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DECEMBER 1978

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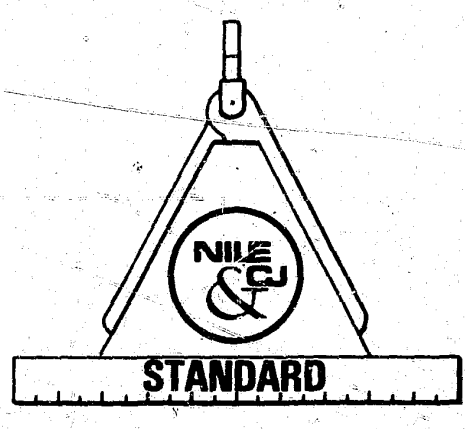
LAW ENFORCEMENT STANDARDS PROGRAM

THE BALLISTIC RESISTANCE OF POLICE BODY ARMOR



U.S. DEPARTMENT OF JUSTICE
Law Enforcement Assistance Administration
National Institute of Law Enforcement and Criminal Justice

LAW ENFORCEMENT STANDARDS PROGRAM

NILECJ STANDARD FOR THE BALLISTIC RESISTANCE OF POLICE BODY ARMOR

A Voluntary National Standard Promulgated by the National Institute of Law Enforcement and Criminal Justice.

DECEMBER 1978

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ACKNOWLEDGMENTS

This standard was formulated by the Law Enforcement Standards Laboratory of the National Bureau of Standards under the direction of Ronald C. Dobbyn, Manager, Protective Equipment Program, and Jacob J. Diamond, Chief of LESL. The technical research was performed by Nicholas J. Calvano, project leader, and other personnel of the NBS Center for Consumer Product Technology. The standard has been reviewed and approved by the National Advisory Committee for Law Enforcement Equipment and Technology of the International Association of Chiefs of Police and adopted by them as an IACP standard.

NILECJ STANDARD FOR THE BALLISTIC RESISTANCE OF POLICE BODY ARMOR

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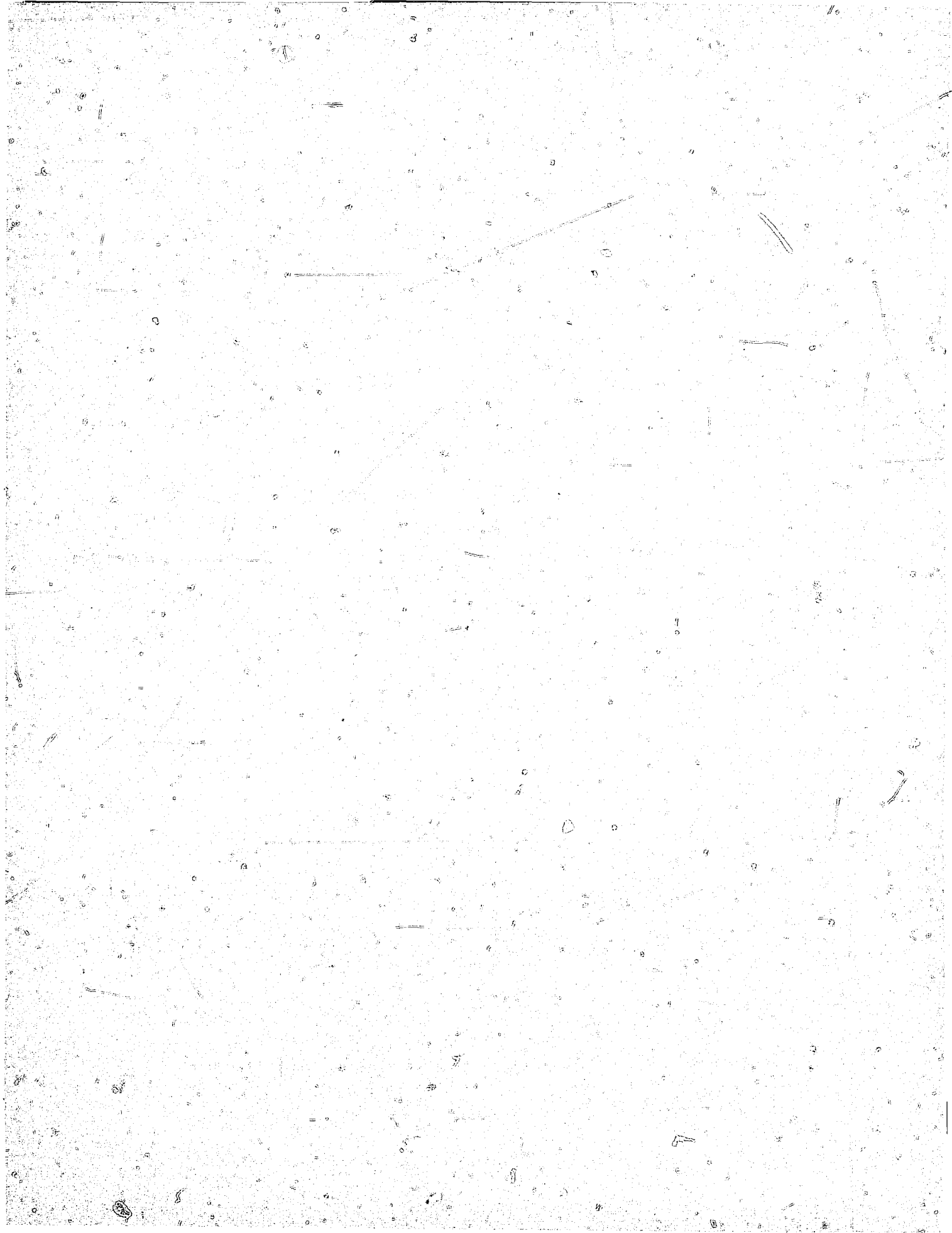

