INCH-POUND

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DEPARTMENT OF DEFENSE
TEST METHOD STANDARD

V_{50} BALLISTIC TEST FOR ARMOR



AMSC N/A

FSC 8470

FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense (DoD).

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons & Materials Research Directorate, ATTN: AMSRL-WM-M, APG, MD 21005-5069 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Purpose. The purpose of this standard is to provide general guidelines for procedures, equipment, physical conditions, and terminology for determining the ballistic resistance of metallic, nonmetallic and composite armor against small arms projectiles. The ballistic test procedure described in this standard determines the V_{50} ballistic limit of armor.

1.2 Application. This test method standard is intended for use in ballistic acceptance testing of armor and for the research and development of new armor materials. This ballistic test method is applicable to the following types of armor:

a. Body armor.
b. Armored seats for aircraft and ground vehicles.
c. Crew station armor for military aircraft.
d. Internal and external armor for aircraft.
e. Transparent armor, such as windows, windshields and vision blocks for aircraft and ground vehicles.
f. Bulkhead armor for shipboard use.
g. Structural or integral armor for use on ship exteriors.
h. Armor for military tactical shelters (AFWAL-TR-82-4163).
i. Visors for eye and face protection.
j. Armor for potential space applications.
k. Armor for light and heavy combat vehicles and structures.

1.3 Limitations. This standard has the following limitations:

a. When specified by the procuring activity, ballistic acceptance of armor may be based upon pass/fail or accept/reject criteria other than the V_{50} BL(P) ballistic limit method contained herein.

b. Military activities or DoD contractors may use in-house ballistic test facilities and equipment not covered by this standard (see MIL-STD-1161).

c. This standard does not take precedence over nor supersede armor specification ballistic test procedures.

d. Unique requirements for the ballistic testing of specific end-items not covered in this standard should be specified in the contract.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. Not applicable.

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

ARL PROGRAM No.: 0183009 Security Classification Guide for Armor Materials (30 JULY 1993)

(Application for copies should be addressed to U.S. Army Research Laboratory, Intelligence and Security Office, ATTN: AMSRL-OP-SC, 2800 Powder Mill Road, Adelphi, MD 20783-1145.

USATECOM TOP 2-2-7l0	Ballistic Tests of Armor Materials
ITOP 4-2-805	Projectile Velocity and Time of Flight Measurements

(Application for copies should be addressed to the Defense Technical Information Center, 8725 John J. Kingman Road, Ste. 0944, Fort Belvoir, VA 22060-6218.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Applique armor. Armor that can be easily installed or removed from a weapon system in kit form without adversely affecting its structural integrity or operation.

3.2 Areal density. A measure of the weight of armor material per unit area, usually expressed in pounds per square foot ($1b/ft^2$) or kilograms per square meter (kg/m^2) of surface area.

3.3 Armor. A shielding material provided for ballistic defeat of projectiles or fragments when inherent shielding is inadequate.

3.4 Ballistic acceptance test. A test performed on lot representative samples to determine whether or not the lot of armor is ballistically acceptable for use in production armor items.

3.5 Ballistic coefficient. A parameter or measure which is used to represent or account for the attenuation of the velocity of a projectile or fragment in transit from the firing mechanism to the target. "Ballistic coefficients" are normally used in approximate formulations to determine average speed or times-of-flight for a projectile. For example, average projectile speed, $V_{p,}$ can be obtained from:

$$V_p = V_o \; \propto R$$
$$\exp (\propto R)-1$$

where
V_o = muzzle velocity
R = range
$\propto$ = ballistic coefficient

3.6 Ballistic impact. Those impacts due to hits on the target by projectiles, fragments or other aerodynamically-affected threat mechanisms.

