

Implementation of NIJ Standard 0101.07 to Test and Evaluate Ballistic Resistant Body Armor

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Abstract. The U.S. National Institute of Justice (NIJ) has revised its standard for ballistic-resistant body armor that protects law enforcement personnel against gunshots. NIJ is actively evaluating armor models submitted to test to NIJ Standard 0101.07, *Ballistic Resistance of Body Armor*, using the threats enumerated in NIJ Standard 0123.00, *Specification for NIJ Ballistic Protection Levels and Associated Test Threats*. This paper focuses on the activities that have occurred during the first year and a half of implementation of the new standard and provides a comprehensive update on the NIJ Compliance Testing Program (CTP) based on a decade and a half of experience operating with NIJ Standard 0101.06. Law enforcement purchasers can now find armors that have been successfully tested to NIJ Standard 0101.07—the seventh revision of the NIJ standard for torso-worn ballistic resistant of body armor—on the NIJ Compliant Products List (CPL). As previously presented at the Personal Armour Systems Symposium, the new standard is built with ASTM standards as components, with improvements to account for the changing landscape of policing in the U.S. Specifically, NIJ Standard 0101.07 aims to improve the testing of armor designed for women and to explore potential vulnerabilities more thoroughly in all armor designs certified by NIJ. Some of the improvements include the use of new test methods for nonplanar armor, three new rifle threats, reconfigured shot placements, testing conditioned armor at the reference velocity rather than a reduced velocity, and nonzero angles of incidence for shots in the proximity of edges. After the publication of NIJ Standard 0101.07 in November 2023, NIJ has continued to refine the standard through engagement with the body armor community and with the NIJ-approved test laboratories, currently numbered at five. Those engagements have produced a number of interpretations and clarifications to the standard which have been communicated through updates to the original publication. A potential ammunition manufacturing change to the Remington 9mm 124 grain FMJ test threat also necessitated that NIJ develop methods to reevaluate the threat specifications in NIJ Standard 0123.00. This paper will give a complete overview of NIJ’s ballistic body armor activities, describing the ongoing improvements to NIJ Standard 0101.07, NIJ Standard 0123.00, the NIJ CTP, and provide guidance for agencies, purchasers, and end users.

1. NIJ STANDARD 0101.07: BALLISTIC RESISTANCE OF BODY ARMOR – IN PRACTICE

NIJ is actively evaluating armor models to NIJ Standard 0101.07, *Ballistic Resistance of Body Armor* [1], using the updated body armor test threats and protection levels enumerated in NIJ Standard 0123.00, *Specification for NIJ Ballistic Protection Levels and Associated Test Threats* [2]. Law enforcement in the United States continues to be a highly dangerous profession. Body armor worn by U.S. law enforcement, to protect the torso against handgun and rifle ammunition, remains a critical component of the safety equipment that officers rely upon. Since 1972, when NIJ published its first performance standard for ballistic-resistant police body armor [3], the minimum performance requirements and test methods for body armor have continued to evolve. Accordingly, the NIJ body armor standard’s current revision, the seventh, aims to implement methodological and procedural improvements to keep pace with the evolving landscape, workforce, and threats that law enforcement officers face. Recent updates incorporate many of the lessons learned during the past decade and a half of testing using NIJ Standard 0101.06, published in 2008 [4].

In addition to updated body armor test threats and protection levels, many of the test methods and laboratory practices in NIJ Standard 0101.07 have been improved and it now includes new test methods for female body armor, as discussed previously [5, 6]. This revision also aims to explore potential vulnerabilities more thoroughly in all armor designs certified by NIJ through reconfigured shot placements, testing conditioned armor at the reference velocity rather than a reduced velocity, and nonzero angles of incidence for shots in the proximity of edges. Additionally, NIJ Standard 0101.07 is the first revision of the body armor standard for which the NIJ Mark[®], a registered trademark with the United States Patent and Trademark Office (USPTO) in 2019 [7], is available at the time of certification of all armor models listed on a new Compliant Products List (CPL) for body armor.

Considering the broad scope of updates that have been incorporated in the new standard, NIJ has continued to refine the laboratory test methods and procedures after its publication in November 2023.