FOREWORD

Following a Congressional mandate[1] to develop new and improved techniques, systems, and equipment to strengthen law enforcement and criminal justice, the National Institute of Law Enforcement and Criminal Justice (NILECJ) has established the Law Enforcement Standards Laboratory (LESL) at the National Bureau of Standards. LESL's function is to conduct research that will assist law enforcement and criminal justice agencies in the selection and procurement of quality equipment.

In response to priorities established by NILECJ, LESL is: (1) Subjecting existing equipment to laboratory testing and evaluation and (2) conducting research leading to the development of several series of documents, including national voluntary equipment standards, user guides and technical reports.

This document, NILECJ-STD-0101.01, Ballistic Resistance of Police Body Armor, is a law enforcement equipment standard developed by LESL and approved and issued by NILECJ. Additional standards as well as other documents are being issued under the LESL program in the areas of protective equipment, communications equipment, security systems, weapons, emergency equipment, investigative aids, vehicles and clothing.

This equipment standard is a technical document consisting of performance and other requirements together with a description of test methods. Equipment which can meet these requirements is of superior quality and is suited to the needs of law enforcement agencies. Purchasers can use the test methods described in this standard to determine firsthand whether a particular equipment item meets the requirements of the standard, or they may have the tests conducted on their behalf by a qualified testing laboratory. Law enforcement personnel may also reference this standard in purchase documents and require that any equipment offered for purchase meet its requirements and that this compliance be either guaranteed by the vendor or attested to by an independent testing laboratory.

The necessarily technical nature of this NILECJ standard, and its special focus as a procurement aid, make it of limited use to those who seek general guidance concerning body armor. The User Guide Series is designed to fill that need. We plan to issue guides to various items of law enforcement equipment as soon as possible, within the constraints of available funding and the overall NILECJ program.

The user guides being issued are highly readable and tutorial in nature in contrast to the standards, which are highly technical and intended for laboratory use by technical personnel. The guides provide, in non-technical language, information for purchasing agents and other interested persons concerning the capabilities of equipment currently available. They may then select equipment appropriate to the performance required by their agency. Recommendations for the development of particular guides should be sent to us.

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[1]Section 402(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended.

NILECJ standards are subjected to continuing review. Technical comments and recommended revisions are invited from all interested parties. Suggestions should be addressed to the Program Manager for Standards, National Institute of Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, U.S. Department of Justice, Washington, D.C. 20531.