3.7 Ballistic limit. The minimum velocity at which a particular projectile is expected to consistently, completely penetrate armor of given thickness and physical properties at a specified angle of obliquity. The ballistic limit may also be defined as the maximum velocity at which a particular projectile is expected to consistently fail to penetrate armor of given thickness and physical properties at a specified angle of obliquity. Because of the expense of firing tests and the impossibility of controlling striking velocity precisely, plus the existence of a zone of mixed results in which a projectile may completely penetrate or only partially penetrate under apparently identical conditions, statistical approaches are necessary, based upon limited firings. Certain approaches lead to approximation of the V_{50} Point, that is, the velocity at which complete penetration and incomplete penetration are equally likely to occur. Other methods attempt to approximate the V_O Point, that is, the maximum velocity at which no complete penetration will occur.

Other methods attempt to approximate the V_{100} Point, that is, the minimum velocity at which all projectiles will completely penetrate.

3.8 Ballistic limit, protection criteria (V_{50}BL(P)). The V_{50}BL(P) may be defined as the average of an equal number of highest partial penetration velocities and the lowest complete penetration velocities which occur within a specified velocity spread. The normal up-and-down firing procedure is used. A 0.020 in. (0.51 mm) thick 2024 T3 sheet of aluminum is placed 6 $\pm$ 1/2 in. (152 $\pm$ 12.7 mm) behind and parallel to the target to witness complete penetrations. Normally, at least two partial and two complete penetration velocities are used to complete the BL(P). Four, six, and ten-round ballistic limits are frequently used. The maximum allowable velocity span is dependent on the armor material and test conditions. Maximum velocity spans of 60, 90, 100 and 125 feet per second (ft/s) (18, 27, 30 and 38 m/s) are frequently used.

3.9 Ballistic resistance. A measure of the capability of a material or component to stop or reduce the impact velocity and mass of an impacting projectile or fragment.

3.10 Ceramic composite armor. A type of composite armor which consists of a ceramic face bonded to a reinforced plastic laminate or metallic backplate.

3.11 Chronograph. An electronic instrument used to determine the time interval of projectile flight between two fixed measuring stations.

3.12 Composite armor. An armor system consisting of two or more different armor materials bonded together to form a protective unit.

3.13 Fair hits (for ceramic composite armor). The definitions contained herein apply to the ballistic testing of ceramic composite armor which consists (in part) of ceramic tiles.

a. Fair hit (center tile) - A fair hit for the center tile of the ceramic composite armor is an area within one inch (25.4 mm) radius of the center of an undamaged tile.

b. Fair hit (adjacent tile) - A fair hit in an adjacent tile is a fair hit (center tile) in a tile that has an edge adjacent to a previously impacted tile whose hit was declared a fair hit.

c. Fair hit (joint line) - A fair hit on a joint line is a hit within 0.15 in. (3.8 mm) of a single joint between two tiles, but no closer than 0.5 in. (12.7 mm) from the intersection of three or more tiles.

3.14 Fair impact. An impact shall be considered fair when an unyawed (see 5.3.2) fragment simulator or test projectile strikes an unsupported area of the target material at a specified obliquity at a distance of at least two projectile diameters from any previous impact or disturbed area resulting from an impact, or from any crack, or from any edge of the test specimen.

3.15 Fragment simulator. A projectile designed to simulate the effects of fragmenting munitions when such fragments strike a target.

3.16 Initial velocity. The projectile velocity at the moment that the projectile ceases to be acted upon by propelling forces. For a gunfired projectile the initial velocity, expressed as feet or meters per second, is also called "muzzle velocity."

3.17 Integral armor. Armor material used as part of a structure to perform a load-carrying or other operational function, in addition to ballistic protection. Also known as structural armor.

3.18 Lumiline screen. Photoelectric device used to activate or deactivate a chronograph upon passage of a projectile.

3.19 Muzzle velocity. The velocity of the projectile with respect to the muzzle at the instant the projectile leaves the weapon. This velocity is a function of the projectile weight, firing charge of the projectile, barrel characteristics, etc. See also "initial velocity."

3.20 Obliquity. A measure, normally in degrees, of the extent to which the impact of a projectile on an armor material deviates from a line normal to the target. Thus, a projectile fired perpendicular to the armor surface has 0 degrees obliquity.

