

INCH-POUND

MIL-A-12560H (MR)  
w/INT. AMENDMENT 4  
20 July 2007  
USED IN LIEU OF  
MIL-A-12560H (MR)  
w/AMENDMENT 3  
27 September 2000

MILITARY SPECIFICATION

ARMOR PLATE, STEEL, WROUGHT, HOMOGENEOUS  
(FOR USE IN COMBAT-VEHICLES AND FOR AMMUNITION TESTING)

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

1. SCOPE

1.1 Scope. This specification covers wrought-steel homogeneous armor plate in thicknesses for 1/4 to 6 inches inclusive for use in combat-vehicles and 1/2 to 12 inches inclusive for use in proof and acceptance testing of armor defeating ammunition (see 6.1 and 6.4.3).

1.2 Classification. Wrought armor should be of the following classes as specified (see 6.1).

1.2.1 Class 1. Wrought armor plate which is heat treated to develop maximum resistance to penetration.

1.2.2 Class 2. Wrought armor plate which is heat treated to develop maximum resistance to shock.

1.2.3 Class 3. Wrought armor plate which is heat treated to develop specific hardness and impact values for evaluation of armor defeating ammunition only. This class armor is not intended for use in combat-vehicles. To meet the thickness tolerances of this class armor special surface finishing may be required.

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Materials Applications Branch, Attn: AMSRD-ARL-WM-MC, Aberdeen Proving Ground, MD 21005-5069 or emailed to [rsquilla@arl.army.mil](mailto:rsquilla@arl.army.mil). Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at [8Hhttp://assist.daps.dla.mil/](http://assist.daps.dla.mil/).

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- 1.2.4 Class 4. Wrought armor plate which is heat treated to higher hardness levels than class 1 armor plate to develop maximum resistance to penetration.
- 1.2.5 Class 4a. Wrought armor plate tempered to attain a minimum through hardness of HRc 47 (BHN 442).
- 1.2.6 Class 4b. Wrought armor plate tempered to attain a maximum through hardness of HRc 41 (BHN 381).

## 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, the issues of these documents are those cited in the solicitation or contract.

#### DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-367 - DELETED  
MIL-STD-410 - DELETED

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

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 of these documents are those cited in the solicitation or contract.

QSTAG 335 - DELETED  
USATECOM TOP 2-2-710 - Ballistic Tests of Armor Materials

(Application for copies is available from the Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218.)

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2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. (AIA)

NAS410 - NAS Certification & Qualification of Nondestructive Test Personnel

(Copies of these documents are available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901 or online at <http://www.aia-aerospace.org>.)

ASTM INTERNATIONAL

ASTM A578/ - Standard Specification for Straight-Beam Ultrasonic  
A578M Examination of Plain and Clad Steel Plates for Special Applications  
ASTM A751 - Standard Test Methods, Practices, and Terminology for  
Chemical Analysis of Steel Products

ASTM E10 - Standard Test Method for Brinell Hardness of Metallic Materials  
ASTM E18 - Standard Test Methods for Rockwell Hardness of Metallic Materials  
ASTM E23 - Standard Test Methods for Notched Bar Impact Testing of Metallic  
Materials

ASTM E110 - Standard Test Method for Indentation Hardness of Metallic Materials by  
Portable Hardness Testers (DoD adopted)

ASTM E140 - Standard Hardness Conversion Tables for Metals Relationship Among  
Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial  
Hardness, Knoop Hardness, and Scleroscope Hardness

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE J406 - Methods of Determining Hardenability of Steels

(Copies of these documents are available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or online at <http://www.sae.org/>.)

2.4 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 retained.

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### 3. REQUIREMENTS

3.1 First Article. When specified in the contract or purchase order (see 4.1.3, 6.2, 6.9 and 6.11), a sample or samples of the specified item shall be made available to the contracting officer or his authorized representative for approval in accordance with 4.1.1. The approval of the first article samples authorizes the commencement of shipment but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The first article samples and test plates shall be manufactured by the process proposed for use on production armor. The manufacturer's declared chemical analysis shall be submitted to the contracting agency and to the ballistic test agency. The ballistic test agency shall record the first article ballistic test plate submitted, showing the dates tested.

3.1.1 First time producer. First time producers wishing to qualify to this specification shall follow the instructions of 6.8.

#### 3.2 Acceptance requirements.

##### 3.2.1 Materials.

3.2.1.1 Structure. Processes of manufacture shall be such as to produce steel plate having, as nearly as practicable, a homogeneous structure throughout.

3.2.2 Chemical composition. The product analysis of all plates within a heat shall conform to the requirement of table I unless otherwise negotiated between the steel supplier and the contractor (see 6.12). All limits as specified in table I (including any deviations negotiated) shall be submitted in advance to the procuring activity. The contractor shall establish and submit separate limits for each thickness of plate to be furnished (see 6.5). A statement showing the product analysis of each melt and complete details of the heat treatment of each lot shall be furnished (see 6.5). A statement showing the product analysis of each melt and complete details of the heat treatment of each lot shall be furnished for the files of the procuring activity at no cost to the procuring activity. All elements of chemical composition shall be shown in the statement. The chemical composition range established by the producer and the chemical analysis of the material submitted shall be reported (see 6.2.2).

3.2.2.1 Hardenability index (class 4 armor plate). An average hardenability index ( $D_I$ ) shall be calculated for class 4 armor plate (see 6.1.4). This ( $D_I$ ) calculation method utilizes a series of hardenability factors for each alloying element in the composition (see SAE J406).

3.2.3 Heat treatment. All plates in each lot, including samples, shall receive the same heat treatment except for such variations in tempering temperature as shall be necessary to produce the prescribed hardness. The austenitizing temperature for production plates may vary within a range of 50° above the temperature used for test plates, but in no case shall it exceed 1700°F (see 6.7). Class 4 armor plate shall be heat treated to higher hardness levels than class 1 armor plate to develop maximum resistance to penetration.

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TABLE I. Chemical composition (product analysis). 1/

Element	Maximum range, weight percent	Maximum limit, weight percent
Carbon	0.10	0.30 up to 2" thick, incl 0.33 over 2" up to 4" 0.35 over 4"
Manganese: Up to 1.00% incl. Over 1.00%	0.30 0.40	--- ---
Phosphorus	---	0.025
Sulfur	---	0.015
Silicon: Up to 0.60% incl. Over 0.60% to 1.00% incl. Over 1.00%	0.20 0.30 0.40	--- --- ---
Nickel	0.50	---
Chromium: Up to 1.25% incl. Over 1.25%	0.30 0.40	--- ---
Molybdenum: Up to 0.20% incl. Over 0.20%	0.07 0.15	--- ---
Vanadium	0.10	---
Boron	---	--- 2/
Copper	---	0.25 3/
Titanium	---	0.10 3/
Zirconium	---	0.10 3/
Aluminum	---	0.10 3/
Lead	---	0.01
Tin	---	0.02 3/
Antimony	---	0.02 3/
Arsenic	---	0.02 3/

1/ This table lists the maximum range for elements of the manufacturer's established chemical composition.

2/ When the amount of boron is specified in the alloy, its content so determined by heat analysis shall not exceed 0.003 percent.

3/ When the amount of an element is less than 0.02 percent the analysis shall be reported as 0.02 percent.

