

INCH-POUND
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MIL-DTL-32375 (MR)  
29 September 2011

## DETAIL SPECIFICATION

### ARMOR PLATE, ALUMINUM ALLOY, 7085, UNWELDABLE APPLIQUE

This specification is approved for use by the Department of the Army and is available for use by all Departments and Agencies of the Department of Defense

#### 1. SCOPE

1.1 Scope. This specification covers 7085 wrought aluminum alloy armor plate for non fusion welded applications in nominal thicknesses from 0.500 to 3.000 inch, inclusive (see 6.2). The fusion weldability of 7085 wrought aluminum alloy armor has not been determined over this thickness range. Therefore, these alloys should only be used as appliqué armor until a weldability study has been completed.

1.2 Classification. The wrought aluminum armor should be of the following class and tempers (Types), as specified (see 6.2).

1.2.1 Class I. Wrought aluminum armor that conforms to the Aluminum Association designation for the 7085 aluminum alloy. The applicable gauge range for Class I is 0.500-3.000 inches.

1.2.1.1 Type A. Type A has a temper designation currently listed as T7E01 (see 6.3.1) which is a high-strength temper designed for maximum resistance to armor piercing (AP) projectiles.

1.2.1.2 Type B. Type B has a temper designation currently listed as T7E02 (see 6.3.1) which is designed for maximum resistance to blast.

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials and Manufacturing Technology Branch, Specifications and Standards Office, Attn: RDRL-WMM-D, Aberdeen Proving Ground, MD 21005-5069 or emailed to richard.j.squillacioti.civ@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <a href="https://assist.daps.dla.mil/">https://assist.daps.dla.mil/</a> .
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AMSC N/A

FSC 9535

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## 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification 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 of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified (see 6.2), the issues of these documents are those cited in the solicitation or contract.

## DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-662 - V<sub>50</sub> Ballistic Test for Armor

(Copies of these documents are available online at <https://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated (see 6.2), the issue in effect on the date of invitation for bids or request for proposal should apply.

## SAE INTERNATIONAL

AMS 2750 - Pyrometry  
AMS 2772 - Heat Treatment of Aluminum Alloy Raw Materials

(Application for copies should be addressed to SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B557 - Standard Test Methods for Tension Testing  
Wrought and Cast Aluminum and Magnesium-  
Alloy Products  
ASTM E34 - Standard Test Methods for Chemical Analysis of  
Aluminum and Aluminum-Base Alloys  
ASTM E607 - Standard Test Method for Atomic Emission  
Spectrometric Analysis of Aluminum Alloys by the  
Point-to-Plane Technique, Nitrogen Atmosphere

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- |            |   |   |
|------------|---|---|
| ASTM E716  | - | Standard Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis         |
| ASTM E1251 | - | Standard Test Method for Analysis of Aluminum and Aluminum Alloys by Atomic Emission Spectrometry |

(Copies of these documents are available from [www.astm.org](http://www.astm.org) or ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), 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. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order (see 6.2), first article testing shall be required and all test samples required by this specification shall be made available to the contracting officer or his authorized representative for approval in accordance with 4.3. First article testing shall be completed before production material is submitted for acceptance testing. The approval of the first article samples authorizes commencement of production but does not relieve the supplier of the responsibility to comply with all the applicable provisions of this specification. The first article samples and acceptance test plates shall be manufactured by the process proposed for use on production items.

3.2 Chemical composition. The chemical composition of the plates shall be within the limits shown in Table I. The limits specified in Table I were taken from Aluminum Association (AA) registered composition limits for Aluminum Alloys. A certification of conformance of the chemical composition of the alloy shall be furnished with the ballistic test plates.

3.3 Mechanical properties. Unless otherwise specified in the contract or order (see 6.2), the mechanical properties of the test specimen taken in the longitudinal direction shall meet the minimum mechanical properties listed in Table II. If mechanical property requirements differ from those contained in Table II, or if any other properties are required, the ballistic requirements shall be negotiated between the procuring activity and the supplier.

3.4 Ballistic limit. The protection ballistic limit, BL(P), shall be as specified in Appendix A. When a complete penetration can not be obtained for any class of armor material, the following rule shall be in effect until a new ballistic acceptance round can be developed and utilized. When the ballistic velocities of four (4) partial penetrations are above the minimum ballistic requirement for the specific thickness, the material shall be certified as acceptable with a  $V_{50}$  (which obviously can not be explicitly determined) above the minimum requirement.

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TABLE I. Chemical composition, weight percent.<sup>1/</sup>

ELEMENTS	SYMBOL	Class I 7085 ALLOY <sup>2/</sup>
Silicon	Si	0.06
Iron	Fe	0.08
Copper	Cu	1.3 - 2.0
Manganese	Mn	0.04
Magnesium	Mg	1.2 - 1.8
Chromium	Cr	0.04
Zinc	Zn	7.0 - 8.0
Titanium	Ti	0.06
Zirconium	Zr	0.08 - 0.15
Other, max. Each	---	0.05
Other, max. Total <sup>3/</sup>	---	0.15
Aluminum	Al	Remainder

<sup>1/</sup> Except for "Aluminum" and "others", analysis normally is made for elements for which specific limits are shown.

<sup>2/</sup> Where single units are shown, these indicate the maximum amounts permitted.

<sup>3/</sup> The sum of those "others" metallic elements 0.010 percent or more each, expressed to the second decimal before determining the sum.

TABLE II. Minimum mechanical properties.<sup>1/</sup> <sup>2/</sup>

Thickness, inches	Tensile Strength, ksi		Yield Strength, 0.2% Offset, ksi		Elongation percent	
	Class I		Class I		Class I	
	Type A	Type B	Type A	Type B	Type A	Type B
0.500 to 1.500, incl.	80	68	74	60	11	12
1.501 to 2.000, incl.	78	67	73	59	11	12
2.001 to 3.000, incl.	77	67	72	58	10	11

<sup>1/</sup> The gage length shall be 1.400 inch for plates having a nominal thickness of 0.500 inch.

<sup>2/</sup> Values are taken in the Longitudinal Direction (LT).

3.5 Thermal processing. Heat treatment shall conform to the requirements of SAE AMS 2750 and SAE AMS 2772 and shall be such as to enable the material to meet the requirements of these specifications.