3.21 Obliquity angle. Angle between the normal to the target surface and the projectile trajectory or line-of-flight.

3.22 Overmatch. A term used primarily in association with steel armor which indicates that the diameter of the impacting projectile is larger than the thickness of the armor plate.

3.23 Parasitic armor. See applique armor.

3.24 Penetration, complete (CP). A complete penetration occurs when the impacting projectile, or any fragment thereof, or any fragment of the test specimen perforates the witness plate, resulting in a crack or hole which permits light passage when a 60-watt, 110-volt bulb is placed proximate to the witness plate.

3.25 Penetration, partial (PP). Any impact which is not a complete penetration shall be considered a partial penetration.

3.26 Petalling. The plastic deformation of a ductile material when struck by an impacting projectile or fragment, resulting in material being forced outward in leaflets or petal forms.

3.27 Projectile, fragment simulating. A projectile designed with special material, shape, and size for ballistic test firings so that the effect of typical fragments can be simulated.

3.28 Propellant. A rapidly burning substance or mixture whose combustion or release produces the gas pressure that propels the projectile through the gun bore.

3.29 Punching. Armor failure in shear where a circular plug about the size of the attacking projectile is pushed from the backside of the plate.

3.30 Sabot. Lightweight carrier in which a specified caliber projectile is centered to permit firing the projectile in the larger caliber weapon. The sabot diameter fills the bore of the weapon from which the projectile is fired. The sabot is usually discarded in flight a short distance from the muzzle, and only the subcaliber projectile continues downrange.

3.31 Small arms. All gas-propelled, tube-type weapons firing a ballistic projectile with a diameter up to and including 20 millimeters (0.787 inches).

3.32 Small arms ammunition. All ammunition up to and including 20 millimeters (0.787 inches). A round of ammunition includes a ballistic projectile, propellant charge, charge igniter (primer), and a charge case.

3.33 Spaced armor. Armor systems having spaces between armor elements.

3.34 Spalling. The detachment or delamination of a layer of material in the area surrounding the location of impact, which may occur on either the front or rear surfaces of the armor. Spalling may be a threat mechanism even when penetration of the armor itself is not complete.

3.35 Striking velocity. The velocity of a projectile or missile at the instant of impact (also known as impact velocity).

3.36 Target base line. The distance from a point midway between the two velocity measuring, triggering devices to the test sample.

3.37 Terminal ballistics. A branch of ballistics which is concerned with the effects of weapons on targets including penetration, fragmentation, detonation, shaped charge, blast, combustion and incendiary effects.

3.38 Test sample. An armor plate or fabricated armor section or component which is to be ballistically tested for evaluation of ballistic protection properties.

3.39 Undermatch. A term used primarily in association with steel armor which indicates that the diameter of the impacting projectile is less than the thickness of the armor plate.

3.40 V_{50} ballistic limit. In general, the velocity at which the probability of penetration of an armor material is 50 percent.

3.41 Witness plate. A thin sheet located behind and parallel to the ballistic test sample which is used to detect penetrating projectiles or spall.

3.42 Yaw. Projectile yaw is the angular deviation of the longitudinal axis of the projectile from the line of flight at a point as close to the impact point on the target as is practical to measure.

4. GENERAL REQUIREMENTS

4.1 Projectile. The test projectile shall be of the type and caliber specified in the contract. Millimeters shall be used to identify the caliber of projectiles unless otherwise specified. Table I provides the velocities (expressed in feet per second) of various projectiles at specific target distances.

4.2 Weapon. The weapon(s) used in the ballistic test firing shall be capable of firing the appropriate projectile at the specified V_{50}BL(P) velocity range within yaw limitations. Millimeters shall be used to identify the caliber of weapons unless otherwise specified.

4.3 Velocity measuring equipment.

4.3.1 Chronograph. An electronic counter type chronograph measuring to at least the nearest microsecond (10^{-6} s) shall be used.