### 3.2.4 Processing controls.

3.2.4.1 Heating. Stress relieving the plates, local or general, shall be allowed after final quenching and tempering at a maximum temperature of 50°F below the tempering temperature.

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Plates shall not be stress relieved in a temperature range of 600-800 °F. After stress relieving, the plates shall be tested for hardness and shall meet the requirements of table II.

TABLE II. Hardness requirements.

Specified nominal thickness of plate, inches From                      To and incl.		Armor class	Brinell hardness range, BHN, 3000 kg load	Brinell indentation diameters, mm	Rockwell C hardness range, HRC
0.250	0.499	1&3	341-388	3.30-3.10	36.6-41.8
0.500	0.749	1&3	331-375	3.35-3.15	35.4-40.5
0.750	1.249	1&3	321-375	3.40-3.15	34.3-40.5
1.250	1.990	1&3	293-331	3.55-3.35	30.9-35.4
2.000	3.990	1&3	269-311	3.70-3.45	27.7-33.0
4.000	6.000	1&3	241-277	3.90-3.65	22.7-28.7
6.001	6.999	3	241-277	3.90-3.65	22.7-28.7
7.000	8.999	3	223-262	4.05-3.75	19.2-26.7
9.000	12.000	3	212-248	4.15-3.85	16.4-24.2
0.250	1.250	2	277-321	3.65-3.40	28.7-34.3

3.2.4.2 Repairing. Unless otherwise approved by the procuring activity, weld repairs shall not be made on any plates.

3.2.4.3 Forming. Forming after the final quenching and tempering operations shall not be done except when authorized by the procuring activity.

3.2.4.4 Grinding. Grinding is not required but shall be performed to remove minor defects not affecting the serviceability of the material provided that, unless otherwise authorized by the procuring activity, the grinding does not result in the reduction of the plate thickness in the ground area to less than the tolerances specified in tables III, IV, or V as applicable.

### 3.2.5 Mechanical properties.

3.2.5.1 Surface hardness. The average surface hardness of each plate including first article samples shall be within the Brinell hardness range shown in table II for the applicable class and thickness. The diameters of Brinell hardness impressions on any individual plate shall not vary by more than 0.15 mm.

3.2.5.1.1 Class 4 armor plate. Surface hardness is required on every plate to insure quality and uniformity of product. In addition, first article samples shall be tested for through hardness to verify that they are within the HB range specified in 1.2.5 and 1.2.6. Respective diameters of the Brinell hardness impression taken on an individual plate shall not vary by more than 0.15 mm. Each lot shall be tested for through hardness. Acceptance for Class 4a material requires a minimum through hardness of HRc 47 (BHN 442). Acceptance for class 4b material requires a maximum through hardness HRc 41 (BHN 381).

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3.2.5.2 Impact. The Charpy V-notch impact test results of armor plate submitted shall meet the requirements shown in table VI for the applicable hardness and thickness. The Charpy V-notch impact specimens shall be obtained in the both the TL orientation (transverse to the major direction of rolling with the notch perpendicular to the plate surface so that the crack propagates in the longitudinal direction) and the LT orientation (parallel to the major direction of rolling). The Charpy value for class 4 armor plate shall be greater than 20 ft-lb (27 J) for all thickness.

3.2.5.3 Bend test. When specified in the contract or order a bend test shall be performed. Bend test criteria shall be agreed upon by the supplier and fabricator.

3.2.6 Ballistic requirements. Ballistic requirements for class 1, 3 and 4 wrought homogeneous armor plate shall be in accordance with the appendix of this specification. Class 2 armor plate shall not be subject to ballistic test requirements. When a complete penetration can not be obtained for either class 1 or class 4 armor material, the following rule shall be in effect until a new ballistic acceptance round can be utilized. When four (4) partial penetrations are above the minimum requirement for the specific thickness, the material shall be certified as acceptable with a  $V_{50}$  (which obviously can not be specified) above the minimum requirement.

3.2.7 Dimensions and tolerances.

3.2.7.1 Dimensions. Classes 1 and 2 armor plate shall comply with the dimensions and tolerances specified on applicable drawings or in the contract (see 6.2). Class 3 armor tolerances on length and width dimensions shall be plus 1 1/2 inches and minus zero.

3.2.7.2 Thickness.

3.2.7.2.1 DELETED.

3.2.7.2.1 Thickness measurements (class 3 armor). The thickness of all class 3 plates shall be determined by measurements made one foot on centers over the entire surface of each plate. The measurements shall be to the nearest thousandth of an inch. The acceptance of each plate shall be based on these measurements meeting the thickness requirements of table V for class 3 armor.

3.2.7.2.2 Thickness tolerances. The thickness tolerances of each plate, after final treatment, shall be in accordance with tables III and IV for classes 1 and 2 armor or with table V for class 3 armor.

3.2.7.3 Flatness. Unless otherwise specified in the contract or order (see 6.2), the flatness tolerance of each plate shall be within the requirements specified in table VII. Tighter tolerance requirements shall be specified in the contract or order and shall be as agreed upon between the contractor and the procuring activity.

3.2.7.4 Waviness. Unless otherwise specified in the contract or order (see 6.2), the waviness tolerance of each plate shall be within the requirements of table VIII for the applicable thickness.

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TABLE III. Thickness tolerances for class 1 and class 2 armor plates up to 2 inches thick inclusive.

Thickness tolerances in inches over and under ordered thickness  $\frac{1}{16}$  for a single plate 2 inches and under in thickness  $\frac{2}{16}$

Tolerances Over and Under Ordered Thickness for Widths Given, inches											
Specified Thickness, Inches	To 60	60 to 72 excl.	72 to 84 excl.	84 to 96 excl.	96 to 108 excl.	108 to 120 excl.	120 to 132 excl.	132 to 144 excl.	144 to 168 excl.	168 to 182 excl.	182 and over
$\frac{1}{4}$	$\frac{2}{16}$	0.016	0.016	0.019	0.019	0.023	----	----	----	----	----
$\frac{5}{16}$	$\frac{2}{16}$	0.016	0.019	0.019	0.019	0.023	0.026	----	----	----	----
$\frac{3}{8}$	$\frac{2}{16}$	0.016	0.019	0.019	0.023	0.023	0.026	----	----	----	----
$\frac{7}{16}$	$\frac{2}{16}$	0.016	0.019	0.019	0.023	0.026	0.026	0.031	----	----	----
$\frac{1}{2}$	$\frac{2}{16}$	0.016	0.019	0.019	0.023	0.026	0.026	0.031	0.036	----	----
$\frac{9}{16}$	$\frac{2}{16}$	0.019	0.019	0.019	0.023	0.026	0.031	0.031	0.036	----	----
$\frac{5}{8}$	$\frac{2}{16}$	0.019	0.019	0.019	0.023	0.026	0.031	0.031	0.036	----	----
$\frac{11}{16}$	$\frac{2}{16}$	0.019	0.019	0.019	0.023	0.026	0.031	0.031	0.036	----	----
$\frac{3}{4}$	$\frac{2}{16}$	0.019	0.019	0.023	0.023	0.026	0.031	0.039	0.043	----	----
$\frac{13}{16}$	$\frac{2}{16}$	0.023	0.023	0.023	0.026	0.031	0.031	0.039	0.043	----	----
$\frac{7}{8}$	$\frac{2}{16}$	0.023	0.023	0.026	0.026	0.031	0.036	0.039	0.043	----	----
$\frac{15}{16}$	$\frac{2}{16}$	0.023	0.023	0.026	0.026	0.031	0.036	0.043	0.048	----	----
1	$\frac{2}{16}$	0.026	0.026	0.026	0.026	0.031	0.036	0.043	0.048	----	----
1- $\frac{1}{16}$	$\frac{2}{16}$	0.026	0.026	0.026	0.031	0.031	0.036	0.043	0.048	----	----
1- $\frac{1}{8}$	$\frac{2}{16}$	0.026	0.026	0.026	0.031	0.031	0.039	0.043	0.048	----	----
1- $\frac{3}{16}$	$\frac{2}{16}$	0.031	0.031	0.031	0.031	0.036	0.043	0.048	0.053	----	----
1- $\frac{1}{4}$	$\frac{2}{16}$	0.031	0.031	0.031	0.036	0.036	0.043	0.048	0.053	----	----
1- $\frac{5}{16}$	$\frac{2}{16}$	0.031	0.031	0.031	0.036	0.036	0.043	0.053	0.058	----	----
1- $\frac{3}{8}$	$\frac{2}{16}$	0.031	0.031	0.031	0.036	0.039	0.048	0.053	0.058	----	----
1- $\frac{7}{16}$	$\frac{2}{16}$	0.036	0.036	0.036	0.036	0.043	0.048	0.058	0.063	----	----
1- $\frac{1}{2}$	$\frac{2}{16}$	0.036	0.036	0.036	0.039	0.043	0.048	0.058	0.063	----	----
1- $\frac{9}{16}$	$\frac{2}{16}$	0.036	0.036	0.036	0.039	0.043	0.053	0.058	0.070	----	----
1- $\frac{5}{8}$	$\frac{2}{16}$	0.036	0.036	0.036	0.043	0.048	0.053	0.063	0.070	----	----