Lester D. Shubin
Program Manager for Standards
National Institute of Law
Enforcement and Criminal
Justice

NILECJ STANDARD FOR THE BALLISTIC RESISTANCE OF POLICE BODY ARMOR

1. PURPOSE

The purpose of this standard is to establish minimum performance requirements and methods of test for the ballistic resistance of police body armor. This standard is a revision of NILECJ-STD-0101.00, dated March 1972 [2].

2. SCOPE AND CLASSIFICATION

2.1 Discussion

This standard is applicable to armors intended to protect the torso against gunfire. Many different types of armor are now available; they range in ballistic resistance from those designed to protect against small caliber handguns to those designed to protect against high-powered rifles.

Personal protective armor manufacturers make a great variety of armors, many to special order, but production is currently concentrated in six classes designed to resist the following threats:

- 22 LRHV, 40 gr RN lead (1050 ± 40 fps); 38 Spec., 158 gr RN lead (850 ± 50 fps); and 12 gauge #4 shot.
- 357 Mag., 158 gr JSP (1250 ± 50 fps); and 9 mm, 124 gr FMJ (1090 ± 75 fps).
- 357 Mag., 158 gr JSP (1395 ± 20 fps); and 9 mm, 124 gr FMJ (1175 ± 75 fps).
- 44 Mag., 240 gr JSP (1425 ± 50 fps).
- 30 Carbine, 110 gr M-1 (1950 ± 50 fps); and 12 gauge rifled slug (1600 ± 50 fps).
- 30-06 rifle, 166 gr AP M-2 (2750 ± 50 fps).

The ballistic threat posed by a bullet depends, among other things, on its composition, shape, caliber, mass, and impact velocity. Because of the wide variety of cartridges available in a given caliber, and because of the existence of hand loads, armors that will defeat a standard test round may not defeat other loadings in the same caliber. For example, an armor that prevents penetration by a 357 Magnum test round may or may not defeat a 357 Magnum round with higher velocity. In general, an armor that defeats a given lead-core round will not resist penetration by an identical round with an armor-piercing core. The test ammunitions specified in this standard represent common threats to law enforcement officers.

2.2 Classification

Police body armors covered by this standard are classified into five types, by level of performance. Table 1 summarizes the protection they afford.

TABLE 1. *Protection Afforded by Police Body Armor*

Threat	Ballistic Protection Afforded				
	Type I Armor	Type II-A Armor	Type II Armor	Type III Armor	Type IV Armor
22 LRHV (H)	Yes	Yes	Yes	Yes	Yes
25 Auto.	Yes	Yes	Yes	Yes	Yes
32 Auto.	Yes	Yes	Yes	Yes	Yes
38 Special Lead	Yes	Yes	Yes	Yes	Yes
12 Gauge #4 Lead Shot	Yes	Yes	Yes	Yes	Yes
357 Magnum JSP	No	Yes[1]	Yes[2]	Yes	Yes
9 mm Luger FMJ	No	Yes[3]	Yes[4]	Yes	Yes
38 Special HV	No	Yes	Yes	Yes	Yes
22 LRHV (R)	No	Yes	Yes	Yes	Yes
45 Auto.	No	Yes	Yes	Yes	Yes
12 Gauge 00 BK	No	Yes	Yes	Yes	Yes
7.62 mm FMJ	No	No	No	Yes	Yes
44 Magnum Lead	No	No	No	Yes	Yes
44 Magnum JSP	No	No	No	Yes	Yes
41 Magnum	No	No	No	Yes	Yes
30-06 PSP	No	No	No	Yes	Yes
30 Carbine	No	No	No	Yes	Yes
12 Gauge RS	No	No	No	Yes	Yes
30-06 AP	No	No	No	No	Yes

Abbreviations:
AP—Armor
BK—Buckshot
FMJ—Full Metal Jacket
(H)—Handgun
HV—High Velocity
JSP—Jacketed Soft Point
LRHV—Long Rifle High Velocity
PSP—Pointed Soft Point
(R)—Rifle
RS—Rifled Slug

Footnotes: (1) Rounds up to 10.2 g (158 gr) with velocities up to 381 ± 15 m (1250 ± 50 ft) per second.
(2) Rounds up to 10.2 g (158 gr) with velocities up to 425 ± 15 m (1395 ± 50 ft) per second.
(3) Rounds up to 8.0 g (124 gr) with velocities up to 332 ± 15 m (1090 ± 50 ft) per second.
(4) Rounds up to 8.0 g (124 gr) with velocities up to 358 ± 15 m (1175 ± 50 ft) per second.