3.6 Dimensions. Dimensions shall be as specified in the contract or order (see 6.2).

3.6.1 Tolerances. Unless otherwise specified in the contract or order (see 6.2), the plates submitted for acceptance shall not vary from the specified dimensions by an amount as specified in Table III.

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TABLE III. Thickness tolerances.

Ordered Thickness (Inches)		SPECIFIED WIDTH (Inches)								
		OVER	0.00	39.38	59.07	78.75	98.44	118.12	137.81	157.49
		THRU	39.37	59.06	78.74	98.43	118.11	137.80	157.48	177.17
OVER	THRU	TOLERANCES - INCHES (PLUS and MINUS)								
0.500	1.000		0.031	0.031	0.037	.043	0.051	0.060	0.070	0.085
1.001	1.575		0.039	0.039	0.047	0.055	0.065	0.075	0.090	0.105
1.576	2.362		0.055	0.055	0.060	0.070	0.085	0.100	0.115	---
2.363	3.000		0.075	0.075	0.085	0.100	0.105	0.125	---	---

3.7 Marking for identification. Unless otherwise specified in the contract or purchase order (see 6.2) each plate shall be marked on one plate edge with the manufacturer's name or CAGE code, the basic number of this specification, the plate thickness in inches, the alloy designation and the lot number or code relating to the lot number (see 4.2). The height of the characters shall be 3/8 of an inch or greater. Each plate shall be marked in lengthwise rows of characters recurring at intervals not greater than 3 feet, the rows being spaced not more than 6 inches apart and alternately staggered. The characters shall be not less than 3/8 inch in height and shall be applied using a suitable marking fluid whose residue shall contain not more than traces of halogen-bearing compounds and shall be capable of being removed in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the plate material or its performance and shall be sufficiently stable to withstand normal handling.

3.7.1 Ballistic test plates. In addition to the markings in 3.7, each ballistic test plate shall be marked with the letters PRE for First Article test plates and ACC for Acceptance test plates. This marking shall be impression stamped on the edge in letters 3/8 inch high or greater. Ballistic retest plates shall be marked "R1" and "R2" respectively (see A.5.2).

3.8 Ballistic test plate information. For each lot of aluminum alloy armor a properly completed Aluminum Armor Test Data Form (See Figure 1) shall be submitted with each ballistic test plate that represents that particular processing lot.

3.9 Workmanship. Plate produced under this specification shall be uniform in quality and clean, smooth and sufficiently free from buckles, blisters, hard spots, damaged ends, laminations and other defects which may affect its use.

#### 4. VERIFICATION

4.1 Classification of inspection. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.3).
- b. Production inspection (see 4.4).

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<b>REQUEST FOR BALLISTIC TEST OF ALUMINUM ALLOY 7085 ARMOR</b>												
<b>FIRING RECORD:</b>						<b>DATE:</b>						
<b>Plate MANUFACTURER / PRODUCER:</b>						<b>PRIME CONTRACTOR:</b>						
Name:						Name:						
Address:						Address:						
POC:						POC:						
Phone No:						Phone No:						
Fax No:						Fax No:						
<b>SPECIFICATION:</b> MIL-DTL- 32375 (MR)						<b>REVISION:</b>			<b>AMENDMENT:</b>			
<b>CONTRACT NO:</b>						<b>ATC PROJECT NO:</b>						
<b>DCAS REGION:</b>						<b>BALLISTIC TEST CONTRACT NO:</b>						
<b>TEST ITEM IDENTIFICATION:</b>												
Lot No.			Plate No.			Ordered Thickness			Alloy and Temper			
Class:												
<b>PURPOSE:</b> Acceptance              First Article              Development												
<b>SAMPLE:</b> Primary              Retest (Firing Record No. of Failed Sample              )												
<b>CHEMICAL ANALYSIS:</b>				<b>OTHERS (list below):</b>							Al :	
Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Zr				
<b>MECHANICAL PROPERTIES:</b>												
UTS (ksi):				0.2% YS (ksi):				Elongation (%):				
<b>BALLISTIC TEST RESULTS:</b>												
Test	Projectile	Obl. (deg)	Actual Thickness (in)	Required V <sub>50</sub> (fps)	Actual V <sub>50</sub> (fps)	Pass/ Fail	Notes					
<b>LOTS REPRESENTED BY:</b>				Reduced Testing				Audit Testing				
Lot [ met ] [failed to meet ] the ballistic requirements of specification MIL-DTL- 32375 MR).												
Government Representative				Date		Supplier Representative				Date		

FIGURE 1. Aluminum Armor Test Data Form.

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4.2 Lot. A lot shall consist of all plate of the same alloy and ordered thickness which has been processed together by the same mill practice. Unless otherwise specified in the contract or purchase order (see 6.2), the weight of the finished plate in the lot shall not exceed 50,000 pounds and shall be submitted for inspection as a unit.

4.3 First article inspection. First article inspection, except as otherwise indicated in this specification, shall utilize the same requirements, inspection, and test methods as the production acceptance inspection shown in 4.4.

4.4 Production inspection. Production inspection or conformance acceptance inspection shall include the examination of 4.6 and the tests of 4.7.

4.5 Sampling.

4.5.1 First article inspection.

4.5.1.1 Chemical composition. One (1) sample for chemical analysis shall be removed from each plate selected for ballistic testing and shall meet the requirements of 3.2 when tested as specified in 4.7.1.

4.5.1.2 Mechanical properties. One tension test specimen shall be removed from each plate that has been selected for ballistic testing and shall meet the requirements when tested as specified in 4.7.2.

4.5.1.3 Ballistic tests. Two plates, 12 inches by 36 inches of each thickness to be supplied on the contract, shall be submitted for ballistic testing in accordance with Appendix A. The orientation of these plates with respect to the rolling direction shall be at the option of the producer.

4.5.2 Production inspection.

4.5.2.1 Chemical composition. The sample shall meet the chemical composition requirements of 3.2 when tested as specified in 4.7.1.

4.5.2.1.1 Ingots analysis. At least one sample shall be taken from the molten metal representing the ingots poured as a unit from the same source molten metal. Complete ingot analysis records shall be available to the Government at the producer's facility.

4.5.2.1.2 Product analysis. When sampling has not been made in accordance with 4.5.2.1.1, one sample shall be randomly taken for each 4,000 pounds or less in a lot. Complete product analysis records shall be available to the Government at the contractor's facility.