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TABLE III. Thickness tolerances for class 1 and class 2 armor plates up to 2 inches thick inclusive – Continued.

1-11/16	<u>2/</u>	0.039	0.039	0.039	0.043	0.048	0.058	0.063	0.070	----	----
1-3/4	<u>2/</u>	0.039	0.039	0.039	0.043	0.048	0.058	0.068	0.078	----	----
1-13/16	<u>2/</u>	0.043	0.043	0.043	0.048	0.053	0.058	0.068	0.078	----	----
1-7/8	<u>2/</u>	0.043	0.043	0.043	0.048	0.053	0.063	0.068	0.078	----	----
1-15/16	<u>2/</u>	0.043	0.043	0.043	0.048	0.053	0.063	0.076	0.084	----	----
2	<u>2/</u>	0.043	0.043	0.043	0.048	0.053	0.063	0.076	0.084	----	----

1/ For intermediate thickness, the tolerance of the closer-specified gage shall apply. In case of mid-point, the tolerance for lower gage or interpolated value shall apply.

2/ When plates under 60 inches are rolled double width, the equivalent wider plate tolerances shall apply.

TABLE IV. Thickness tolerances for class 1 and class 4 armor plates over 2 inches thick.

Thickness tolerances in inches over and under ordered thickness for single plate over 2 inches in thickness when ordered to thickness in inches.

Specified thickness, inches From            To		Tolerances over and under specified thickness for widths given, inches				
		Under 60 excl.	60 to 84 excl.	84 to 120 excl.	120 to 132 excl.	132 and over
2	4, excl.	<u>1/</u>	0.060	0.068	0.068	0.076
4	6, incl.	<u>1/</u>	0.076	0.076	0.083	0.091
6	8, incl.	<u>1/</u>	0.091	0.091	0.098	0.107
8	10, incl.	<u>1/</u>	0.107	0.107	0.122	0.138
10	12, incl.	<u>1/</u>	0.138	0.138	0.144	0.160

1/ When plates under 60 inches are rolled double width, the equivalent wider plate tolerances shall apply.

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3.2.8 Identification marking. Identification marking and records shall be such as to ensure positive identification of all plates, including test samples and specimens, with the lot and corresponding heat from which they were produced. First article and acceptance ballistic test plates shall also be marked with the manufacture's name or trademark, the number of this specification, and the ordered plate thickness in inches. First article plates shall be marked "PRE," acceptance plates "ACC," and retest plates shall be marked "R1" and "R2." If a second set of retest plates are submitted they shall be marked "RR1" and "RR2." The marking shall be approximately 1/16 inch deep and approximately 1/2 inch high and located along the edge with the lifting hole, if present, and shall be stamped into the surface unless the plate hardness makes painting necessary. All plate markings shall be highlighted with a highly visible yellow or orange border such as fluorescent paint or highlighted with a special white paint intended to delineate and highlight stamping. The primary plate rolling direction shall be identified. Manufacturers supplying armor, to be used for proving ground testing of ammunition, are required to:

- a. Mark each class 3 plate with one foot square blocks showing thickness at the center of each block. The acceptance of each plate shall be based on these measurements meeting the thickness requirements set forth in table V.
- b. Stamp each plate "HOMO, class 3, MIL-A-12560, plate No. \_\_\_\_, heat No. \_\_\_\_." Stamping shall be approximately 1/2 inch high letters to a depth approximately 1/16 inch. Location of stamping for all plates shall be in the upper right hand corner.

3.2.9 Information required. A statement showing the product analysis of each melt and complete details of the heat treatment of each lot shall be furnished for the files of the procuring activity. All elements of the chemical composition shall be shown in the statement, including special additives or hardening agents, whether shown in table I or not.

TABLE V. Thickness tolerances for class 3 armor plate. 1/

Specified plate thickness, inches		Permissible variation plus or minus, inches
Over	To and including	
0.250	0.500	0.015
0.500	1.125	0.020
1.125	1.499	0.025
1.499	1.749	0.030
1.749	1.999	0.035
1.999	2.999	.0.040
2.999	4.000	0.045
4.000	6.000	0.075
6.000	8.000	0.083
8.000	10.000	0.098
10.000	12.000	0.122

1/ This armor is not intended for use in combat vehicles. To obtain these thickness tolerances special surfacing finishing shall be required.

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TABLE VI. Minimum Charpy V-notch impact requirements (at -40°F ± 2°F). 1/

Average Brinell hardness, BHN	Plate thickness, inches	Minimum impact values (average of two or more test specimens), ft-lb		
		Specimen Size		
		Standard	3/4 width	1/2 width
207	4-12 incl.	65		
212	4-12 incl.	63		
217	4-12 incl.	61		
223	4-12 incl.	59		
229	4-12 incl.	57		
235	4-12 incl.	55		
241	4-12 incl.	53		
248	4-12 incl.	50		
255	4-12 incl.	47		
262	4-12 incl.	44		
269	4-12 incl.	40		
277	4-12 incl.	37		
285	4-12 incl.	33		
262	1/4 to less than 4	55		
269	1/4 to less than 4	51		
277	1/4 to less than 4	47	36	24
285	1/4 to less than 4	43	33	22
293	1/4 to less than 4	39	30	20
302	1/4 to less than 4	35	27	18
311	1/4 to less than 4	31	24	16
321	1/4 to less than 4	28	21	14
331	1/4 to less than 4	25	19	13
341	1/4 to less than 4	22	17	11
352	1/4 to less than 4	19	15	10
363	1/4 to less than 4	17	13	9
375	1/4 to less than 4	16	12	8
388	1/4 to less than 4	16	12	8

1/ ASTM E140 shall be used to convert HRC readings to BHN equivalents.