2.2.1 Type I (22 LR—38 Special)

This armor protects against the standard test rounds as defined in paragraph 5.1.1. It also provides protection against lesser threats such as 12 gauge No. 4 lead shot and most handgun rounds in calibers 25 and 32.

2.2.2. Type II-A (Lower Velocity 357 Magnum—9mm)

This armor protects against the standard test rounds as defined in paragraph 5.1.2. It also provides protection against lesser threats such as 12 gauge 00 buckshot, 45 Auto., 22 caliber Long Rifle High Velocity (rifle), High Velocity 38 Special and some other factory loads in caliber 357 Magnum and 9 mm, as well as the threats mentioned in paragraph 2.2.1.

2.2.3 Type II (Higher Velocity 357 Magnum—9 mm)

This armor protects against the standard test rounds as defined in paragraph 5.1.3. It also provides protection against lesser threats such as 12 gauge 00 buckshot, 45 Auto., 22 caliber Long Rifle High Velocity (rifle), High Velocity 38 Special and most other factory loads in caliber 357 Magnum and 9 mm, as well as the threats mentioned in paragraph 2.2.1 and 2.2.2.

2.2.4 Type III (High-Powered Rifle)

This armor protects against the standard test round as defined in paragraph 5.1.4. It also provides protection against lesser threats such as 223 Remington (5.56 mm FMJ), 30 Carbine FMJ, and 12 gauge rifled slug, as well as the threats mentioned in paragraphs 2.2.1, 2.2.2 and 2.2.3.

2.2.5 Type IV (Armor-Piercing Rifle)

This armor protects against the standard test round as defined in paragraph 5.1.5. It also provides at least single hit protection against the threats mentioned in paragraphs 2.2.1, 2.2.2, 2.2.3 and 2.2.4.

2.2.6 Special Type

A purchaser having a special requirement for a level of protection other than one of the above standards should specify the exact test rounds to be used, and indicate that this standard shall govern in all other respects.

2.3 Configuration

Police body armor is offered in a variety of configurations. All makes and models offer protection for the torso front. Many models also cover the back, and some offer additional protection. Police body armor may be specified to contain armor parts to cover the:

(a) torso front, or front and sides
(b) torso back, or back and sides
(c) groin,
(d) coccyx (end of the spine)

or any practical combination of these, as required.

3. DEFINITIONS

3.1 Angle of Incidence

The angle between the line of flight of the bullet and the perpendicular to the plane tangent to the point of impact (see figure 1).