4.5.2.2 Mechanical properties. Samples for tension tests shall be selected from each lot in accordance with Table IV. Each sample shall be randomly selected from a different

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plate in the lot, and only one tension test specimen shall be made from each sample. The sample shall meet the requirements when tested as specified in 4.7.2.

TABLE IV. Number of tension tests.

<b>Lot size, pounds</b>	<b>Minimum number of samples <sup>1/</sup></b>
To 8,000, incl.	2
8,001 to 12,000, incl.	3
12,001 to 20,000, incl.	4
20,001 up	5

<sup>1/</sup> If a lot consists of only one plate, one sample shall be required.

4.5.2.3 Ballistic testing. One plate, 12 inches by 36 inches, shall be randomly selected from each lot for ballistic testing. The orientation of the plate with respect to the rolling direction shall be at the option of the producer (see 6.2). The sample shall meet the requirements when tested as specified in 4.7.3.

#### 4.6 Examination.

4.6.1 Visual. Each plate shall be examined for compliance with the identification marking (see 3.7) and workmanship (see 3.9) requirements.

4.6.2 Dimensions. Plates within a lot shall be measured to determine compliance with requirements of paragraph 3.6 in accordance with the sampling procedures approved by the procuring activity (see 6.2).

#### 4.7 Test specimens.

4.7.1 Chemical composition. Samples for chemical analysis shall be prepared and tested in accordance with one or more ASTM methods of E34, E607, E716, and E1251. In case of dispute, analysis by method E34 shall be the basis for acceptance or rejection.

4.7.2 Mechanical properties. Tension test specimens shall be prepared and tested in accordance with ASTM B557. Specimens shall be taken in the longitudinal direction (LT). For material less than 0.500 inch in thickness, a standard rectangular tension test specimen shall be used. For plate in nominal thickness 0.500 to 1.500 inches, inclusive, tension test specimens shall be taken with the axis midway between the two plate surfaces. For plate in nominal thickness greater than 1.500 inches, the axis of the tension test specimen shall be three-fourths of the distance from one surface to the other.

4.7.3 Ballistic testing. The ordered thickness specified in the contract shall be used to determine the test projectile in accordance with Table V. Ballistic testing shall be in accordance with Appendix A. Test plate thickness, as measured by the ballistic testing agency, shall be used in conjunction with Table V and Appendix A to determine the required  $V_{50}$  protection ballistic limit for that plate. Thickness shall be determined as the



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average of at least four thickness measurements read on a deep throat micrometer or by means of an ultrasonic device to the nearest 0.001 of an inch and rounded off to the nearest 0.005 of an inch. Measurements shall be made on the intended impact area. In those cases where the BL(P) is within  $\pm 10$  fps of the minimum required value for the measured average thickness (to the nearest 0.005-inch), an interpolation of the appropriate ballistic limit table shall be performed. The average plate thickness, computed to the nearest 0.001-inch, shall be used to determine the minimum required BL(P) for that plate.

4.7.3.1 Ballistic testing facility. Unless otherwise specified in the contract or purchase order (see 6.2), the ballistic test plates shall be forwarded to the Commander, U.S. Army Aberdeen Test Center, 400 Colleran Road, Bldg. 358, ATTN: CSTE-DTC-AT-SL-V (D. Gessleman), Armor Acceptance – B690, Aberdeen Proving Ground, MD 21005-5059 for ballistic testing for first article or lot acceptance.

TABLE V. Acceptance ballistic test plates.

<b>Ordered Thickness, Inches</b>	<b>Projectile</b>	<b>Angle of Obliquity in Degrees</b>	<b>CLASS I (7085) TYPE A</b>	<b>CLASS I (7085) TYPE B</b>
0.500 - 0.749	Cal. .30 AP M2	30	Table A-I	Table A-I
0.750 - 0.950	Cal. .50 FSP	0	Table A-II	Table A-II
0.951 - 1.500	20-mm FSP	0	Table A-III	Table A-III
0.750 - 1.500	Cal. .30 AP M2	0	Table A-IV	Table A-IV
1.501 - 2.500	Cal. .50 AP M2	0	Table A-V	Table A-V
2.501 – 3.000	Cal. .50 AP M2	0	N/A	Table A-V
2.501 – 3.000	14.5-mm BS-41	0	Table A-VI	N/A

4.7.3.2 Incomplete penetrations. When a complete penetration can not be obtained, the following rule shall be in effect until a new ballistic acceptance round can be developed and utilized. When the ballistic velocities of four (4) partial penetrations are above the minimum ballistic requirement for the specific thickness, the material shall be certified as acceptable with a  $V_{50}$  (which obviously can not be explicitly determined) above the minimum requirement.

4.8 Rejection and retest. Unless otherwise specified in the contract or order (see 6.2) and except as specified in 4.7.2 and 4.7.3, rejection and retest shall be conducted in accordance with 4.8.1, 4.8.1.1, and 4.8.2.

4.8.1 Rejection of first article plates. When one or more first article test specimens fail to meet the requirements of 4.3, the product lot and process, represented by the test plates or specimens shall be subject to rejection except as otherwise provided in a sampling plan approved by the procuring activity and in requirements of 4.8.1.1.

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4.8.1.1 Retest of first article samples. Resubmission and retest of first article samples shall not be made until the manufacturer has made necessary corrections in the processing of the material to the satisfaction of the procuring activity. If one of the retest specimens fails the lot shall be permanently rejected with no further testing permitted.

4.8.2 Ballistic. Rejection and retest of ballistic test plates shall be in accordance with A.5.2.

4.9 Reduced testing. At the discretion of the procuring activity (see 6.2), the amount of testing may be reduced provided the results on consecutive lots indicate that a uniform product meeting the testing requirements is being produced and providing the manufacturer agrees to maintain the same manufacturing procedures. Testing for a given plate thickness shall return to standard (non-reduced testing) conditions of one plate per lot, whenever a ballistic test plate fails to meet ballistic requirements.

## 5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel components are to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES

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

6.1 Intended use. The armor specified herein as Type A is intended for lightweight applications where resistance to ball and armor piercing types of ammunition and multiple hit capabilities are required. The armor specified herein as Type B is intended for use on combat and tactical vehicles to protect the occupants from underbody threats.