### 3.2.10 Workmanship.

3.2.10.1 Surface imperfections. The top and bottom surface of each plate shall be free from the following surface defects: slivers, laps, checks, seams, blisters, snakes, cold shuts, cracks, burning, and laminations (see 6.4). The surface of each plate shall be such that mill scale or oxidation product shall not interfere with determination of acceptability. Imperfections listed above which are of such nature as to affect the fabrication of the material, are rejectable.

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3.2.10.1.1 Depth of imperfections. The depth of rolled-in scale, scale pitting, mechanical gouges, or snakes shall not exceed 0.015 inch and shall not reduce the steel thickness below the allowable minimum. Isolated individual pits over 0.015 inch deep but not over 0.03 inch deep and not within 6 inches of each other and which do not violate the minimum allowable thickness, as specified in the applicable drawings and fabrication documents, are acceptable.

3.2.10.2 Edge preparation. Thermal cutting shall be permitted after final heat treatment provided the procedure, which may include grinding after thermal cutting, is such that no cracks develop on any thermally cut edge whether detected by nondestructive inspection, or as agreed upon in the contract. The heat affected zone of thermally cut plates (up to and including 1/2 inch in thickness) shall not exceed 1.2 times the plates thickness from the cut edge. For plates over 1/2 inch thick, the heat affected zone shall not exceed 5/8 inch from the cut edge. In order to have the heat affected zone exceed these limits approval shall be obtained from the procuring activity.

TABLE VII. Permissible variations for flatness, inches.

Specified thickness, inches	Variations from a flat surface for specified widths, inches					
	Under 48	48 to 60 excl.	60 to 72 excl.	72 to 84 excl.	84 to 96 excl.	96 to 108 excl.
1/4 to 3/8 excl.	3/4	15/16	1-1/8	1-3/4	1-7/8	-
3/8 to 1/2 excl.	1/2	9/16	5/8	3/4	7/8	-
1/2 to 3/4 excl.	1/2	9/16	5/8	3/4	7/8	-
3/4 to 1-1/4 excl.	1/2	9/16	5/8	3/4	7/8	-
1-1/4 to 1-5/8 excl.	3/8	1/2	1/2	5/8	3/4	-
1-5/8 to 3 excl.	3/8	3/8	7/16	1/2	5/8	3/4
3 to 4 excl.	3/8	1/2	1/2	5/8	3/4	3/4
4 to 6 excl.	1/2	5/8	5/8	3/4	7/8	7/8
6 to 8 excl.	9/16	11/16	11/16	13/16	15/16	15/16
8 to 10 excl.	5/8	3/4	3/4	7/8	1	1
10 to 12 excl.	11/16	13/16	13/16	15/16	1-1/8	1-1/8

Note: The above variations apply to plates up to 12 feet in length, or to any 12 feet or longer plates.

3.2.10.3 Edge condition. Plate edge on plates delivered after heat treatment shall be free of cracks. The supplier shall practice such necessary process controls to prevent this condition.

3.2.10.4 Internal soundness. All plates 1/2 inch and greater in thickness shall be ultrasonically examined for internal soundness in accordance with 4.6.5. The steel supplier shall institute process controls such that any edge of any cut part shall comply with the requirements of 3.2.10.4.1.

3.2.10.4.1 Acceptance criteria.

3.2.10.4.1.1 Single linear indications. In any four inches of length a single linear indication shall not exceed twice the plate thickness.

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TABLE VIII. Waviness tolerances for plates.

Flatness tolerance from table VII	When number of waves in 12 ft is:						
	1	2	3	4	5	6	7
5/16	5/16	1/4	3/16	1/8	1/8	1/16	1/16
3/8	3/8	5/16	3/16	3/16	1/8	1/16	1/16
7/16	7/16	5/16	1/4	3/16	1/8	1/8	1/16
1/2	1/2	3/8	5/16	3/16	3/16	1/8	1/16
9/16	9/16	7/16	5/16	1/4	3/16	1/8	1/8
5/8	5/8	1/2	3/8	1/4	3/16	1/8	1/8
11/16	11/16	1/2	3/8	5/16	3/16	3/16	1/8
3/4	3/4	9/16	7/16	5/16	1/4	3/16	1/8
13/16	13/16	5/8	7/16	5/16	1/4	3/16	1/8
7/8	7/8	11/16	1/2	3/8	1/4	3/16	1/8
15/16	15/16	11/16	1/2	3/8	5/16	1/4	3/16
1	1	3/4	9/16	7/16	5/16	1/4	3/16
1-1/8	1-1/8	7/8	5/8	1/2	3/8	1/4	3/16
1-1/4	1-1/4	15/16	11/16	1/2	3/8	5/16	1/4
1-3/8	1-3/8	1-1/16	3/4	9/16	7/16	5/16	1/4
1-1/2	1-1/2	1-1/8	7/8	5/8	1/2	3/8	1/4
1-5/8	1-5/8	1-1/4	15/16	11/16	1/2	3/8	5/16
1-3/4	1-3/4	1-5/16	1	3/4	9/16	7/16	5/16
1-7/8	1-7/8	1-7/16	1-1/16	13/16	9/16	7/16	5/16
2	2	1-1/2	1-1/8	7/8	5/8	1/2	3/8
2-1/8	2-1/8	1-5/8	1-3/16	7/8	11/16	1/2	3/8
2-1/4	2-1/4	1-11/16	1-1/4	15/16	11/16	9/16	3/8
2-3/8	2-3/8	1-13/16	1-5/16	1	3/4	9/16	7/16
2-1/2	2-1/2	1-7/8	1-7/16	1-1/16	13/16	9/16	7/16
2-5/8	2-5/8	2	1-1/2	1-1/8	13/16	5/8	7/16
2-3/4	2-3/4	2-1/16	1-9/16	1-1/8	7/8	5/8	1/2

Note 1. Waviness denotes the deviation of the top or bottom surface from a horizontal line, when the plate is resting on a flat surface, as measured in an increment of less than 12 ft of length. The waviness tolerance is a function of the flatness tolerance as obtained from Table VII.

Note 2. When the flatness tolerance is 1/2 inch or less for plates 1/2-inch or less in thickness, the waviness tolerance shall not apply.

3.2.10.4.1.2 Multiple linear indications. Multiple linear indications shall not exceed 1 1/2 times the plate thickness if two or more lie in the same plane. The total length of indications in one plane, in any four inch length, shall not exceed twice the plate thickness. No more than ten indications, whether in one plane or multiple planes, are permitted in any four inch length.

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3.2.10.4.1.3 Cracks. All cracks shall be rejectable.

3.2.10.4.1.4 Removal of large indications. Large indications shall be removed by the manufacturer or processor by grinding, provided the resulting cavity does not exceed 1/4 inch.

4. VERIFICATION

4.1 Responsibility for inspection. DELETED.

4.1.1 Responsibility for compliance. DELETED.

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

- a. First article inspection (see 4.1.1).
- b. Conformance inspection (see 4.2).

4.1.1 First article inspection. When required (see 6.2), the first article samples submitted in accordance with 3.1, shall be examined for all the provisions of this specification applicable to end item examination.