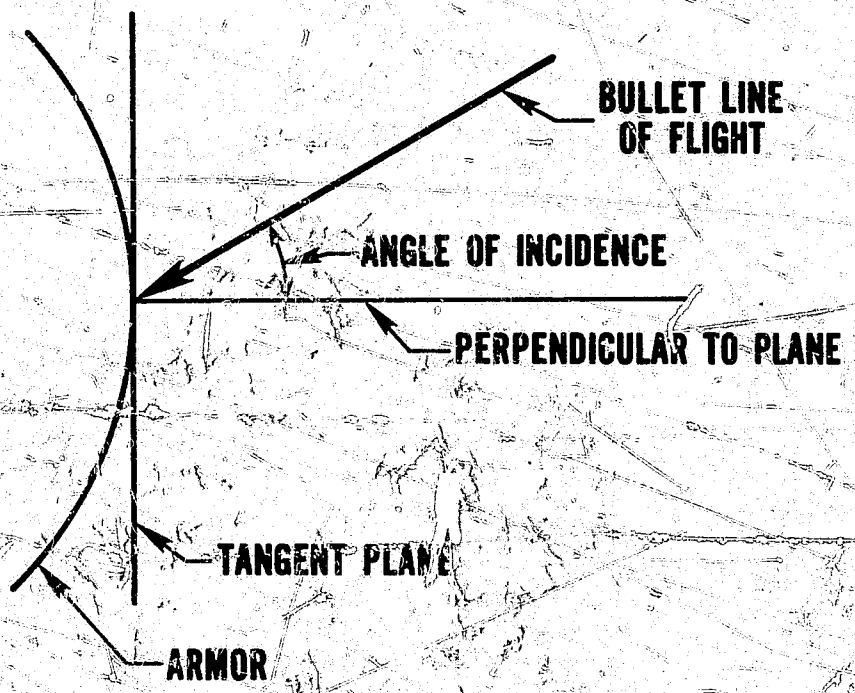

FIGURE 1. *Angle of incidence.*

3.2 Backing Material

A block of non-hardening, oil-base modeling clay, 45 cm by 45 cm by 10 cm thick (18 by 18 by 4 in), placed in contact with the back of the armor test specimen during ballistic testing.

3.3 Deformation

The maximum momentary displacement of the back surface of the armor test specimen caused by a fair hit that does not penetrate the armor.

3.4 Fair Hit

A bullet that impacts the armor at an angle of incidence no greater than 5 degrees, no closer to the edge of the armor part or to a prior hit than 5 cm (2 in), and at an acceptable velocity as defined in this standard. A bullet that impacts too close to the edge or a prior hit and/or at too high a velocity, but does not penetrate, shall be considered a fair hit for the determination of penetration but not deformation.

3.5 Full Metal Jacketed Bullet (FMJ)

A bullet made of lead completely covered, except for the base, with copper alloy (approximately 90 copper, 10 zinc).

3.6 Jacketed Soft Point (JSP)

A bullet made of lead completely covered, except for the point, with copper alloy (approximately 90 copper-10 zinc).

3.7 Lead Bullet

A bullet made of lead alloyed with hardening agents.

3.8 Penetration

Complete perforation of an armor test sample by a test bullet or by a fragment of the bullet or armor, as evidenced by the presence of that bullet or a fragment in the backing material, or by a hole which passes through the backing material.

3.9 Strike Face

The surface of an armor designated by the manufacturer as the face that should be worn away from the body.

4. REQUIREMENTS

4.1 Sampling for Test

Two complete armors, selected at random, shall constitute a test sample. A maximum of two additional type I, II-A and II armors may be required for retesting.

4.2 Test Sequence

Armors shall be examined to determine compliance with the requirements of paragraphs 4.3 and 4.4, and shall then be tested for compliance with the requirements of paragraph 4.5.

4.3 Workmanship

Each armor shall be free from wrinkles, blisters, cracks or fabric tears, crazing, chipped or sharp corners and other evidences of inferior workmanship.

4.4 Labeling

Each armor shall be clearly and durably marked to provide the following information:

a) name, logo or other identification of the manufacturer
b) type of body armor, according to section 2 of this standard
c) size
d) lot number
e) month and year of manufacture
f) strike face, if any
g) cleaning instructions for the ballistic material and for the armor carrier, if any

Items d and e may be incorporated into a single number, e.g., a serial number.

4.5 Ballistic Penetration and Deformation

One complete armor shall be tested for resistance to ballistic penetration and ballistic deformation in accordance with paragraph 5.2. A second armor shall be so tested after wet conditioning in accordance with paragraph 5.1.8. Penetration by any fair hit, or deformation to a depth greater than 44 mm (1.73 in), in either test, shall constitute failure. The detailed requirements are summarized in table 2.