This has been accomplished through engagements with end user communities, government partners including the U.S. Army and the National Institute of Standards and Technology (NIST), body armor manufacturers, material suppliers, and with the five current NIJ-approved test laboratories. These engagements have produced substantive feedback and have been important opportunities for consultation with the body armor community during the implementation of NIJ Standard 0101.07 in the NIJ Compliance Testing Program (CTP). Interpretations and clarifications to the standard that have been produced are being communicated through updates and addenda to the original publications. These engagements have also helped make possible the successful incorporation, by reference, of ten ASTM test methods and laboratory practices in NIJ Standard 0101.07. NIJ continues to work through ASTM's Committee E54 on Homeland Security Applications, Subcommittee E54.04 on Public Safety Equipment, with its large group of end users and technical experts, to produce and maintain a suite of standardized test methods and laboratory practices for incorporation in NIJ standards [8].

Recently, a potential ammunition manufacturing variation necessitated that NIJ, with the support of all the NIJ-approved laboratories and several material manufacturers, develop methods to evaluate threat specifications in NIJ Standard 0123.00. For this purpose, an evaluation of the Remington 9mm 124 grain FMJ (full metal jacket) test threat was conducted. This was necessary due to an unexpected change in the jacket material of the ammunition, but the evaluation also serves as an initial study of potential methods for conducting similar evaluations of NIJ test threats in the future. This paper will provide a complete overview of the NIJ's body armor activities that have occurred during the first year and a half of implementation of the new standard. It includes information on some of the latest clarifications to the standard, a review of the testing that was conducted to reevaluate the 9mm test threat, updates on the NIJ CTP, and provides guidance for commercial participants, agencies, purchasers, and end users.

2. CLARIFICATIONS OF LABORATORY TEST METHODS AND PRACTICES

NIJ published Addendum 1 to NIJ Standard 0101.07, *Ballistic Resistance of Body Armor* in October 2024, which includes revisions to the standard [9]. The revisions are the product of the previously discussed ongoing collaborative engagements with stakeholders in the body armor community and the five currently NIJ-approved laboratories. Revisions are necessary for most test standards to clarify their content and methods and to provide interpretations of the standard's intent as they are being put into practice. These recent changes affect the application of NIJ Standard 0101.07 for assessing the minimum performance requirements of body armor during Initial Type Testing (ITT) and for Follow-up Inspection and Testing (FIT). Regular consultation between NIJ and the NIJ-approved test laboratories through the NIJ CTP in 2024 and 2025 has functioned as a forum to discuss the test methods and laboratory practices as they are being implemented by numerous ballistics testing experts from different testing organizations at different locations for testing body armor to NIJ's standard. This forum offers the laboratories a means to pose questions and raise concerns to NIJ and NIJ CTP staff among a ready community of experts to work through technical issues. It also offers a means for NIJ and the NIJ CTP to canvass the laboratories to gather a variety of viewpoints on matters impacting the body armor program.

NIJ is continuing to review the original publication of the standard during the implementation phase of NIJ Standard 0101.07. Additional clarifications to those published in Addendum 1 have been made during implementation of the standard. Revisions may be incorporated into the standard in several ways. They may replace or supplement the information in the original publication, or in some cases, the revisions may replace *and* supplement information in the standard. Like the updates published in Addendum 1, ongoing updates also affect the implementation of the standard for soft and hard body armor, planar and nonplanar armor designs, as well as the testing of armor designed for women. NIJ anticipates publishing these additional interpretations and clarifications on a periodic basis going forward as either new addenda or revised versions of an existing addendum to the standard.

Table 1 provides an overview of the revisions in Addendum 1 and some further revisions that have subsequently been made after its publication. While it is not possible in the scope of this paper to reproduce verbatim the complete list of all revisions that have been made and fully explore each revision within the context of the standard as discussed by NIJ, the NIJ CTP, and the NIJ-approved laboratories during the implementation phase of the new standard, this overview table summarizes a majority of the revisions. The goal here is to provide a succinct update on many of the changes that are of the greatest interest to the body armor community. For example, the first entry in Table 1 clarifies certain additional conditions that would be characterized as a complete penetration (CP) of soft or hard armor to occur during testing. The specific changes cited are not the only conditions in NIJ Standard 0101.07 that if met, may constitute a CP during testing.

Table 1. Select revisions to NIJ Standard 0101.07.