4.1.2 First article tests. First article tests (see 6.2) shall consist of all the tests specified in 4.6.

4.1.3 First article ballistic test. Unless otherwise specified (see 3.1, 6.2, and 6.11), the first article ballistic test shall not be required provided (a) the manufacturer, within 37 months, has produced acceptable plates within the same nominal thickness ranges of table IX, and (b) the production conditions are the same as for previously accepted plates. A supplier who has previously met the first article requirements shall furnish the procuring activity the firing record of the ballistic test plate and other pertinent data relative to compliance with first article. Neither first article nor acceptance ballistic tests shall be required for plates ordered to thicknesses of more than 6.25 inches. Acceptance of these thicker plates shall be based on meeting the other requirements of the specification.

4.2 Conformance inspection. The acceptance examination under 4.5 and the tests under 4.6 shall serve as a basis for the acceptance of individual production lots.

4.3 Lot. A lot shall consist of all production and ballistic test plates of the same melt of steel, of the same thickness, having the same treatment, and heat treated with the same thermal cycle in the same production furnace(s) in the same facility. When specified by the procuring activity (see 4.3.1), production and ballistic test plates shall be allowed to be heat treated separately. The test plate shall be heat treated in a production furnace.

4.3.1 Separately heat treated ballistic test plate. When the procuring activity allows a ballistic test plate to be heat treated separately from the production plates it represents (see 6.2), it shall be so stated in the data (see 6.7).

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#### 4.4 Sampling.

##### 4.4.1 First article sampling.

4.4.1.1 Chemical composition. Samples for chemical analysis shall be taken from each plate selected for the ballistic tests.

4.4.1.2 Impact samples. At least one impact test sample shall be taken from each submitted test plate in accordance with 4.6.3.1 or 4.6.3.2 and each shall consist of enough material for four impact specimens.

4.4.1.3 Ultrasonic examination. Each submitted test plate 3/8 inch in thickness and thicker, shall be ultrasonically examined in accordance with 4.6.5.

4.4.1.4 Ballistic test plates. Three ballistic test plates for each nominal thickness range (see table IX) shall be randomly selected and submitted for ballistic test. Any thickness within the range can be chosen to represent any other thickness in the range but the three plates submitted shall be of the same ordered thickness. Unless otherwise specified, the average thickness of each test plate shall be determined at the test site by the test agency as indicated in 4.4.2.5.

##### 4.4.2 Sampling for quality conformance inspection.

4.4.2.1 For chemical analysis. At least one sample for chemical analysis shall be taken from each heat in accordance with the applicable method specified in ASTM A751 (see 6.6).

4.4.2.2 For hardness test. The Brinell hardness of each plate as heat treated in each lot up to 1 1/2 inches thick shall be measured in two places, one at each end of a diagonal on both plate surfaces. The Brinell hardness of each plate as heat treated in each lot over 1 1/2 inches thick shall be measured in four places, one at each end of a diagonal on both plate surfaces.

4.4.2.3 For Charpy V-notch impact tests. At least one sample shall be taken from a plate representing each lot for Charpy V-notch impact tests. The sample shall be the same thickness as the plate they represent and large enough to obtain at least two specimens, in each direction, from each sample in accordance with 4.6.3.

4.4.2.4 Ultrasonic examination. All plates 1/2 inch and greater in thickness shall be examined ultrasonically. The ultrasonic examination shall be performed in accordance with 4.6.5.

4.4.2.5 For ballistic acceptance samples. Unless otherwise specified in the contract or order, one test plate shall be submitted from each lot. The minimum plate size shall be as shown in table IX for the applicable thickness. Unless otherwise specified, the average thickness of each test plate shall be determined at the test site by taking the average of four thickness measurements. Measurements shall be made at least 1 inch from each edge but preferably at random in the intended impact area. Thickness measurements for plates up to and including 2.750 inch shall be read to the nearest 0.001 inch. Plates over 2.750 inch shall be read to the nearest 0.01 inch. If a producer submits plates outside the specified plate tolerances (see tables III, IV and V), the

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procuring activity shall be notified. A check list shall be completed and submitted with each ballistic test plate.

#### 4.5 Examination.

4.5.1 Visual. All steel plate shall be subject to visual inspection for compliance with the requirements for surface conditions (see 3.2.10 .1), edge quality (see 3.2.10.3 and 3.2.10.4) and identification marking (see 3.2.8).

4.5.2 Dimensions. All steel plates shall be subject to inspection for compliance with dimensional and tolerance requirements (3.2.7). Each class 3 armor plate shall be divided into one foot squares painted on one surface and the results of each thickness measurement shall be painted in the square in which it was taken.

4.5.3 Preparation for shipment. Examination shall be made to determine compliance with the requirements for preparation for shipment (see section 5).

#### 4.6 Tests.

4.6.1 Chemical analysis. Chemical analysis shall be conducted in accordance with the applicable method specified in ASTM A751 (see 6.6). The analysis shall comply with the declared composition established in accordance with the requirement of table I (see 3.2.2).

4.6.2 Hardness tests. Brinell hardness tests shall be conducted in accordance with either ASTM E10 or ASTM E110 using a 10 mm carbide ball and a 3000 kilogram load. Surface scale and decarburization shall be removed from the areas where the tests are to be made. Hardness tests shall be made on the surfaces of pieces cut from the plate after heat treatment.

TABLE IX. Ballistic test plate sizes and corresponding test projectiles for first article and acceptance testing.

Nominal thickness range, inches	Minimum size <u>1/</u> of test plates, inches	Test projectile and obliquity
0.25 to 0.565 incl.	12 x 36	Cal .30 M2 AP at 0°
0.566 to 1.125 incl.	12 x 36	Cal .50 M2 AP at 0°
1.126 to 2.750 incl.	12 x 36	20 mm M602 APIT at 0°
2.751 to 3.500 incl.	60 x 60	90 mm M82 APC at 45°
3.501 to 3.999 incl.	60 x 60	90 mm M82 APC at 30°
4.00 to 6.250 incl.	60 x 60	90 mm M318A1 AP at 0°
Over 6.251 <u>2/</u>	---	---

1/ Other sizes may be submitted for the convenience of the manufacturer if approved by the Armor Vulnerability Division, USACSTA, Aberdeen Proving Ground.

2/ No ballistic test required.



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4.6.2.1 Hardness tests on impact test specimens. Samples for all classifications shall be examined on a lot by lot basis. Except as provided in 4.6.2.2, each sample from which impact test specimens are taken shall have a hardness check made upon it as follows: For samples 1/4 to 1/2 inch inclusive the hardness check shall be made on the surface. For samples of 1/2 inch up to 4 inches in thickness, at least two hardness tests shall be taken from an adjacent location, midway between the surfaces of the plate. For samples of 4 inches in thickness or greater, at least six hardness tests shall be made at equal intervals across the plate thickness.

4.6.2.2 Rockwell hardness tests on impact specimens. At the option of the contractor at least two Rockwell C hardness tests shall be made on each impact test specimen sampled from each lot. The test specimens shall be prepared and tested in accordance with ASTM E18. The average shall not exceed the maximum requirement for thickness specified in table II.

4.6.3 Charpy V-notch impact tests. At least two Charpy V-notch impact test specimens shall be taken in each direction from each sample as obtained in accordance with 4.6.3.1 or 4.6.3.2, and shall be prepared and tested in accordance with ASTM E23.