4.3.2 Detectors. Either high-velocity lumiline screens, or electrical contact screens which either open or close an electrical circuit by passage of the projectile through the detector shall be used. Contact screens may consist of metallic foils separated by a thin insulating layer, or may consist of a circuit printed on paper with the circuit spacing such

that the projectile passing through the screen will "break" the circuit. Chronograph or electronic timers used shall be calibrated and certified for accuracy. If accuracy is not certified, two pairs of velocity screens and two chronograph counters shall be used. This system enables the computation of an average projectile velocity between each pair of screens. The difference between the two instrumentation velocities shall be less than or equal to l0 ft/s (3 m/s); thus, giving greater accuracy in actual average velocity.

4.3.3 Radar. Doppler radar is used occasionally to check lumiline screens.

4.4 Propellant. Any propellant which is either standard or suitable for the weapon shall be used. A projectile velocity-propellant charge curve for the weapon shall be determined before any testing is performed. This curve is required to provide a basis for selecting a powder charge to achieve a desired velocity. It is recommended that the propellant storage and weighing area be maintained at 19-24°C (65-75°F) and 50 ± 5% relative humidity.

4.5 Test sample mount. The armor test sample shall be secured on the test target mount with impact side perpendicular to the line-of-flight of the projectile. The frame supports and clamps or mounting fixtures must be capable of retaining the sample and withstanding shock resulting from ballistic impact by the test projectiles. The test sample mount shall be capable of adjustment for moving the sample in the vertical or horizontal directions so that the point of impact can be located anywhere on the sample, and so that zero degree obliquity impacts can be achieved anywhere on the sample. The test sample mount shall be able to rotate on the vertical or horizontal axis so that various obliquity attack angles can be achieved. The test samples shall be mounted with a rigidity equal to or greater than the actual installation of the part.

4.6 Test sample. The sampling plan for ballistic acceptance tests shall be specified in the contract.

5. DETAILED REQUIREMENTS

5.1 Test conditions. Unless otherwise specified, all ballistic tests shall be performed in a standard atmosphere of 23 ± 2°C (73 ± 4°F) and 50 ± 5% relative humidity. Temperature and humidity measurements shall be recorded for each firing.

5.2 Equipment setup.

5.2.1 Triggering devices. The spacing from the weapon muzzle to the first pair of triggering devices shall be sufficient to prevent damage from muzzle blast and obscuration from smoke in case optical devices are used. Recommended distances can

be found in ITOP 4-2-805. Spacing between triggering devices is a function of the expected velocity of the projectile being fired. In many instances, physical restriction, such as short overall distance from muzzle to test sample, dictates the spacing of the triggering devices. The last pair of triggering devices shall be placed at least 4 ft (122 cm) in front of test sample and should be protected from possible damage resulting from fragments.

5.2.2 Witness plate. The witness plate shall be 0.002 in. (0.05 mm) thick aluminum sheet for transparent armors and vision devices and 0.020 in. (0.51 mm) thick aluminum sheet for all other armors. The minimum size of the witness plate shall be 11 in. by l4 in. (279 mm X 356 mm) and be of sufficient size to be impacted by all fragments resulting from projectile penetration. The witness plate shall be made of 2024-T3, 2024-T4 or 5052 aluminum alloy sheet, and shall be located 6 ± 0.5 in. (150 ± 10 mm) behind and parallel to the armor test sample. When the test sample is a helmet the witness plate shall be rigidly mounted inside the helmet and 2 in. (51 mm) behind the area of impact and may be smaller than specified above so that it will fit inside the helmet. When the target presents a curved surface, such as a visor, the witness plate shall be located 6 ± 0.5 in. (150 ± 10 mm) behind the target, curved and oriented to maximize the probability of perpendicular impact.

5.3 Ballistic test procedure. The procedure listed below is a general description of the method for obtaining a V_{50}BL(P). One should note that the actual method to be used may vary depending on target composition, specification or contract requirement.