NIJ Standard 0101.07 Revision and Description
<p>Conditions to be met for a <i>complete penetration</i> (CP)</p> <p>1. (NEW) Adds for nonzero angles of obliquity on soft armor:</p> <ul style="list-style-type: none"> (i) any portion of a test threat or a fragment of a test threat that is visible through the panel cover; (ii) if the shot exits the panel cover from the edge and is not retained by the ballistic panel; (iii) any portion of a test threat or a fragment of a test threat deflecting toward an edge between layers of ballistic material that meets <i>all</i> the following three conditions: <ul style="list-style-type: none"> (a) breaks the ballistic panel cover; (b) is visible when facing the wear face (i.e., line of sight is normal to the wear face); (c) extends beyond the edge contour of the armor panel. <p>2. (NEW) Adds for hard armor, a fragment of any hard component (i.e. ceramics and metals) of a test item that penetrates the back cover of the test item. Spall embedded in the clay surface beyond the perimeter of the test item shall not be considered a CP.</p>
<p>Definition of <i>crown</i> on a hard armor plate</p> <p>Modifies a crown location to be at the intersection of multiple curvatures on the strike face of a multi-curve plate.</p>
<p>Equation for estimated probability of complete penetration at V_{ref}</p> <p>Corrects the sign of the inequality to: V_{ref} shall be less than 5% (i.e., $\hat{V}_{05} \geq V_{ref}$)</p>
<p>Shot locations for P-BFD testing on soft armor</p> <p>(NEW) Adds schematics for shot locations and order on the smallest are largest test items.</p>
<p>Shot pattern for ballistic limit on soft armor</p> <p>(NEW) Adds a schematic for shot locations and shot order.</p>
<p>Positioning of ballistic panels to accommodate shot 7 on soft armor</p> <p>(NEW) Adds that ballistic panels shall not be folded and that the test item be positioned so that the entire test item shall be supported coplanar with the backing material.</p>
<p>Tolerances on the location of shot 7 on soft armor</p> <p>(NEW) Adds tolerances at the center of the neck strip to be not more than 19 mm (0.75 in.) from the centerline.</p>
<p>Use of a witness panel and clay surface observations during edge shots</p> <p>(NEW) Adds that for any shot at a nonzero angle of obliquity on soft armor, including shot 7, a witness panel and the clay surface between the test item and witness panel shall be used to determine if any portion of a test threat or a fragment of a test threat exited the side of the armor.</p>
<p>Adjustments to clay block requirements</p> <p>Modifies that a clay block that meets the acceptance criteria may be used for up to 45 minutes after the final drop in the verification procedure prior to testing as well as removes the requirement for clay block verification between test items and after the final test item.</p>
<p>Clarifications regarding use of test items on a clay block</p> <p>(NEW) Clarifies that multiple soft armor test items can be used on a clay block, how they can be rotated, how they should be affixed with strapping and supported with extensions, and how many shots of one type of threat may be used on a clay block before reconditioning.</p>
<p>Exploiting vulnerabilities in conditioned soft armor</p> <p>(NEW) Clarifies that shot locations that overlap with features introduced by conditioning by tumbling, such as creases, shall not be avoided during testing and should be preferentially selected within the fair impact areas to strike features to exploit potential weaknesses or vulnerabilities in the armor.</p>

NIJ Standard 0101.07 Revision and Description
<p>Hard armor test item dimensions</p> <p>Clarifies that hard armor test items shall be no larger than 254 mm x 305 mm (10 in. x 12 in.) and no smaller than 203 mm x 254 mm (8 in. x 10 in.).</p>
<p>Adjustment of velocity tolerances on the first shot of the ballistic limit test series</p> <p>Modifies the actual velocity of the first shot to be the reference velocity for the test threat, including its tolerances, $-9/+30$ m/s ($-30/+100$ft/sec).</p>
<p>Supplier declares number of shots per test item for RF1 and RF2 P-BFD testing</p> <p>(NEW) Adds that the supplier may declare the number of shots (3 or 6) on a single test item <i>based on threat round</i>, rather than protection level alone.</p>
<p>Number of hard armor test items required</p> <p>(NEW) Clarifies the number of test items needed depending on how many shots per test item per threat round declared by the supplier.</p>
<p>Hard armor test item conditioning</p> <p>(NEW) Clarifies the requirements for the apparatus used for hard armor test item conditioning.</p>
<p>Shot placement for 3-shot hard armor test items for RF1, RF2, and RF3 P-BFD testing</p> <ol style="list-style-type: none"> 1. (NEW) Adds that for a 3-shot plate with 0-degree shots, BFD is taken for shots 1 and 2. 2. Modifies multi-curve plate schematic so that for shot angles for a 3-shot plate with 30-degree shots: <ol style="list-style-type: none"> (i) the crown shot and next closest shot shall be angle parallel to each other; (ii) shots in the shaded band (around the edges) shall be angled toward the centerline.
<p>Shot 6 on a curved hard armor test item</p> <p>Modifies that shot 6 shall be placed on the crown.</p>
<p>Shot placement for 6-shot hard armor test items for RF1, RF2, and RF3 P-BFD testing</p> <ol style="list-style-type: none"> 1. Modifies that BFD measurements shall be taken for shots 1 and 2 at 0-degrees. 2. Modifies multi-curve plate schematic so that shot 5 in the cross-hatched area and one shot in the shaded band (around the edges) shall be angled at 30-degrees toward the centerline.
<p>Shot patterns for ballistic limit on hard armor</p> <p>(NEW) Adds schematics for shot locations and order on 1-shot, 3-shot, and 6-shot test items.</p>
<p>Label test method</p> <p>Modifies the label test to improve the practicality of the test.</p>