TABLE 2. *Test Summary*

	Test Variables				Performance Requirements		
Armor Type	Test Ammunition	Nominal Bullet Mass	Suggested Barrel Length	Required Bullet Velocity	Required Fair Hits Per Armor Part	Permitted Penetrations	Maximum Depth of Deformation
I	22 LRHV Lead	2.6 grams 40 grains	15 to 16.5 cm 6 to 6.5 in	320 ± 12 m/s 1050 ± 40 ft/s	5*	0	44 mm 1.73 in
	38 Special RN Lead	10.2 grams 158 grains	15 to 16.5 cm 6 to 6.5 in	259 ± 15 m/s 850 ± 50 ft/s	5*	0	44 mm 1.73 in
II-A	357 Magnum JSP	10.2 grams 158 grains	10 to 12 cm 4 to 4.75 in	381 ± 15 m/s 1250 ± 50 ft/s	5*	0	44 mm 1.73 in
	9 mm FMJ	8.0 grams 124 grains	10 to 12 cm 4 to 4.75 in	332 ± 15 m/s 1090 ± 50 ft/s	5*	0	44 mm 1.73 in
II	357 Magnum JSP	10.2 grams 158 grains	15 to 16.5 cm 6 to 6.5 in	425 ± 15 m/s 1395 ± 50 ft/s	5*	0	44 mm 1.73 in
	9 mm FMJ	8.0 grams 124 grains	10 to 12 cm 4 to 4.75 in	358 ± 15 m/s 1175 ± 50 ft/s	5*	0	44 mm 1.73 in
III	7.62 mm (308 Winchester) FMJ	9.7 grams 150 grains	56 cm 22 in	873 ± 46 m/s 2863 ± 151 ft/s	5*	0	44 mm 1.73
IV	30-06 AP	10.8 grams 166 grains	56 cm 22 in	838 ± 15 m/s 2750 ± 50 ft/s	1	0	44 mm 1.73 in

* Armor parts covering the torso front and torso back, with or without side coverage, shall each be impacted with the indicated number of fair hits. Armor parts covering the groin and coccyx shall each be impacted with 3 fair hits. The deformations due to the first two fair hits shall be measured to determine compliance.

Abbreviations: AP—Armor Piercing
FMJ—Full Metal Jacketed
JSP—Jacketed Soft Point
LRHV—Long Rifle High Velocity
RN—Round Nose

At the option of the tester, a type I, II-A or II armor part which has successfully withstood 5 fair hits with one test ammunition may thereupon be tested with the second test ammunition. However, if failure occurs with the second test ammunition a retest shall be conducted. A second specimen of that armor part shall be tested with the second test ammunition and the results of that test shall govern.

5. TEST METHODS

5.1 Test Equipment

It should be noted that hand-loaded ammunition may be required to achieve some of the bullet velocities required in the following paragraphs.

5.1.1 Type I Test Weapons and Ammunition

5.1.1.1 22 LR

The test weapon may be a 22 caliber handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 22 Long Rifle High Velocity lead, with nominal masses of 2.6 grams (40 grains) and measured velocities of 320 ± 12 meters (1,050 ± 40 feet) per second.

5.1.1.2 38 Special

The test weapon may be a 38 Special handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 38 Special round-nose lead, with nominal masses of 10.2 grams (158 grains) and measured velocities of 259 ± 15 meters (850 ± 50 feet) per second.

5.1.2 Type II-A Test Weapons and Ammunition

5.1.2.1 Lower Velocity 357 Magnum

The test weapon may be a 357 Magnum handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 357 Magnum jacketed soft point, with nominal masses of 10.2 grams (158 grains) and measured velocities of 381 ± 15 meters (1250 ± 50 feet) per second.

5.1.2.2 Lower Velocity 9 mm

The test weapon may be a 9 mm handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 9 mm full metal jacketed, with nominal masses of 8.0 grams (124 grains) and measured velocities of 332 ± 15 meters (1090 ± 50 feet) per second.

5.1.3 Type II Test Weapons and Ammunition

5.1.3.1 Higher Velocity 357 Magnum

The test weapon may be a 357 Magnum handgun or test barrel. The use of a handgun with a 15 to 16.5 cm (6 to 6.5 in) barrel is suggested. Test bullets shall be 357 Magnum jacketed soft point, with nominal masses of 10.2 grams (158 grains) and measured velocities of 425 ± 15 meters (1395 ± 50 feet) per second.

5.1.3.2 Higher Velocity 9 mm

The test weapon may be a 9 mm handgun or test barrel. The use of a handgun with a 10 to 12 cm (4 to 4.75 in) barrel is suggested. Test bullets shall be 9 mm full metal jacketed, with nominal masses of 8.0 grams (124 grains) and measured velocities of 358 ± 15 meters (1175 ± 50 feet) per second.