4.6.3.1 For samples less than 4 inches in thickness. Charpy V-notch impact test specimens from samples less than 4 inches in thickness shall be taken in both the TL orientation and in the LT (see 3.2.5.2) orientation from a location midway between the top and bottom surfaces of the plate and at least 4 inches or 2T, whichever is less, from any quenched edge as well as outside the heat affected zone of any thermal-cut edge. When the amount of materials available is insufficient to obtain standard specimens, the largest attainable subsize Charpy V-notch impact specimens shown in figure 3 of ASTM E23 shall be used and the results compared to the applicable requirements of table VI.

4.6.3.2 For sample 4 inches or greater in thickness. Charpy V-notch impact test specimens from samples 4 inches or greater in thickness shall be approximately 1 inch below the surface of the plate and at least 4 inches from any quenched edge as well as outside the heat-affected zone of any thermally-cut edge.

4.6.4 Ballistic tests. Ballistic testing of armor plate shall be conducted at a Government test facility specified in the contract or order or at a test facility approved by the Government. Testing shall be conducted in accordance with the requirements of the appendix.

4.6.5 Ultrasonic examination.

4.6.5.1 Inspection equipment. The ultrasonic soundness inspection equipment shall conform to ASTM A578/A578M.

4.6.5.2 Procedure. Unless otherwise specified (see 6.2), the ultrasonic examination shall be carried out in accordance with ASTM A578/A578M with the following exceptions.

- (a) Scanning shall be continuous over 100% of the plate surface.
- (b) Scanning rate shall be at a speed where recordable discontinuities can be detected.
- (c) The testing frequency shall be a minimum of 2 megahertz (MHz).

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- (d) Any area within a plate where a discontinuity produces a continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed within a circle whose diameter is 1 inch shall be cause for rejection of that plate. All discontinuities shall be evaluated using a frequency of 2.25 megahertz (MHz).

4.6.5.3 Certification of inspection personnel. Unless otherwise specified (see 6.2), personnel performing ultrasonic inspection shall comply with the qualification requirements of NAS410. Personnel making accept/reject decisions in accordance with the process described by this specification shall be qualified to at least a level II.

4.6.6 Reduced testing. At the discretion of the procuring activity, the amount of testing shall be reduced provided the results on consecutive lots indicate that a satisfactory uniform product meeting the testing requirements is being produced (see 6.2). Reduced testing shall be in accordance with a system previously approved or established by the procuring activity involved.

4.6.7 Rejection and retest.

4.6.7.1 Rejection. Unless otherwise specified in the contract or order (see 6.2), failure of the first article samples to meet the requirements of this specification shall be cause for rejection of the process, and failure of the acceptance samples to meet the requirements of this specification shall be cause for rejection of the lot (see 4.6.7.2).

4.6.7.2 Retest. Unless specific retest procedure is specified in the contract or order (see 6.2), two retest samples shall be submitted for each failed sample. Failure of either of the retest samples (plates) shall be cause for rejection of the material. First article retests shall not be permitted until the supplier has made the necessary correction in the processing of the material to the satisfaction of the procuring activity.

4.6.8 Hardness traverse test. Prior to production to assure compliance to paragraph 3.2.10.2, the size of the heat affected zone for thermally cut edges shall be determined by taking Rockwell C hardness tests at 1/16 inch increments from the edge. Surface scale and decarburization shall be removed from the test surface. The distance at which there is no change in surface hardness shall be considered the depth of the heat affected zone. The contractor shall document the test results for each thickness and thermal cutting method used in production. The contractor is also responsible for documenting all heat input controls to assure the cutting process is under control. Re-verification of heat affected zone size for subsequent production lots is not required provided there is no change in the cutting method or heat input from that previously tested. The records shall be available for review by the cognizant government representative.

## 5. PACKAGING

5.1 Preservation and packaging. DELETED.

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 is to be performed by DoD or in-house

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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 command. 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.

5.1.1 Level C. DELETED.

5.2 Packing. DELETED.

5.2.1 Level C. DELETED.

5.3 Marking. DELETED.

## 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 is intended for use on combat vehicles and/or proof and acceptance testing of armor defeating ammunition, but should also be applicable to armor for emplacements, shields, pill boxes, testing, and the like.

6.1.1 Class 1. Class 1 wrought armor is intended for use in those areas where maximum resistance to penetration by armor piercing types of ammunition is required.

6.1.2 Class 2. Class 2 wrought armor is intended for use in those areas where maximum resistance to failure under conditions of high rates of shock loading is required and where resistance to penetration by armor piercing ammunition is of secondary importance. It is intended for use as protection against anti-tank land mines, hand grenades, bursting shells, and other blast-producing weapons.

6.1.3 Class 3. Class 3 wrought armor is intended for use in the proof and acceptance testing of armor defeating ammunition. This class is not intended for use in combat vehicles. Lift hole requirements for class 3 armor should be specified by the procuring activity.

6.1.4 Class 4. Provision for this new class 4 type of armor plate is the result of an Army Research Laboratory (ARL) Research & Development (R&D) Program. The information related to this study was published in a Technical Report, ARL-TR-1347 dated April 1997, entitled Improved Rolled Homogeneous Armor (IRHA) Steel Through Higher Hardness. Copies of this report are published as ADA 329222 and are available from the Defense Technical Information Center (DTIC), Suite 0944, 8725 John J. Kingman Road, Fort Belvoir, VA 22060-6218. The R&D study illustrated enhanced ballistic performance with the use of increased hardness levels for maintaining tougher and more ductile characteristics. This new classification was developed to use in combat vehicles (3/4 inches to 6 inches) and tank construction. Class 4 material provides

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higher ballistic protection than class 1 material against conventional hard steel core AP projectiles, such as, the 0.50 cal, M2 AP. Class 4 material also provides greater ballistic protection than class 1 material against very hard and brittle tungsten carbide penetrators, such as, the 20 mm M602 APIT. In semi-infinite or appliqué-type armor configurations, class 4 material erodes heavy metal (DU or tungsten alloys) long-rod penetrators more efficiently than class 1 material. Approximately 22% and 14% less penetration was observed on this class 4 armor at HRc 48 (BHN 451) and HRc 40 (BHN 371), respectively in the ARL R&D study.

## 6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. Class of steel.
- c. If first article sample is required (see 3.1).
- d. If local or general heating is permitted (see 3.2.4.1).
- e. If weld repairing is permitted (see 3.2.4.2).
- f. Dimensional requirements (see 3.2.7).
- g. First article tests (see 4.1.2).
- h. When a special first article ballistic test is required (see 3.1, 4.1.3 and 6.11).
- i. If ballistic test plates may be separately heat treated from the production plates it represents, (see 4.3.1).
- j. If ballistic acceptance samples should be other than in 4.4.2.5.
- k. If ultrasonic examination is to be different than 4.6.5.2.
- l. If certification of inspection personnel is different from 4.6.5.3.
- m. If rejection and retesting differs from 4.6.7.
- n. The reduced testing plan when applicable (see 4.6.8).
- o. Preparation for delivery if different than specified in section 5.
- p. If lifting holes are required (see 6.1.3).

6.2.2 Associated Data Item Descriptions (DIDs). This specification has been assigned an Acquisition Management Systems Control number authorizing it as the source document for the following DIDs. When it is necessary to obtain data, the applicable DIDs must be listed on the Contract Data Requirements List (DD Form 1423).