6.2 Ordering data. Procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Specify choice of alloy, and ordered thickness (see 1.1)
- (c) Specify classification (see 1.2).
- (d) If issues of documents are different (see 2.2.1 and A.2.1.1).
- (e) If a different issue is to be used (see 2.3)
- (f) When first article is required (see 3.1).
- (g) Special mechanical properties and ballistic requirements, if required (see 3.3).
- (h) Dimension and tolerance requirements if other than in 3.6 and 3.6.1.

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- (i) If markings are different (see 3.7).
- (j) If the weight of finished plate can exceed 50,000 pounds (see 4.2).
- (k) The orientation of the ballistic plate is different (see 4.5.2.3).
- (l) Dimensional sampling procedure approved by the procuring activity (see 4.6.2).
- (m) If approval was requested and received for a different ballistic testing facility (see 4.7.3.1)
- (n) Rejection and retest requirement, if other than in 4.8.
- (o) If reduced testing is allowed (see 4.9).
- (p) Packaging requirements (see 5.1).

### 6.3 Definitions. According to the Aluminum Association.

6.3.1 Temper. Temper is the state of an alloy based on its processing route, i.e. metallurgical processes performed on an alloy. Temper of an alloy determines its mechanical properties as well as some other properties. Please note that the currently listed tempers, T7E01 and T7E02, are being registered with the Aluminum Association. When the registrations result in the assignment of an official temper designation, both T7E01 and T7E02 will be changed to reflect these new designations.

6.3.2 Recovery. The process preceding re-crystallization in point of time, or at lower temperatures when a deformed (cold worked) metal is heated. It is characterized by changes in internal stresses and physical properties, but is not accompanied by marked changes in mechanical properties or detectable micro-structural changes.

6.3.3 Stabilizing. The cold worked tempers of certain aluminum alloys will gradually soften on standing at room temperature over a long period of time. Stabilizing is a recovery treatment given to these alloys in order to eliminate age softening effects and to achieve strength and hardness that do not show further change on standing at room temperature

6.3.4 Annealing. A process involving heating and cooling to induce softening. In wrought Aluminum, the term generally indicates a treatment above the re-crystallization temperature.

6.3.5 Cold Working or Cold deformation. Working a metal at such a temperature and rate that strain hardening occurs. This means simply working below re-crystallization temperature.

6.3.6 Recrystallization. The process of nucleation and growth by which the deformed and stressed grains are replaced by a new system of essentially equi-axed and stress free grains.

6.3.7 Nucleation. The formation of aggregates of atoms which are stable enough to grow and form new grains upon heating after deformation.

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6.3.8 Partial Annealing. A treatment below the re-crystallization temperature, used to bring fully strain hardened alloy back to a desired intermediate strength. The terms “Recovery” and “Stress relief” also used for this type of treatment in some cases.

6.4 Alternate ballistic testing facility. Request for approval for an alternate ballistic testing facility should be forwarded by the procuring activity to the Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials and Manufacturing Technology Branch, Specifications and Standards Office, Attn: RDRL-WMM-D, Aberdeen Proving Ground, MD 21005-5069 and should be obtained prior to the contract award. Please note that alternate ballistic testing facilities are being considered but at the present time, the requirements needed for approving an alternate facility are not fully known.

6.5 Metric units. When metric divisions are required, units for inch, foot, foot-pounds, feet per second, and pounds per square inch may be converted to the metric equivalent by multiplying them by the following conversion factors:

English	Multiply by	Equals	Metric SI unit
inch	0.0254	=	meter (m)
foot	0.3048	=	meter (m)
pound	0.4536	=	kilogram (kg)
foot-lb	1.3558	=	joule (j)
feet/second	0.3048	=	meter per second (m/s)
pounds/sq. inch	0.00689	=	Mega Pascal (MPa)

6.6 Subject term (key word) listing.

Ballistic testing  
 Caliber .30 AP M2  
 Caliber .50 AP M2  
 Caliber .50 FSP  
 Military vehicles  
 20-mm FSP

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APPENDIX A

BALLISTIC TESTING OF ARMOR PLATE, ALUMINUM ALLOY, 7085,  
UNWELDABLE APPLIQUE

A.1 SCOPE

A.1.1 Scope. This appendix covers the minimum ballistic limits for acceptable requirements of aluminum alloy armor plate, un-weldable, 7085 when tested in accordance with the provisions of this specification. When there is mutual agreement between contractor and procuring activity, this appendix becomes a mandatory part of this specification and the information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 Government documents.

A.2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified (see 6.2), the issues of these documents are those cited in the solicitation or contract.

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-662 - V50 Ballistic Test for Armor

(Copies of this document are available online at <https://assist.daps.dla.mil/quicksearch/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

A.3 DEFINITIONS

A.3.1 Complete penetration, (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.

A.3.2 Fair impact. An impact may be considered fair when an un-yawed 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.

A.3.3 Gap. A gap is the difference in fps between the high partial penetration velocity and the low complete penetration velocity used to compute the ballistic limit when the high partial penetration velocity is lower than the low complete penetration velocity.

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A.3.4 Partial penetration, (PP). Any impact which is not a complete penetration may be considered a partial penetration.

A.3.5 Witness plate. A thin sheet located behind and parallel to the ballistic test sample which is used to detect penetrating projectiles or spall.

#### A.4 REQUIREMENTS

A.4.1 Resistance to penetration. The minimum required V50 ballistic limit shall be in accordance with the values shown in tables A-I through A-VI.

#### A.5 TESTS

A.5.1 Ballistic tests. Testing shall be in accordance with MIL-STD-662, V50 Ballistic Test for Armor, except that nothing in this procedure shall be construed to supersede or invalidate the requirements of this specification.

A.5.1.1 Temperature Conditioning. Prior to the test, the test item(s) shall be temperature conditioned at least eight hours. Thermostatic control shall be such that the average temperature of the item during the test shall be  $72 \pm 15^{\circ}\text{F}$  ( $22 \pm 8^{\circ}\text{C}$ ).

A.5.1.2 Protection ballistic limit, BL(P).

A.5.1.2.1 Normal circumstances. The BL(P) shall consist of an equal number of fair impact complete and partial penetration velocities attained by the up-and-down firing method. All BL(P)'s shall be computed using the highest partial penetration velocities and the lowest complete penetration velocities. Firing shall continue until either a 4-round BL(P) having a maximum velocity spread of 60 fps or a 6-round BL(P) having a maximum velocity spread of 90 fps has been attained, whichever comes first in the normal sequence of firing. If both occur simultaneously, the 6-round BL(P) shall be reported.