5.1.4 Type III Test Weapon and Ammunition

The test weapon may be a rifle or a test barrel chambered for 7.62 mm (308 Winchester) ammunition. The use of a rifle with a barrel length of 56 cm (22 in) is suggested. Test bullets shall be 7.62 mm full metal jacketed (U.S. military designation M80), with nominal masses of 9.7 grams (150 grains) and measured velocities of 873 ± 46 meters ($2{,}863 \pm 151$ feet) per second.

5.1.5 Type IV Test Weapon and Ammunition

The test weapon may be a rifle or a test barrel chambered for caliber 30–06 ammunition. The use of a rifle with a barrel length of 56 cm (22 in) is suggested. Test bullets shall be caliber 30–06 armor piercing (U.S. military designation APM2), with nominal masses of 10.8 grams (166 grains) and measured velocities of 838 ± 15 meters ($2{,}750 \pm 50$ feet) per second.

5.1.6 Chronograph

The chronograph shall have a precision of one microsecond and an accuracy of two microseconds. Its triggering devices shall be of either the photoelectric or conductive screen type.

5.1.7 Armor Backing Material

The armor backing material shall be conditioned by being kept for at least three hours at a temperature between 15 and 30°C (59 and 86°F), and shall be worked thoroughly to eliminate any voids. Its consistency shall be such that a depression of 25 ± 3 mm (1 ± 0.1 in) in depth is obtained when a 1 kg (2.2 lb) cylindrical steel mass, 45 mm (1.75 in) in diameter and having a hemispherical striking end, is dropped from a height of 2 meters (6.5 feet) onto one of its square faces. Three drop tests shall be made, and the center of each impact site shall be at least 75 mm (3 in) from a previous impact site and from any edge. A guide tube or other means may be used as required to assure that the striking end of the cylindrical mass impacts the backing material squarely. The backing material may be maintained at any temperature in the above range that will give it the required consistency.

A backing material found to be suitable is Roma Plastilina No. 1 modeling clay, available from Sculpture House, 304 West 42nd Street, New York, NY 10036, and other artist supply centers.

5.1.8 Wet Armor Conditioning

One complete armor shall be conditioned by subjecting both sides of each armor part to a water spray under the following conditions:

The spray nozzles shall be of such size and so spaced that 10 ± 2 liters (2.5 ± 0.5 gallons) of water per hour falls uniformly distributed on each 0.1 m^2 (1 ft^2) of spray booth floor area, and so located that the droplets are falling from gravitational force only, when they strike the armor surface.

Each surface of each armor part shall be sprayed for 3 minutes. Ballistic testing shall begin immediately after the armor is removed from the spray. The maximum time the armor may be out of the spray shall not exceed 10 minutes. After 10 minutes of testing, the armor shall be returned to the spray environment for an additional 3 minute spray on each surface.

5.2 Test Procedure

Set up the test equipment as shown in figure 2. Firmly clamp the appropriate test weapon, with barrel horizontal, in such a manner that alignment of the weapon is not altered when it is discharged.