5.3.1 Warm-up for constant velocity. When warmer rounds are needed for weapon or target alignment or establishment of a specific striking velocity, a test round shall be fired through the witness plate to determine the exact point of impact. Additional rounds shall be fired as required until the proper alignment and a stable striking velocity have been achieved. The propellant charge versus velocity curve for the weapon being used shall be referred to as a guide for establishing the required velocity within a practical ± tolerance. Normally, this will be about ± 25 ft/s (8 m/s).

5.3.2 Yaw. The test sample shall be mounted as described in 4.5. The point of impact shall be located on the test sample and shall be positioned to line up with the previously determined line of flight of the projectile. Yaw shall be measured for each round by yaw cards, flash radiograph or photography. Any round for which yaw is determined to be greater than 5^{o} shall be disregarded in the calculation of the ballistic limit. In the case of a dispute concerning a particular barrel, yaw shall be measured by a photographic measurement system using a multi-flash light source to determine projectile velocity and yaw. Yaw shall be measured by the system to an accuracy of 0.5 degree.

5.3.3 First firing. For acceptance testing, the first round shall be loaded with a reference propellant charge so that the striking velocity is approximately 75 to l00 ft/s (23 to 30 m/s) above the minimum required V_{50}BL(P) as given by the appropriate specification. For most other types of ballistic tests, the first round shall be loaded with a reference propellant charge where the estimated likelihood of either complete or partial penetration is 50%.

5.3.4 Examination of witness plate. The witness plate shall be examined for penetration by holding it up to a light to observe light passage. A complete penetration is recorded when any light passes through the witness plate. If no light is visible through the witness plate, a partial penetration is recorded.

5.3.5 Subsequent firings. If the first round fired yields a complete penetration, the propellant charge for the second round shall be equal to that of the first round minus a propellant decrement for a 50 or 100 ft/s (15 or 30 m/s) velocity decrease in order to obtain a partial penetration. If the first round fired yields a partial penetration, the propellant charge for the second round shall be equal to that of the first round plus a propellant increment for a 50 ft/s (15 m/s) velocity increase in order to obtain a complete penetration. A propellant increment or decrement, as applicable, for at least 50 ft/s (15 m/s) shall be used until one partial and one complete penetration is obtained. After obtaining a partial and a complete penetration, the propellant increment or decrement for 50 ft/s (15 m/s) shall be used. Firing shall be continued until a V_{50}BL(P) is determined, using a random pattern of impact sites, unless otherwise specified.

5.4 Calculation of the V50 BL(P) ballistic limit. The V_{50} BL(P) shall be calculated by taking the arithmetic mean of an equal number of the highest partial and the lowest complete penetration impact velocities within the allowable velocity span as defined by the contracting officer (see USATECOM TOP 2-2-7l0).

5.5 Computation of striking velocity. Instrumentation velocities shall be corrected as follows:

$$V_S = V_I - V_L$$

Where:

V_S = Striking velocity at the test sample

V_I = Instrumentation velocity

$$= \frac{\text{Distance (between sensory devices)}}{\text{Time (chronograph reading)}}$$

V_L = Velocity loss (over target base line)

Velocity loss is calculated in accordance with the following formula:

$V_L = (XG^D rel)/C$

Where:

X = Distance from baseline to target

G = Drag factor (can be obtained from APG per ITOP 4-2-805, Appendix F).

$^D rel$ = Relative air density

C = Ballistic coefficient(per ITOP 4-2-805, Appendix F).

5.6 Ballistic test report. Ballistic test reports shall contain the following minimum information as applicable:

a. Contractor identification.
b. Test facility.
c. Contract number.
d. Lot numbers and quantities.
e. Item specification number.
f. Armor material description.
g. Material identification number for each test sample.
h. Temperature and humidity at the test facility.
i. Date.
j. Personnel conducting test and any witnesses.
k. Weapon used.
l. Projectile used.
m. Projectile weight, grains.
n. Type of propellant.
o. Weight of propellant for each shot, grains.
p. Impact velocities used in computing V_{50}'s with highest partial penetration, lowest complete penetration, range (spread), and velocities of all rounds.
q. Witness plate characteristics, partial or complete.
r. Calculated $V_{50}BL(P)$ ballistic limit.
s. Remarks pertinent to the conduct of the test, or behavior of the material.