A.5.1.2.2 Large zone of mixed results. In the event that the zone of mixed results (difference between the high partial penetration velocity and the low complete penetration velocity, the PP[P] velocity being higher than the low CP[P] velocity) exceeds 90 fps, the firing data shall be compared with the specification minimum ballistic requirements. If the lowest complete penetration velocity is equal to or above the minimum specified ballistic limit velocity for the plate thickness, the ballistic limit shall be computed on the basis of 4- or 6-rounds using the smallest possible velocity spread. If the lowest complete penetration velocity is below the minimum allowable ballistic limit velocity, then testing shall continue until a 10-round ballistic limit has been attained using the smallest possible velocity spread. Ten-round ballistic limits shall be reported as agreed upon between the contractor and procuring activity.

A.5.1.2.3 Reduction of large velocity gap in borderline cases. If the ballistic limit, which has been determined, is within  $\pm 10$  fps from the minimum allowable ballistic limit and a gap exists which is greater than 25 fps, then another round, or rounds, shall be fired to

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reduce the gap to 25 fps or less. The ballistic limit shall then be recomputed using the above criteria. The recomputed BL(P) shall be reported as the BL(P) of the plate (in borderline cases, a reduction of the gap between the high partial penetration velocity and the low complete velocity should result in a better evaluation of the BL(P)).

A.5.2 Rejection and retest of ballistic plates.

A.5.2.1 First article tests (rejection). Unless otherwise specified in the contract or order, failure of any of the first article test plates to meet the minimum ballistic requirements shown in the appendix of this specification indicates failure of the product and process.

A.5.2.2 First article (retests). Resubmission of ballistic retest plates shall not be made until the manufacturer has made the necessary corrections in the processing of the material to the satisfaction of the procuring activity. Two retest plates shall be submitted for first article testing, and both tests shall pass; otherwise, the armor material shall be rejected.

A.5.2.3 Acceptance tests (rejection). Unless otherwise specified in the contract or order, failure of a test plate to meet the ballistic requirements indicates failure of the lot; however, the final decision shall depend on the outcome of retests, if submitted.

A.5.2.4 Acceptance tests (retests). If a test plate representing a lot fails to meet the ballistic requirement, the manufacturer, upon notification of the failure may submit at his expense two additional test plates from the same lot for ballistic retest. If either of these plates fails the ballistic test, the lot shall be rejected. The manufacturer may elect to resubmit the lot after retreatment of the entire lot by submitting two additional test plates. If either of these plates fails, the lot shall be permanently rejected.

A.5.3 Disposal of ballistic test plates.

A.5.3.1 First article test plates. Upon request of the applicant within 15 days after ballistic testing, first article plates shall be returned "as is" to the applicant, at his expense, unless the plates were destroyed in testing.

A.5.3.2 Acceptance test plates. Acceptance test plates that comply with the requirements of this specification are considered part of the lot they represent, and ownership of the test plates passes to the Government with the acceptance of that lot. Acceptance test plates that fail to comply with the requirements of this specification are considered part of the lot they represent and remain the property of the producer. The now rejected lot also remains the property of the producer. The failed plates shall be returned, upon request, as in A.5.3.1.

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TABLE A-I. Minimum required ballistic limits - caliber .30 AP  
M2 projectiles at 30° obliquity.

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
0.475	1580	1481	0.580	1822	1679	0.685	2035	1856
0.480	1592	1491	0.585	1832	1688	0.690	2044	1864
0.485	1604	1501	0.590	1843	1697	0.695	2054	1872
0.490	1617	1511	0.595	1854	1705	0.700	2063	1880
0.495	1629	1520	0.600	1864	1714	0.705	2073	1888
0.500 <sup>1/</sup>	1641	1530	0.605	1875	1723	0.710	2082	1896
0.505	1653	1540	0.610	1885	1731	0.715	2092	1904
0.510	1664	1550	0.615	1895	1740	0.720	2101	1911
0.515	1676	1559	0.620	1906	1748	0.725	2110	1919
0.520	1688	1569	0.625	1916	1757	0.730	2120	1927
0.525	1699	1578	0.630	1926	1765	0.735	2129	1935
0.530	1711	1588	0.635	1936	1774	0.740	2138	1942
0.535	1722	1597	0.640	1946	1782	0.745	2147	1950
0.540	1733	1606	0.645	1956	1791	0.749 <sup>2/</sup>	2154	1956
0.545	1745	1616	0.650	1966	1799	0.755	2165	1965
0.550	1756	1625	0.655	1976	1807	0.760	2174	1973
0.555	1767	1634	0.660	1986	1815	0.765	2183	1980
0.560	1778	1643	0.665	1996	1824	0.770	2192	1988
0.565	1789	1652	0.670	2006	1832	0.775	2201	1995
0.570	1800	1661	0.675	2015	1840	0.780	2210	2003
0.575	1811	1670	0.680	2025	1848	0.785	2219	2010

<sup>1/</sup> Specification (Type A & B) requirements begin for this ordered thickness.

<sup>2/</sup> Specification (Type A & B) requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.



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TABLE A-II. Minimum required ballistic limits – caliber .50 fragment  
simulating projectiles at 0° obliquity.

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
0.730	1916	1858	0.815	2287	2191	0.900	2730	2583
0.735	1936	1876	0.820	2311	2212	0.905	2759	2608
0.740	1956	1894	0.825	2335	2234	0.910	2787	2634
0.745	1976	1913	0.830	2359	2255	0.915	2817	2659
0.750 <sup>1/</sup>	1997	1931	0.835	2384	2277	0.920	2846	2685
0.755	2018	1950	0.840	2409	2299	0.925	2876	2711
0.760	2039	1969	0.845	2434	2322	0.930	2906	2738
0.765	2061	1988	0.850	2460	2344	0.935	2936	2764
0.770	2082	2008	0.855	2486	2367	0.940	2967	2791
0.775	2104	2027	0.860	2512	2390	0.945	2998	2819
0.780	2126	2047	0.865	2538	2414	0.950 <sup>2/</sup>	3030	2846
0.785	2148	2067	0.870	2565	2437	0.955	3061	2874
0.790	2171	2087	0.875	2591	2461	0.960	3093	2902
0.795	2193	2107	0.880	2619	2485	0.965	3126	2930
0.800	2216	2128	0.885	2646	2509	0.970	3159	2959
0.805	2240	2149	0.890	2674	2533	0.975	3192	2987
0.810	2263	2169	0.895	2702	2558	0.980	3225	3016

<sup>1/</sup> Specification (Type A & B) requirements begin for this ordered thickness.