<u>DID Number</u>	<u>DID Title</u>
UDI-T-23790	Report, First Article Test
UDI-T-23264	Certification Data Report
DI-MISC-80073	Armor Material Test Reports

The above DIDs were current as of the date of this standard. The ASSIST database should be researched at <http://assist.daps.dla.mil/quicksearch/> or <http://assist.daps.dla.mil/> to ensure that only current and approved DIDs are cited on the DD Form 1423.

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6.3 Thickness. The symbol “T” is used throughout this specification to indicate the nominal thickness of the plate under consideration.

6.4 Definitions.

6.4.1 Contractor. The contractor or prime contractor is the company which has a direct contract from the Government to furnish an end item, usually a vehicle.

6.4.2 Contracting officer. The term “contracting officer” means the person executing a contract on behalf of the Government and any other officer or civilian employee who is properly designated contracting officer; and the term includes, except as otherwise provided, the authorized representative of a contracting officer acting within the limits of his authority.

6.4.3 Homogeneous rolled armor. Homogeneous rolled armor is armor having uniform composition heat treatment.

6.4.4 Manufacturer. The manufacturer is defined as the company producing the steel alloy plate.

6.4.5 Procuring activity. The term “procuring activity” is that activity of the Government which actually initiates the request for procurement and maintains the records of the procurement.

6.4.6 Slivers. An imperfection consisting of a very thin elongated piece of metal attached by only one end to the parent metal into whose surface it has been worked.

6.4.7 Laps. A surface imperfection with appearance of a seam caused by hot metal, fins or sharp corners being folded over and thus being forged or rolled into the surface but without being welded.

6.4.8 Checks. Numerous very fine cracks at the surface of a metal part. Checks may appear during processing or during service and are most often associated with thermal cycling or thermal treatment. Also called check marks, checking, and heat checks.

6.4.9 Seams. An unwelded fold or lap that appears as a crack, usually resulting from a discontinuity on a metal surface.

6.4.10 Blisters. A raised area, often dome shaped, resulting from delamination under pressure of expanding gas trapped in a metal in a near sub-surface zone. Very small blisters may be called pinhead blisters or pepper blisters.

6.4.11 Snakes. Any crooked surface imperfection in a metal plate, resembling a snake.

6.4.12 Cold shuts. Freezing of the top surface of an ingot before mold is full.

6.4.13 Burning. Permanently damaged metal due to overheating enough to cause incipient melting or intergranular oxidations. Note: this condition is usually obscured by normal cleaning

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methods and would require deep pickling and/or metallography to note the continuous oxidation (chicken wire effect) of the enlarged grain boundaries.

6.4.14 Lamination. A type of discontinuity with separation or weakness generally aligned parallel to direction of the worked surface of the metal and may be the result of pipe, blisters, seams, inclusions, or segregation; elongated and made directional by working.

6.4.15 Pit. A cavity or depressed area on the surface of a plate.

6.4.16 Linear indication. For nondestructive examination purposes, a linear indication is evidence of a discontinuity that requires interpretation to determine its significance.

6.5 Changes in composition. Changes in composition may not necessarily be cause for retesting but should be subject to review by the procuring activity to determine whether additional first article testing is required.

6.6 Chemical analysis. Suggested ASTM instrumental methods that can be used for chemical analysis are E322 and E415. ASTM A751 should be consulted for a complete list of methods.

6.7 MIL-STD-367. DELETED.

6.7 Production plates. Material made to this specification has tendency to develop stress cracks if not tempered as soon as possible after austenitizing treatment. To avoid this situation, all plates should be left in the hot rolled or tempered condition while waiting for the ballistic test results.

6.8 Potential suppliers. Potential suppliers who have not previously supplied armor plate to MIL-A-12560 and wish to have their material ballistic tested may do so at their own expense. It is recommended that inquiries for such testing be directed to Commander, US Army CSTA, ATTN: STECS-LI-A, Aberdeen Proving Ground, MD 21005-5059.

6.9 New contracts sponsored by Government agencies. At the time that a new contract is initiated for the production of combat vehicles, the contractor's supplier is to estimate the number, size and delivery schedule of the ballistic test plates which are to be submitted for first article or acceptance testing. A lead time of 60 days after the contract has been signed is to be allowed prior to shipment of the first ballistic test plate(s) to APG to insure that all administrative functions for the establishment of a new TECOM project have been completed in preparation for the test. The contracting government agency is to initiate the new project through a letter to Commander, US Army TECOM, ATTN: AMSTE-TA-O, APG, MD 21005-5055 requesting a cost estimate for the ballistic testing of the applicable number of sizes of plates. In the case of increases in scope of existing projects, similar correspondence is needed.

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

To go from <u>English</u>	Multiply by	To get <u>Metric SI unit</u>
inch	0.0254	meter (m)
foot	0.3048	meter (m)
foot-lb	1.3558	joule (J)
feet/sec	0.3048	meter per second (m/s)

Note: Conversion factors can be associated with ASTM E380 entitled "Metric Practice Guide"

6.11 Special first article ballistic test. Special first article ballistic tests are required when the manufacturer changes either the melting procedure or heat treatment or the declared chemistry of the armor.

6.12 Fabrication. The armor plate covered by this specification is subject to fabrication involving cutting, drilling, forming and welding. It is intended that selection and control of chemical composition, cleanliness, and plate processing should be such that the armor will be suitable for fabrication in accordance with TACOM code 12479550, TACOM Ground Combat Vehicle Welding Code-Steel. Copies of this document are available from U.S. Army Tank-Automotive and Armaments Command, Warren, MI 48397-6000.

6.13 Subject term (key word) listing.

Ballistic limit  
Combat vehicles  
M2 projectile  
M70 projectile  
M82 projectile  
M318 projectile  
M602 projectile

6.14 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.



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APPENDIX A

BALLISTIC TESTING OF ARMOR, STEEL PLATE, WROUGHT, HOMOGENEOUS

A.1 SCOPE

A.1.1 This appendix covers the requirements for ballistic testing of wrought homogeneous steel armor plate.

A.2 DEFINITIONS

A.2.1 Fair impact.

A.2.1.1 Caliber .30 AP through 20 mm tests. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no excessive yawing or tumbling) and separated from another impact or the edge of the plate, hole, crack or spalled area by an undisturbed area at least two test projectile diameters.

A.2.1.2 57 mm AP and larger calibers. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no yawing or tumbling) and separated from another impact or from the edge of plate, hole, crack or spalled area by at least one test projectile diameter of undisturbed area.

A.2.2 Witness plate. A witness plate is normally a 0.014 inch thick sheet of 5052 aluminum alloy (or a 0.020 inch thick sheet of 2024-T3 aluminum alloy placed 6 inches (+ 1/2 inch) behind and parallel to the test plates or other ballistic sample.

A.2.3 Complete penetration, protection, CP (P).

A.2.3.1 For caliber .30 M2 AP through 20 mm M602 APIT. A protection complete penetration occurs when the projectile or one or more fragments of a projectile or plate pass beyond the back of the test plate and perforates the witness plate.

A.2.3.2 For projectiles larger than 20 mm. A protection complete penetration occurs when one or more fragments of a projectile or plate has been ejected from the rear of the plate as determined by visual inspection.

A.2.4 Partial penetration, protection, PP (PI). A partial penetration is any impact that is not a complete penetration.