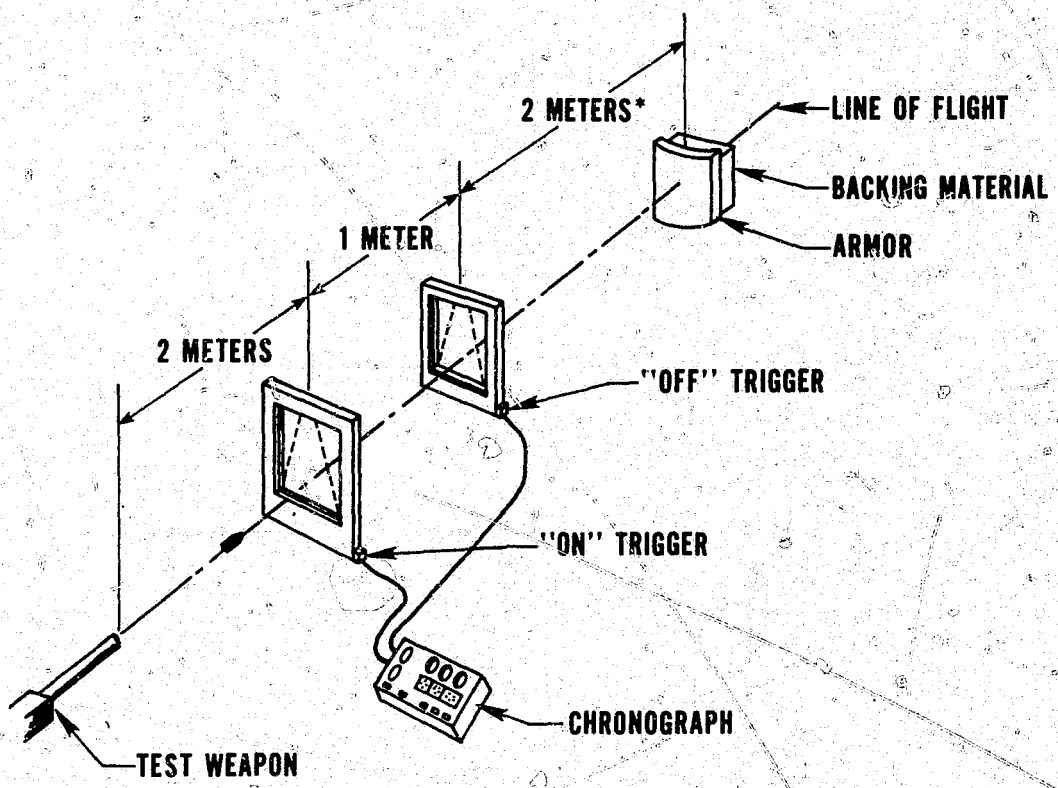

FIGURE 2. *Ballistic test setup.*

Allow all electronic equipment to warm up for 30 minutes or until stability is achieved, whichever time is greater. During testing, maintain the ambient temperature at 20–28°C (68–82°F) and the relative humidity at 30 to 70 percent.

Condition the armor test backing material and test it for consistency in accordance with paragraph 5.1.7. Reshape and smooth the backing material to its defined dimensions, and maintain it at the temperature required to maintain the required consistency.

Place the chronograph triggering screens two and three meters (6.6 and 9.8 feet), respectively, from the muzzle of the test weapon and arrange them so that they define planes perpendicular to the line of flight of the bullet. Measure the distance between the triggering planes with an accuracy of one millimeter (0.04 in).

Position a sheet of cardboard five meters (16 feet) from the muzzle of the test weapon if type I, II-A or II armor is being tested; position it 15 meters (50 feet) away if type III or IV armor is being tested. Fire a pre-test round through the cardboard to determine the line of flight and point of impact of the bullet; alternatively, use an aiming light or other suitable means.

Place one of the square faces of the armor backing material in intimate contact with the back face of the armor specimen under test and secure it with tape, the armor straps or

other means which will not interfere with the test. Place this assembly in back of the sheet of cardboard with the armor front face perpendicular to the line of flight of the bullet so that the desired point of impact touches the bullet hole made by the pre-test round, and then remove the cardboard.

Fire a test round at the armor. Record the time of flight of the bullet between the two triggering screens, as determined by the chronograph, and calculate the bullet velocity. Examine the armor and the backing material to determine whether penetration occurred when a bullet made a fair hit.

If no penetration occurred, measure and record the depth of the depression made in the armor backing material; do so for the first two (only) fair hits made with each test ammunition on each armor part.

If no failure occurred, reposition the armor so as to space additional impacts evenly over its surface or position another armor specimen (as required) and repeat the procedure with additional test rounds until the required number of fair hits (see table 2) has been obtained on each armor part. To minimize the concomitant bunching of ballistic material in soft armors, place each successive fair hit as far as possible from the center of each armor part. Reposition the backing material (as required) to avoid any overlap of depressions. If there are seams in the ballistic material, place the required number of fair hits so as to include impacts directly on those seams.

If no failure occurred, test the second complete armor, which had been preconditioned in accordance with paragraph 5.1.8.

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