<sup>2/</sup> Specification (Type A & B) requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation  
of BL(P) requirements on undersize or oversize plates.

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TABLE A-III. Minimum required ballistic limits – 20mm fragment  
simulating projectiles at 0° obliquity.

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
0.930	1311	1255	1.130	1694	1622	1.330	2188	2097
0.935	1319	1263	1.135	1705	1633	1.335	2202	2111
0.940	1328	1271	1.140	1716	1643	1.340	2217	2124
0.945	1336	1279	1.145	1727	1654	1.345	2231	2138
0.951 <sup>1/</sup>	1347	1289	1.150	1738	1664	1.350	2245	2152
0.955	1354	1296	1.155	1749	1675	1.355	2260	2166
0.960	1362	1304	1.160	1760	1686	1.360	2274	2179
0.965	1371	1313	1.165	1771	1697	1.365	2289	2194
0.970	1380	1321	1.170	1783	1708	1.370	2303	2208
0.975	1389	1330	1.175	1794	1719	1.375	2318	2222
0.980	1398	1338	1.180	1806	1730	1.380	2333	2236
0.985	1407	1347	1.185	1817	1741	1.385	2348	2251
0.990	1416	1355	1.190	1829	1752	1.390	2363	2265
0.995	1425	1364	1.195	1841	1763	1.395	2378	2280
1.000	1434	1373	1.200	1853	1775	1.400	2394	2294
1.005	1443	1382	1.205	1864	1786	1.405	2409	2309
1.010	1452	1391	1.210	1876	1798	1.410	2424	2324
1.015	1462	1400	1.215	1889	1809	1.415	2440	2339
1.020	1471	1409	1.220	1901	1821	1.420	2456	2354
1.025	1481	1418	1.225	1913	1833	1.425	2471	2369
1.030	1490	1427	1.230	1925	1844	1.430	2487	2384
1.035	1500	1436	1.235	1938	1856	1.435	2503	2400
1.040	1509	1445	1.240	1950	1868	1.440	2519	2415
1.045	1519	1455	1.245	1963	1880	1.445	2536	2431
1.050	1529	1464	1.250	1975	1892	1.450	2552	2446
1.055	1539	1473	1.255	1988	1905	1.455	2568	2462
1.060	1548	1483	1.260	2001	1917	1.460	2585	2478
1.065	1558	1492	1.265	2013	1929	1.465	2601	2494
1.070	1568	1502	1.270	2026	1942	1.470	2618	2510
1.075	1578	1512	1.275	2039	1954	1.475	2635	2526
1.080	1589	1521	1.280	2053	1967	1.480	2652	2542
1.085	1599	1531	1.285	2066	1979	1.485	2669	2559
1.090	1609	1541	1.290	2079	1992	1.490	2686	2575
1.095	1619	1551	1.295	2092	2005	1.495	2703	2592
1.100	1630	1561	1.300	2106	2018	1.500 <sup>2/</sup>	2721	2609
1.105	1640	1571	1.305	2119	2031	1.505	2738	2625
1.110	1651	1581	1.310	2133	2044	1.510	2756	2642
1.115	1661	1591	1.315	2147	2057	1.515	2774	2659
1.120	1672	1602	1.320	2160	2070	1.520	2791	2676
1.125	1683	1612	1.325	2174	2084	1.525	2809	2694

<sup>1/</sup> Specification (Type A & B) requirements begin for this ordered thickness.

<sup>2/</sup> Specification (Type A & B) requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation  
of BL(P) requirements on undersize or oversize plates.

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TABLE A-IV. Minimum required ballistic limits - caliber .30 AP  
M2 projectiles at 0° obliquity.

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
0.730	1912	1787	0.910	2192	2040	1.090	2440	2265
0.735	1920	1794	0.915	2199	2046	1.095	2446	2271
0.740	1928	1802	0.920	2206	2053	1.100	2453	2277
0.745	1937	1809	0.925	2214	2059	1.105	2459	2282
0.750 <sup>1/2</sup>	1945	1816	0.930	2221	2066	1.110	2466	2288
0.755	1953	1824	0.935	2228	2072	1.115	2472	2294
0.760	1961	1831	0.940	2235	2079	1.120	2479	2300
0.765	1969	1839	0.945	2242	2085	1.125	2485	2306
0.770	1977	1846	0.950	2249	2092	1.130	2492	2312
0.775	1985	1853	0.955	2256	2098	1.135	2498	2318
0.780	1994	1860	0.960	2263	2105	1.140	2504	2323
0.785	2002	1868	0.965	2270	2111	1.145	2511	2329
0.790	2009	1875	0.970	2278	2117	1.150	2517	2335
0.795	2017	1882	0.975	2284	2124	1.155	2523	2341
0.800	2025	1889	0.980	2291	2130	1.160	2530	2346
0.805	2033	1896	0.985	2298	2136	1.165	2536	2352
0.810	2041	1903	0.990	2305	2143	1.170	2542	2358
0.815	2049	1910	0.995	2312	2149	1.175	2549	2364
0.820	2057	1917	1.000	2319	2155	1.180	2555	2369
0.825	2064	1924	1.005	2326	2161	1.185	2561	2375
0.830	2072	1931	1.010	2333	2168	1.190	2567	2381
0.835	2080	1938	1.015	2340	2174	1.195	2574	2386
0.840	2087	1945	1.020	2347	2180	1.200	2580	2392
0.845	2095	1952	1.025	2353	2186	1.205	2586	2397
0.850	2103	1959	1.030	2360	2192	1.210	2592	2403
0.855	2110	1966	1.035	2367	2198	1.215	2598	2409
0.860	2118	1973	1.040	2374	2205	1.220	2604	2414
0.865	2125	1979	1.045	2380	2211	1.225	2611	2420
0.870	2133	1986	1.050	2387	2217	1.230	2617	2425
0.875	2140	1993	1.055	2394	2223	1.235	2623	2431
0.880	2148	2000	1.060	2400	2229	1.240	2629	2436
0.885	2155	2006	1.065	2407	2235	1.245	2635	2442
0.890	2162	2013	1.070	2414	2241	1.250	2641	2447
0.895	2170	2020	1.075	2420	2247	1.255	2647	2453
0.900	2177	2026	1.080	2427	2253	1.260	2653	2458
0.905	2185	2033	1.085	2433	2259	1.265	2659	2464

<sup>1/2</sup> Specification (Type A & B) requirements begin for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-IV. Minimum required ballistic limits - caliber .30 AP  
M2 projectiles at 0° obliquity (continued).