Additional data may be required by a contracting activity. When testing is done at a place other than a Government facility, results shall be reported on forms either furnished or approved by the Government. One copy of each complete report shall be forwarded to the agency designated by the Government.

5.7 Acceptance and rejection. The selected armor samples shall meet the minimum V_{50}BL(P) ballistic requirements specified in the order for the represented lot to be acceptable. Failure of any test samples to meet the minimum specified V_{50}BL(P) ballistic limit shall constitute rejection of the entire lot which they represent. Unless otherwise specified, the ballistic tests shall be conducted and the test results accepted prior to shipment of the lot of armor represented by the test samples.

5.8 Test samples ownership. Ballistic test samples that comply with ballistic requirements are considered as part of the lot of armor they represent, and ownership of them passes to the Government upon acceptance. The Government inspector shall dispose of these test samples unless instructed otherwise by the procuring activity. Test samples that fail to comply with the ballistic requirements are considered as part of the lot they represent and remain the property of the supplier just as does the rejected lot they represent.

5.9 Retests. Reference shall be made to the appropriate specification or applicable test directive for guidance on the number of retest samples required, if such are allowed. If the retest samples do not pass the ballistic test, the lot from which they came, or the process by which they were made shall be permanently rejected. Otherwise, if all retest samples pass, the lot or process shall be accepted.

5.10 Security classification of armor. Terminal ballistics performance data on armor materials shall be classified in accordance with ARL PROGRAM No. 0183009, "Security Classification Guide for Armor Materials" dated 30 July 1993.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This test method standard is military unique because it is intended for use in ballistic acceptance testing of armor and for research and development of new armor materials (see 1.2).

6.2 Subject term (key word) listing.

Projectile
Propellant
Weapons

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

TABLE I. Projectile velocities (feet/second).

REMAINING VELOCITY (F/S) AT SPECIFIC DISTANCE

TARGET DISTANCE	5.56mm M193		7.62mm Ball M80, M59		7.62mm API BZ M43 SOVIET, Short		7.62mm Ball X54R SOVIET, TYPE L		7.62mm API X54R CHICOM, TYPE 53	
METERS OR YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS
0		3150		2740		2380		2836		2880
100	2780	2620	2510	2550	1950	2000	2562	2575	2620	2640
200	2400	2470	2275	2320	1650	1700	2303	2350	2365	2405
300	2050	2145	2070	2130	1400	1460	2067	2130	2150	2200
400	1750	1845	1875	1940	1190	1275	1850	1925	1940	2005
500	1510	1600	1715	1780	990	1080	1654	1735	1745	1820
600							1476	1560		
700							1322	1410		
800							1194	1275		
900							1096	1175		
1000							1020	1085		

REMAINING VELOCITY (F/S) AT SPECIFIC DISTANCE

TARGET DISTANCE	7.62mm AP M61		Cal.30 Ball M2		Cal.30 AP M2		Cal.50 Ball M2 for: 36" BARREL		Cal.50 Ball M2 for: 45" BARREL	
METERS OR YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS
0		2800		2800		2760		2845		2935
100	2560	2565	2540	2565	2535	2560	2700	2710	2785	2800
200	2320	2325	2275	2325	2325	2360	2550	2570	2655	2670
300	2080	2135	2025	2090	2115	2165	2410	2435	2520	2540
400	1850	1915	1175	1865	1915	1985	2275	2310	2385	2425
500	1650	1730	1560	1650	1730	1800	2150	2190	2260	2300
600	1460	1550	1345	1450	1560	1640	2020	2080	2130	2130
700	1295	1375	1175	1270	1390	1490	1900	1970	2010	2060
800	1160	1240	1040	1125	1255	1340	1780	1835	1865	1945
900	1065	1135	950	1010	1140	1220	1665	1745	1765	1845
1000	1010	1050	910	940	1070	1130	1550	1640	1655	1735

TABLE I. Projectile velocities (feet/second) (cont.).