NIJ also published Addendum 1 to NIJ Standard 0123.01, *Specification for NIJ Ballistic Protection Levels and Associated Test Threats* in October 2024, which includes revisions to that standard as well [10]. The review followed the same process as with NIJ Standard 0101.07 with regular consultation among NIJ, the NIJ CTP, and the NIJ-approved laboratories. While this document is much shorter than NIJ Standard 0101.07 and did not incorporate as many revisions, several notable adjustments were made. These include correcting the listed mass of the 7.62x51mm M80 Ball NATO FMJ Steel Jacket RF1 and RF2 test threat, clarifying the ammunition identifier for the RF3 test threat, and clarifying the requirements regarding ammunition measurements. Another modification was to clarify the use of the terms “lot” and “can” for purposes of auditing 7.62x39mm mild steel core (MSC) test ammunition. More information about the complete list of revisions to NIJ Standard 0101.07 and NIJ Standard 0123.00 is available on the NIJ website [11, 12].

3. A METHOD TO EVALUATE AMMUNITION SPECIFICATIONS IN NIJ STANDARD 0123.00 - EVALUATION OF THE REMINGTON 9MM HANDGUN TEST THREAT

The Remington 9mm Luger 124 grain FMJ ammunition has a longstanding history of use by the body armor industry as a standard ammunition for the assessment of handgun ballistic protection levels for law enforcement. Recently, Remington made changes to the projectile jacket material for certain lots of this ammunition. At the time of this paper, two variants of the ammunition are being sold under Remington product number #23558. Due to the potential significance of this type of manufacturing change on the terminal ballistic response of the projectile, NIJ determined that it was necessary to develop a method to reevaluate the specification of the 9mm test threat in NIJ Standard 0123.00. With the participation of five NIJ-approved laboratories and four material manufacturers, NIJ conducted an evaluation of the two projectile variants and compared their ballistic performance against planar-soft armor panels of two common material types used in ballistic body armor, para-aramid and ultra-high-molecular-weight polyethylene (UHMWPE), which involved collecting over 1100 shots across 104 test panels.

Figure 1 shows the projectile variants, both brass in composition. To simplify the descriptions of the different the jacket types, the projectile variants are here referred to as “copper”, the original projectile jacket, and “brass”, the new projectile jacket. Material composition of the jackets was determined via metalurgical analysis by a partnering government agency to be approximately 89:11 (Cu:Zn) for the “copper” jacket, and approximately 69:31 (Cu:Zn) for the “brass” jacket. The thickness and hardness (Rockwell B) of the projectile jackets was also analyzed and determined to be nominally equivalent. Sample sizes used to conduct the physical analysis were $n = 30$, and each sample came from a single lot of ammunition for each jacket type. Figure 1 also shows two examples of projectile core fragments for each jacket type that were recovered after testing at HG2 velocity and 30° angle of incidence with a UHMWPE soft armor panel. Minor, but recognizable differences were observed post-test in the deformation and fragmentation of the projectile cores that were tested at high angles of incidence against UHMWPE panel types. However, most of the core fragments recovered after testing exhibited similar characteristics when the jacket types were compared.

