878 ± 9.1 m/s [2880 ± 30 ft/s]
ASTM-Shield-SG	T8: Shotgun, 12 Gauge, 1 oz, 2¾ in. lead slug	427 ± 9.1 m/s [1400 ± 30 ft/s]

Figure 5. ASTM Shield Ballistic Protection Levels and Associated Test Threats from ASTM E3347/E3347M

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To ensure actual shields are tested, the specification requires that at least one of the smallest and one of the largest sizes of a shield model available on the market be tested. This requirement also addresses any performance changes that may be caused by a change in size of the product.

By including requirements for ballistic performance, pre-conditioning procedures, and detailed shots to all parts of the shield, ASTM E3347/E3347M, *Specification for Ballistic-Resistant Shields Used by Law Enforcement Officers*, [4] is a robust standard appropriate for assessing the durability and protective capabilities of a complete ballistic-resistant shield.

6. ASTM VERIFICATION PROGRAM

Having a robust standard specification, based on standard test methods, is an excellent starting point but is not sufficient for ensuring that shields are tested and perform as expected; a conformity assessment process is necessary.

The team considered independent third-party certification because it gives the highest confidence in product performance. Certification is a decision and statement by a third-party authoritative body, based on review of test reports and documentation, that a product is compliant with a standard specification based on the following:

(1) pre-market product testing and evaluation,
(2) periodic product testing to a limited set of critical tests (e.g., post-market testing),
(3) manufacturing facility inspections, and
(4) supplier management system audits.

The certifying body has responsibility for reviewing test reports and making a determination of the product's compliance with requirements at the time of initial testing and for performing periodic testing to determine whether the products continue to meet requirements. Certified products are listed by the certifying body in a publicly accessible listing and are authorized to be labeled with the certification body's mark. Because certification offers the highest level of confidence in a product's performance, it is the preferred conformity assessment process. However, participating in a certification program is very expensive for a supplier, with up-front costs for initial certification and recurring costs for maintaining certification. This means there must be a strong driver, such as regulations or grant funding requirements, mandating or motivating a supplier to submit products for certification.

A less-costly conformity assessment option is verification, which is a decision and statement by a third-party authoritative body that a product is compliant with a product standard based on the following:

(1) pre-market product testing and evaluation and
(2) periodic product testing to a limited set of critical tests (e.g., post-market testing).

The authoritative body has responsibility for reviewing test reports and making a determination of the product's compliance with the standard. Verified products are listed in a publicly accessible listing and authorized to be labeled with the verification body's mark.

Verification of responder products to recognized standards is a fairly new concept. It offers a slightly lower level of confidence in a product's performance than certification, but the cost is significantly less, making it more likely that a supplier will be willing to submit products for verification.

The team agreed that verification is an acceptable choice for ballistic-resistant shields, and an ASTM Verification Program was established.

As with certification, there must be a driver mandating or motivating a supplier to submit products for verification. There are currently no federal regulations or grant programs that require verification, but the NASPO ValuePoint program intends to require that ballistic-resistant shields be ASTM Verified to be included in their contract. Additionally, manufacturers involved in the project team agreed to participate in the ASTM Verification Program.

7. CONCLUSIONS

The new ASTM Verification Program and related ASTM standards for ballistic shields work together to address the needs and requirements identified by U.S. law enforcement officers, balancing current technology limitations, testing costs, and necessary confidence in the performance of ballistic shields. As technology improves, ballistic threats change, and operational scenarios evolve, the ballistic shield standards and ASTM Verification Program will be updated to ensure officers continue to have the protection they need.

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