REMAINING VELOCITY (F/S) AT SPECIFIC DISTANCE

TARGET DISTANCE	Cal.50 AP M2 for: 36" BARREL		Cal.50 AP M2 for: 45" BARREL		12.7mm API&T, B32 SOVIET		14.5mm API-B32 SOVIET		14.5mm API-BS-41 SOVIET	
METERS OR YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS
0		2845		2940		2690		3280		3280
100	2700	2710	2790	2800	2570	2575	3120	3130	3140	3150
200	2555	2580	2660	2680	2450	2470	2990	3000	2975	3010
300	2430	2455	2525	2560	2325	2360	2840	2870	2825	2875
400	2280	2340	2390	2445	2210	2250	2710	2750	2680	2745
500	2165	2220	2275	2320	2097	2150	2590	2630	2545	2610
600	2040	2100	2140	2200	1995	2045	2470	2520	2400	2480
700	1925	1985	2030	2100	1890	1950	2340	2410	2265	2340
800	1800	1875	1910	1990	1780	1850	2230	2310	2125	2220
900	1695	1765	1780	1880	1680	1760	2120	2200	1980	2090
1000	1570	1665	1680	1780	1580	1675	2000	2100	1860	1970

REMAINING VELOCITY (F/S) AT SPECIFIC DISTANCE

TARGET DISTANCE	20mm AP-T M602 (HVAP-T DM-43)		20mm AP M75		20mm APT M95 49.5" BARREL		20mm AP-M95 67.5" BARREL		23mm API-T BZT SOVIET	
METERS OR YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS
0		3620		2620		2800		3000		3280
100	3440	3460	2450	2455	2650	2665	2845	2850	3110	3120
200	3300	3330	2300	2320	2505	2525	2695	2720	2950	2975
300	3140	3190	2150	2170	2355	2385	2540	2580	2790	2830
400	3000	3050	2020	2050	2195	2250	2395	2435	2640	2690
500	2850	2910	1875	1920	2060	2120	2245	2310	2490	2560
600	2710	2780	1760	1800	1930	1995	2100	2170	2350	2420
700	2580	2650	1620	1695	1800	1875	1960	2040	2205	2290
800	2430	2520	1500	1590	1670	1760	1830	1915	2065	2160
900	2290	2390	1410	1500	1555	1655	1700	1800	1925	2030
1000	2180	2280	1305	1400	1455	1550	1585	1675	1795	1910

TABLE I. Projectile velocities (feet/second) (cont.).

REMAINING VELOCITY (F/S) AT SPECIFIC DISTANCE

TARGET DISTANCE	37mm AP M74									
METERS OR YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS	METERS	YARDS
0		2900								
100	2760	2765								
200	2630	2650								
300	2510	2535								
400	2385	2425								
500	2270	2315								
600	2160	2223								
700	2060	2118								
800	1955	2025								
900	1860	1930								
1000	1765	1845								

CONCLUDING MATERIAL

Custodians:
Army - MR
Navy - MC
Air Force - 11

Preparing activity
Army - MR

Project 8470-0169

Review activities:
Army - AR, AT, AV, GL, IE, TE
Navy - CG, NU
Air Force - 03, 45, 82
DLA - CT
DOT - CGCT

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-STD-662F	2. DOCUMENT DATE (YYMMDD) 971218

3. DOCUMENT TITLE

V_{50} BALLISTIC TEST FOR ARMOR

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)
	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)
US Army Research Laboratory	(1) Commercial: 410-306-0725 (2) AUTOVON: 458-0725
c. ADDRESS (Include Zip Code) Weapons & Materials Research Directorate ATTN: AMSRL-WM-M Aberdeen Proving Ground, MD 21005-5069	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340