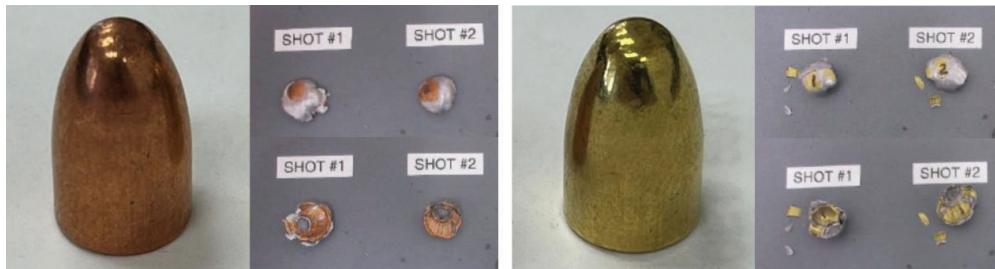


Figure 1. Copper (left) and brass (right) projectile variants of the Remington 9mm Luger 124 grain FMJ ammunition and examples of tested projectile core fragments. The projectile fragments are shown from a perspective of the projectile’s nose (top row) and base (bottom row).

Ballistic performance of the copper and brass projectile jackets was compared in several ways using two types of testing and four armor panel designs. In the first test series, one plain-woven para-aramid panel design, referred to as Aramid 1, and one cross-ply unidirectional UHMWPE panel design, referred to as PE 1, were tested at 0° angle of incidence over velocities ranging from below the HG1 protection level reference velocity, to above the predicted V_{50} ballistic limit of each panel. A total of 640 shots were conducted during these tests using forty test panels, and ten test panels were used for each of four possible projectile and panel type combinations. Test results were then analyzed by statistical regression methods, yielding full regression curves and ballistic limit values for both projectiles against a single panel design of each material type. Table 2 provides a comparison of the V_{50} values calculated from the regression analysis and the sample size “n” for each test. The absolute difference and percentage change of the V_{50} for the brass projectile compared to the V_{50} for the copper projectile are also provided for each panel type as a simple comparison of projectile performance. Absolute difference and percentage change are calculated using the V_{50} values for the copper projectile as the reference values.

Table 2. V_{50} ballistic limit values determined by statistical regression analysis for copper and brass variants of the Remington 9mm Luger 124 grain FMJ.

Panel Type	V_{50}		
	Copper	Brass	Absolute Difference and Percentage Change in V_{50} of Brass Relative to Copper
Aramid 1	491 m/s (1610 ft/s) n = 160	490 m/s (1608 ft/s) n = 160	-0.6 m/s (-2 ft/s) -0.1%
PE 1	510 m/s (1676 ft/s) n = 160	524 m/s (1719 ft/s) n = 160	+13.1 m/s (+43 ft/s) +2.6%

Backface deformation (BFD) in the clay backing substrate was also measured and collected for the small number of shots that were conducted in the first test series at velocities in the HG1 and HG2 reference velocity ranges. Average BFD values for these shots are presented alongside the results from the second test series in Tables 3 and 4. All of the soft armor panels used during this evaluation had dimensions of 38.1 cm x 38.1 cm (15 in. x 15 in.), with 10.2 cm (4 in.) corner stitches, and ballistic nylon covers. A more complete review of the results of the first test series and of the regression analysis performed, was submitted to the conference in a separate paper.

In the second test series, two panel designs for each material type, para-aramid, and UHMWPE were used to compare projectile performance for 30° and 45° angles of incidence at HG1 and HG2 protection level reference velocities using NIJ P-BFD laboratory methods. Aramid 1 and PE 1 panel designs, used during V_{50} testing, were utilized again to compare projectile performance at HG1 protection level reference velocity. Two new panel designs were also introduced, one cross-ply unidirectional para-aramid, referred to as Aramid 2, and a different type of cross-ply unidirectional UHMWPE, referred to as PE 2, to compare projectile performance at HG2 protection level reference velocity. A total of 512 shots were conducted during these tests using sixty-four test panels. In most of these tests, four test panels were used to test one panel design of each material type at 30° and 45° angles of incidence for each reference velocity. For the Aramid 2 panel type only, two test panels were used for each projectile and shot angle combination at both reference velocities.

BFD values were measured and collected for all shots in the second test series. Tables 3 provides a comparison of the average BFD measurements and the sample size for each test. Table 4 compares the average BFD measurements for the brass projectile with the copper projectile using the absolute difference and percentage change between them for each panel type. Absolute difference and percentage change are calculated using the BFD values for the copper projectile as the reference values. Data trends observed here showed differences of less than 9% in measured BFD when comparing projectile types for the 0° test conditions. BFD percentage differences observed between the projectiles types for the 30° and 45° test conditions were comparatively smaller, and were obtained using larger sample sizes.