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
1.270	2665	2469	1.355	2765	2560	1.440	2861	2648
1.275	2671	2475	1.360	2771	2566	1.445	2867	2653
1.280	2677	2480	1.365	2776	2571	1.450	2872	2658
1.285	2683	2486	1.370	2782	2576	1.455	2878	2663
1.290	2689	2491	1.375	2788	2581	1.460	2884	2668
1.295	2695	2496	1.380	2794	2586	1.465	2889	2673
1.300	2701	2502	1.385	2799	2592	1.470	2895	2678
1.305	2707	2507	1.390	2805	2597	1.475	2900	2683
1.310	2712	2513	1.395	2811	2602	1.480	2906	2688
1.315	2718	2518	1.400	2816	2607	1.485	2911	2693
1.320	2724	2523	1.405	2822	2612	1.490	2917	2698
1.325	2730	2529	1.410	2828	2617	1.495	2922	2703
1.330	2736	2534	1.415	2833	2623	1.500 <sup>2/</sup>	2928	2708
1.335	2742	2539	1.420	2839	2628	1.505	2933	2713
1.340	2748	2544	1.425	2845	2633	1.510	2938	2718
1.345	2753	2550	1.430	2850	2638	1.515	2944	2723
1.350	2759	2555	1.435	2856	2643	1.520	2949	2728

<sup>2/</sup> Specification (Type A & B) requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation  
of BL(P) requirements on undersize or oversize plates.

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TABLE A-V. Minimum required ballistic limits - caliber .50 AP  
M2 projectiles at 0° obliquity.

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
1.480	2131	1952	1.670	2296	2119	1.860	2450	2275
1.485	2135	1956	1.675	2300	2124	1.865	2454	2279
1.490	2140	1961	1.680	2304	2128	1.870	2458	2283
1.495	2144	1966	1.685	2308	2132	1.875	2461	2287
1.501 <sup>1/</sup>	2150	1971	1.690	2312	2136	1.880	2465	2291
1.505	2153	1975	1.695	2317	2141	1.885	2469	2294
1.510	2158	1979	1.700	2321	2145	1.890	2473	2298
1.515	2162	1984	1.705	2325	2149	1.895	2477	2302
1.520	2167	1988	1.710	2329	2153	1.900	2481	2306
1.525	2171	1993	1.715	2333	2157	1.905	2485	2310
1.530	2175	1997	1.720	2337	2161	1.910	2489	2314
1.535	2180	2002	1.725	2341	2166	1.915	2492	2318
1.540	2184	2006	1.730	2345	2170	1.920	2496	2322
1.545	2189	2011	1.735	2350	2174	1.925	2500	2326
1.550	2193	2015	1.740	2354	2178	1.930	2504	2329
1.555	2197	2020	1.745	2358	2182	1.935	2508	2333
1.560	2202	2024	1.750	2362	2186	1.940	2512	2337
1.565	2206	2029	1.755	2366	2190	1.945	2516	2341
1.570	2210	2033	1.760	2370	2194	1.950	2519	2345
1.575	2215	2037	1.765	2374	2198	1.955	2523	2349
1.580	2219	2042	1.770	2378	2203	1.960	2527	2352
1.585	2223	2046	1.775	2382	2207	1.965	2531	2356
1.590	2228	2051	1.780	2386	2211	1.970	2535	2360
1.595	2232	2055	1.785	2390	2215	1.975	2538	2364
1.600	2236	2059	1.790	2394	2219	1.980	2542	2368
1.605	2241	2064	1.795	2398	2223	1.985	2546	2371
1.610	2245	2068	1.800	2402	2227	1.990	2550	2375
1.615	2249	2072	1.805	2406	2231	1.995	2553	2379
1.620	2254	2077	1.810	2410	2235	2.000	2557	2383
1.625	2258	2081	1.815	2414	2239	2.005	2561	2386
1.630	2262	2085	1.820	2418	2243	2.010	2565	2390
1.635	2266	2090	1.825	2422	2247	2.015	2568	2394
1.640	2271	2094	1.830	2426	2251	2.020	2572	2398
1.645	2275	2098	1.835	2430	2255	2.025	2576	2402
1.650	2279	2102	1.840	2434	2259	2.030	2580	2405
1.655	2283	2107	1.845	2438	2263	2.035	2583	2409
1.660	2287	2111	1.850	2442	2267	2.040	2587	2413
1.665	2292	2115	1.855	2446	2271	2.045	2591	2416

<sup>1/</sup> Specification (Type A & B) requirements begin for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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TABLE A-V. Minimum required ballistic limits - caliber .50 AP  
M2 projectiles at 0° obliquity (continued).

Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps		Thickness, inches	Required BL(P), fps	
	Type A	Type B		Type A	Type B		Type A	Type B
2.050	2595	2420	2.225	2721	2547	2.400	2842	2667
2.055	2598	2424	2.230	2725	2550	2.405	2845	2671
2.060	2602	2428	2.235	2728	2554	2.410	2849	2674
2.065	2606	2431	2.240	2732	2557	2.415	2852	2677
2.070	2609	2435	2.245	2735	2561	2.420	2856	2681
2.075	2613	2439	2.250	2739	2564	2.425	2859	2684
2.080	2617	2442	2.255	2742	2568	2.430	2862	2687
2.085	2620	2446	2.260	2746	2571	2.435	2866	2691
2.090	2624	2450	2.265	2749	2575	2.440	2869	2694
2.095	2628	2453	2.270	2753	2578	2.445	2872	2697
2.100	2631	2457	2.275	2756	2582	2.450	2876	2701
2.105	2635	2461	2.280	2760	2585	2.455	2879	2704
2.110	2639	2464	2.285	2763	2589	2.460	2882	2707
2.115	2642	2468	2.290	2767	2592	2.465	2886	2711
2.120	2646	2472	2.295	2770	2596	2.470	2889	2714
2.125	2650	2475	2.300	2774	2599	2.475	2892	2717
2.130	2653	2479	2.305	2777	2602	2.480	2896	2721
2.135	2657	2482	2.310	2781	2606	2.485	2899	2724
2.140	2660	2486	2.315	2784	2609	2.490	2902	2727
2.145	2664	2490	2.320	2787	2613	2.495	2906	2730
2.150	2668	2493	2.325	2791	2616	2.500 <sup>2/</sup>	2909	2734
2.155	2671	2497	2.330	2794	2620	2.505	2912	2737
2.160	2675	2500	2.335	2798	2623	2.510	2916	2740
2.165	2678	2504	2.340	2801	2627	2.515	2919	2744
2.170	2682	2508	2.345	2805	2630	2.520	2922	2747
2.175	2686	2511	2.350	2808	2633	2.525	N/A	2750
2.180	2689	2515	2.355	2811	2637	2.530	N/A	2753
2.185	2693	2518	2.360	2815	2640	2.535	N/A	2757
2.190	2696	2522	2.365	2818	2644	2.540	N/A	2760
2.195	2700	2525	2.370	2822	2647	2.545	N/A	2763
2.200	2703	2529	2.375	2825	2650	2.550	N/A	2766
2.205	2707	2533	2.380	2828	2654	2.555	N/A	2770
2.210	2710	2536	2.385	2832	2657	2.560	N/A	2773
2.215	2714	2540	2.390	2835	2660	2.565	N/A	2776
2.220	2718	2543	2.395	2839	2664	2.570	N/A	2779

<sup>2/</sup> Type A requirements end for this ordered thickness

Note: Tabulated values on either side of the ordered thicknesses are for interpolation  
of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-V. Minimum required ballistic limits - caliber .50 AP  
M2 projectiles at 0° obliquity (continued).

Thickness, inches	Required BL(P), fps	Thickness, inches	Required BL(P), fps	Thickness, inches	Required BL(P), fps
	Type B		Type B		Type B
2.575	2783	2.730	2881	2.885	2976
2.580	2786	2.735	2884	2.890	2979
2.585	2789	2.740	2887	2.895	2982
2.590	2792	2.745	2890	2.900	2985
2.595	2795	2.750	2893	2.905	2988
2.600	2799	2.755	2896	2.910	2991
2.605	2802	2.760	2900	2.915	2994
2.610	2805	2.765	2903	2.920	2997
2.615	2808	2.770	2906	2.925	3000
2.620	2811	2.775	2909	2.930	3003
2.625	2815	2.780	2912	2.935	3006
2.630	2818	2.785	2915	2.940	3009
2.635	2821	2.790	2918	2.945	3012
2.640	2824	2.795	2921	2.950	3015
2.645	2827	2.800	2924	2.955	3018
2.650	2831	2.805	2927	2.960	3021
2.655	2834	2.810	2930	2.965	3024
2.660	2837	2.815	2933	2.970	3027
2.665	2840	2.820	2936	2.975	3030
2.670	2843	2.825	2940	2.980	3033
2.675	2846	2.830	2943	2.985	3036
2.680	2850	2.835	2946	2.990	3039
2.685	2853	2.840	2949	2.995	3042
2.690	2856	2.845	2952	3.000 <sup>2/</sup>	3045
2.695	2859	2.850	2955	3.005	3047
2.700	2862	2.855	2958	3.010	3050
2.705	2865	2.860	2961	3.015	3053
2.710	2868	2.865	2964	3.020	3056
2.715	2872	2.870	2967	3.025	3059
2.720	2875	2.875	2970	3.030	3062
2.725	2878	2.880	2973	3.035	3065

<sup>2/</sup> Type B requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.

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APPENDIX A

TABLE A-VI. Minimum required ballistic limits – 14.5-mm  
BS-41 projectiles at 0° obliquity.

Thickness, inches	Required BL(P), fps	Thickness, inches	Required BL(P), fps	Thickness, inches	Required BL(P), fps
	Type A		Type A		Type A
2.480	2706	2.665	2854	2.850	2995
2.485	2710	2.670	2858	2.855	2998
2.490	2714	2.675	2861	2.860	3002
2.495	2718	2.680	2865	2.865	3006
2.501 <sup>1/</sup>	2723	2.685	2869	2.870	3009
2.505	2726	2.690	2873	2.875	3013
2.510	2730	2.695	2877	2.880	3017
2.515	2734	2.700	2881	2.885	3020
2.520	2738	2.705	2885	2.890	3024
2.525	2742	2.710	2889	2.895	3028
2.530	2746	2.715	2892	2.900	3031
2.535	2750	2.720	2896	2.905	3035
2.540	2754	2.725	2900	2.910	3039
2.545	2758	2.730	2904	2.915	3042
2.550	2763	2.735	2908	2.920	3046
2.555	2767	2.740	2912	2.925	3050
2.560	2771	2.745	2915	2.930	3053
2.565	2775	2.750	2919	2.935	3057
2.570	2779	2.755	2923	2.940	3061
2.575	2783	2.760	2927	2.945	3064
2.580	2787	2.765	2931	2.950	3068
2.585	2791	2.770	2934	2.955	3072
2.590	2795	2.775	2938	2.960	3075
2.595	2799	2.780	2942	2.965	3079
2.600	2803	2.785	2946	2.970	3082
2.605	2806	2.790	2950	2.975	3086
2.610	2810	2.795	2953	2.980	3090
2.615	2814	2.800	2957	2.985	3093
2.620	2818	2.805	2961	2.990	3097
2.625	2822	2.810	2965	2.995	3100
2.630	2826	2.815	2968	3.000 <sup>2/</sup>	3104
2.635	2830	2.820	2972	3.005	3108
2.640	2834	2.825	2976	3.010	3111
2.645	2838	2.830	2980	3.015	3115
2.650	2842	2.835	2983	3.020	3118
2.655	2846	2.840	2987	3.025	3122
2.660	2850	2.845	2991	3.030	3125

<sup>1/</sup> Type A requirements begin for this ordered thickness.

<sup>2/</sup> Type A requirements end for this ordered thickness.

Note: Tabulated values on either side of the ordered thicknesses are for interpolation of BL(P) requirements on undersize or oversize plates.



MIL-DTL-32375 (MR)

CONCLUDING MATERIAL

Custodians:  
Army – MR

Preparing activity:  
ARMY – MR  
(Project 9535-2011-001)

Review activities:  
Army – AR, AT, AV, TE  
DLA – IS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.daps.dla.mil/>.