Table 3. Measured BFD values from P-BFD testing of copper and brass variants of the Remington 9mm Luger 124 grain FMJ.

NIJ Ballistic Protection Level	Reference Velocity	Panel Type	BFD (mm)					
			0°		30°		45°	
			Copper	Brass	Copper	Brass	Copper	Brass
HG1	398 m/s (1305 ft/s)	Aramid 1	35.3 n = 11	32.9 n = 11	25.0 n = 32	24.5 n = 32	21.6 n = 32	20.9 n = 32
		Aramid 2	n/a	n/a	25.0 n = 16	25.2 n = 16	22.9 n = 16	23.3 n = 16
		PE 1	32.8 n = 8	29.8 n = 9	26.3 n = 32	25.6 n = 32	24.9 n = 32	24.7 n = 32
HG2	448 m/s (1470 ft/s)	Aramid 1	40.5 n = 7	37.6 n = 9	n/a	n/a	n/a	n/a
		Aramid 2	n/a	n/a	26.3 n = 16	26.5 n = 16	24.2 n = 16	24.8 n = 16
		PE 1	33.3 n = 7	34.1 n = 11	n/a	n/a	n/a	n/a
		PE 2	n/a	n/a	31.7 n = 32	30.7 n = 32	31.1 n = 32	29.2 n = 32

n/a = data was not acquired for this test condition.

Table 4. Difference comparison from P-BFD testing of copper and brass variants of the Remington 9mm Luger 124 grain FMJ.

NIJ Ballistic Protection Level	Reference Velocity	Panel Type	Absolute Difference and Percentage Change in BFD of Brass Relative to Copper		
			0°	30°	45°
HG1	398 m/s (1305 ft/s)	Aramid 1	-2.5 mm, -7.0%	-0.5 mm, -2.0%	-0.8 mm, -3.5%
		Aramid 2	<i>n/a</i>	+0.2 mm, +0.7%	+0.4 mm, +1.9%
		PE 1	-2.9 mm, -8.9%	-0.7 mm, -2.8%	-0.2 mm, -0.9%
HG2	448 m/s (1470 ft/s)	Aramid 1	-2.9 mm, -7.1%	<i>n/a</i>	<i>n/a</i>
		Aramid 2	<i>n/a</i>	+0.2 mm, +0.8%	+0.6 mm, +2.6%
		PE 1	+0.8 mm, +2.3%	<i>n/a</i>	<i>n/a</i>
		PE 2	<i>n/a</i>	-1.1 mm, -3.4%	-1.9 mm, -6.0%

n/a = data was not acquired for this test condition.

Coefficients of variation of the average BFD values, calculated by dividing the standard deviation by the average value for the sample, were similar between the projectile types. Coefficient of variation values ranged between 5%–13% for para-aramid panels and 4%–8% for UHMWPE panels tested at 0° angle of incidence, and between 5%–15% for para-aramid panels and 4%–9% for UHMWPE panels tested at 30° and 45° angles of incidence. No complete penetrations of either panel type were witnessed during testing at HG1 or HG2 reference velocities. Post-test examinations of the test panels showed similar trends in the number of layers penetrated by both projectile types for all directly comparable test conditions.

4. UPDATE ON THE NIJ COMPLIANCE TESTING PROGRAM

Use of NIJ-certified body armor remains ubiquitous among U.S. law enforcement and corrections agencies, and many agencies outside the U.S. make use of NIJ standards and NIJ-certified armor. Since the NIJ CTP began accepting armor submissions to meet the requirements of NIJ Standard 0101.06 in 2009, over 2,000 unique models of ballistic-resistant body armor have been submitted to the CTP for compliance testing through the end of 2024, with an overall failure rate of approximately 36% of models submitted for initial testing which do not meet the requirements for listing on the CPL. Currently there are over 440 models of ballistic-resistant body armor listed on NIJ’s Compliant Products List [13, 14].

Industry participation in the program by manufacturers is voluntary; however, it is recognized by manufacturers as the standard in body armor quality assurance. At the end of 2024, the NIJ CTP had 83 participants worldwide producing armor compliant with NIJ Standard 0101.06 at 144 manufacturing locations, with 75 locations inside the U.S. and 69 outside the U.S. The NIJ CTP also recognizes Body Armor Quality Management System Requirements called BA9000, which are optional quality assurance requirements to which body armor manufacturers can choose to have their manufacturing locations certified. Body armor manufactured at locations certified to BA9000 are required to undergo FIT less frequently than those manufactured at those that are not due to the enhanced quality assurance in place, which can have the added benefit of reduced overall costs to NIJ CTP participants to maintain their listed armor models. There are 20 manufacturing locations certified to BA 9000 operated by 19 of the NIJ CTP participants, representing 218 models, or 49%, of the ballistic-resistant body armor currently listed on the CPL.

The NIJ CTP is incorporating many improvements to the program in addition to the updated test methods and laboratory practices used to certify body armor to NIJ Standard 0101.07. The program continues to provide U.S. law enforcement and correctional agencies confidence that the body armor they purchase and use meets the NIJ’s minimum performance requirements against common handgun and rifle threats, as well as stab threats. Other improvements in the NIJ CTP for NIJ 0101.07 include a new web application for the Testing Information Management System (TIMS) [15], an updated Compliance Testing Report (CTR) that helps test laboratories to generate and report test results, and reorganized process documents to assist participants in navigating program policies and procedures.

While NIJ is certifying body armor to the new NIJ Standard 0101.07, and creating the new CPL for those armor models, it continues to recognize armor certified to NIJ Standard 0101.06. Given the large number of ballistic-resistant equipment models currently worn by law enforcement officers, NIJ will continue to maintain its CPL for armor models compliant with NIJ Standard 0101.06 through at least year-end 2027 and will continue to require FIT on these models. This will allow manufacturers and

law enforcement agencies to transition their equipment to armor that meets the new standard as smoothly as possible over a reasonable amount of time.

5. CONCLUSION

NIJ is actively implementing NIJ Standard 0101.07, *Ballistic Resistance of Body Armor*, to evaluate the performance of ballistic resistant body armor for commercial participants, law enforcement agencies, purchasers, and users. Body armor is currently being certified to the new standard and NIJ is in the process of publishing a new Compliant Products List for those armor models. The revised standard includes updated body armor test threats and protection levels, new test methods for female body armor, and improved test methods and laboratory practices. Many functions of the NIJ CTP have also been improved through the new TIMS web application and updated program policies and procedures. With the introduction of NIJ Standard 0101.07, for the first time the NIJ Mark[®] is available at the time of certification of all the newly listed armor models. NIJ also continues to recognize armor certified to NIJ Standard 0101.06 and will maintain its CPL for NIJ Standard 0101.06 compliant armor models through at least year-end 2027.

Continuous collaborative engagements with the body armor community and with the five NIJ-approved test laboratories during the first year and a half of implementation of the new standard has produced numerous refinements to the standard. Insights gained from these collaborations for the implementation of reconfigured shot placements, shots at nonzero angles of incidence in the proximity of edges, new procedures for testing conditioned armor, and multiple other aspects of laboratory testing procedures, has been critical to successful implementation. New interpretations and clarifications to the standard are being communicated with the body armor community through addenda to the original publication and will continue to be published on a periodic basis to the NIJ website.

With the support of five NIJ-approved laboratories and four material manufacturers, the NIJ also developed potential methods for conducting comparative evaluations of current and future threat specifications in NIJ Standard 0123.00, *Specification for NIJ Ballistic Protection Levels and Associated Test Threats*. In the study discussed here, an unexpected manufacturing change in the jacket material of the Remington 9mm Luger 124 grain FMJ made it necessary to evaluate the effects of the change on the performance of common types of armor materials. The ballistic performance of the original copper jacketed and new brass jacketed projectiles was evaluated in V_{50} testing, and P-BFD testing, against planar-soft armor panels of para-aramid and UHMWPE materials. Over 1100 shots were conducted in total using 104 test panels, comparing the projectiles at HG1 and HG2 velocities for 0°, 30°, and 45° angles of incidence. For the materials, panel designs, and test conditions that were evaluated, similar armor performance was observed between the variants of this ammunition. While only an overview of the results of the evaluation was discussed in this paper, it provides the foundation of a potential framework for NIJ to perform similar threat comparisons in the future. Information from this initial study also prepared NIJ to adapt the threat specification for the 9mm threat if a permanent change in the manufacturing of this ammunition occurs.

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