A.2.5 Gap. The difference in velocity between the high partial penetration velocity and the low complete penetration velocity used in computing the ballistic limit where the high partial penetration velocity is lower than the low complete penetration velocity.



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A.2.6 Protection ballistic limit, BL (P).

A.2.6.1 Caliber .30 M2 AP caliber .50 M2 AP, 20 mm M602 APIT penetration tests. 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 90 ft/sec 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.2.6.1.1 Difference between the high partial penetration velocity and the low complete penetration. 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 ft/sec, 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 ten round ballistic limit has been attained using the smallest possible velocity spread.

A.2.6.2 57 mm M70 AP and larger caliber projectiles. For the purpose of this specification, the protection ballistic limit is the average of four fair protection criteria impact velocities comprising the first two lowest velocities in the firing order resulting in complete penetrations and the first two highest velocities in the firing order resulting in partial penetrations which meet the condition that the velocity spread for the 4 rounds shall not exceed 100 ft/sec.

A.2.6.3 Reduction of large velocity gap in borderline cases. If the ballistic limit which has been determined is within  $\pm 10$  ft/sec from the minimum allowable ballistic limit and a gap exists which is greater than 25 ft/sec, then another round, or rounds, shall be fired to reduce the gap to 25 ft/sec or less. The ballistic limit shall then be recomputed using the criteria of paragraphs A.2.6.1 or A.2.6.2 as applicable. 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 shall result in a better evaluation of the BL (P).

A.3 REQUIREMENTS

A.3.1 Resistance to penetration. The minimum acceptable ballistic limits shall be in accordance with the values shown in tables X through XVII.

A.3.1.1 Class 3 armor plate. For class 3 armor plate, upper ballistic limit (maximum) values shall be as specified in the applicable footnotes of tables X through XVII.

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A.3.2 Back spalling.

A.3.2.1 Plates 1/2 to 11/16 inch in thickness. Plates of these ordered thicknesses shall be subjected to a back spall test consisting of firing two rounds of 20 mm M95 AP ammunition at a 0° obliquity at the test plate, the striking velocity shall be in the velocity range of 2500-2550 ft/sec. The maximum allowable back spall dimension shall be 1 5/8 inches.

A.3.2.2 Plates 3/4 inch and greater in thickness. Spalling shall not exceed 2.0 test projectile diameters after proof firing at normal obliquity in accordance with the appropriate table of the appendix, and shall not exceed 2.5 test projectile diameters in the case of oblique penetration tests.

A.3.3 Cracking.

A.3.3.1 0° obliquity attack. Immediately after ballistic testing, plates subject to oblique attack shall not develop any crack which, when measured from the center of impact, extends outside a circle having a radius equivalent to twice the test projectile diameter.

A.3.3.2 Oblique attack. Immediately after ballistic testing, plates subjected to 0° obliquity attack shall not develop any crack which when measured from the center of impact, extends outside a circle having a radius equivalent to twice the test projectile diameters.

A.3.4 Rejection. Failure to meet any of the above requirements shall be cause for plate rejection.

A.4 TESTS

A.4.1 Ballistic tests. V<sub>50</sub> ballistic tests shall be performed in accordance with USATECOM TOP 2-2-710, Ballistic Tests of Armor Materials to determine compliance with the requirements of tables X through XVII.

A.4.1.1 Plate thickness. Plate thickness as measured by the ballistic test agency shall be used to determine the required ballistic limit of the plate. The required ballistic limit shall be determined by interpolation of the tables in the appendix, if necessary.

A.4.1.2 Lift hole requirement for test plates.

A.4.1.2.1 Ballistic acceptance testing plates.

- a. Ballistic acceptance test plates for either class 1 or armor which are less than 2.751 inches ordered thickness are to be supplied without a lifting hole.
- b. Ballistic acceptance test plates for either class 1 or 3 armor which are 2.751 inches through 6.25 inches thick shall be provided with 3-inch diameter lifting holes, one in each of two adjacent sides as shown in figure 1.

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A.4.1.3 Rejection and retest of ballistic plates.

A.4.1.3.1 First article tests (rejection). Unless noted otherwise in the contract or order, failure of any one or more of the three first article test plates to meet the minimum ballistic requirements as specified in the appendix to the specification indicates failure of the products and process.

A.4.1.3.2 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. Three retest plates shall be submitted for first article testing and all three shall pass.

A.4.1.3.3 Acceptance tests (rejection). Unless otherwise noted in the contract or order, failure of a test plate to meet the ballistic requirement indicates failure of the lot; however, the final decision shall depend on the outcome of retests, if submitted.

A.4.1.3.4 Acceptance tests (retests). If a test plate representing a lot fails to meet the ballistic requirement, the manufacturer has the following options: Immediately upon notification of the failure:

- (1) At manufacturer's expense submit two additional test plates from the same lot for ballistic retest, or
- (2) First re-heat treat (quenching and tempering) the lot and then submit a test plate from the re-treated lot, or
- (3) Scrap the lot and submit a plate representing a new lot for acceptance.

If the manufacturer chooses any one of these options and the ballistic retest plate (or plates) meet the requirements then the lot represented is acceptable. If he chooses option (1) and one or both the retest plates fail, the manufacturer shall re-heat treat the lot and submit a test plate from the re-treated lot. If this plate fails the lot is rejected. If the manufacturer chooses option (3) and the test plate fails, the manufacturer shall again resort to any one of the three options.

A.4.1.4 Disposition of ballistic test plates.

A.4.1.4.1 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 the applicant's expense, unless the plates were destroyed in testing.

A.4.1.4.2 Acceptance test plates. Acceptance test plates that comply with the requirements of this specification are considered as part of the lot of steel they represent and ownership of them 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 as part of the lot they represent and remain the property of the producer just as the rejectable lot does. The failed plates shall be returned, upon request, as in A.4.1.4.1

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TABLE A-X. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: caliber .30 M2 AP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.230	1509	0.355	1994	0.480	2385
0.235	1532	0.360	2011	0.485	2400
0.240	1554	0.365	2028	0.490	2414
0.245	1575	0.370	2045	0.495	2428
<u>1/</u> 0.250	1596	0.375	2062	0.500	2442
0.255	1618	0.380	2078	0.505	2456
0.260	1638	0.385	2095	0.510	2470
0.265	1659	0.390	2111	0.515	2484
0.270	1679	0.395	2127	0.520	2498
0.275	1699	0.400	2143	0.525	2512
0.280	1719	0.405	2159	0.530	2525
0.285	1739	0.410	2175	0.535	2539
0.290	1758	0.415	2191	0.540	2552
0.295	1778	0.420	2206	0.545	2566
0.300	1797	0.425	2222	0.550	2579
0.305	1815	0.430	2237	0.555	2593
0.310	1834	0.435	2252	0.560	2606
0.315	1853	0.440	2267	<u>2/</u> 0.565	2619
0.320	1871	0.445	2282	0.570	2632
0.325	1889	0.450	2297	0.575	2645
0.330	1907	0.455	2312	0.580	2658
0.335	1925	0.460	2327	0.585	2671
0.340	1942	0.465	2342	0.590	2684
0.345	1960	0.470	2356	0.595	2697
0.350	1977	0.475	2371	0.600	2710

1/ Specification requirements begin for this ordered thickness

2/ Specification requirements end for this ordered thickness.

Note 1: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

Note 2: For class 3 armor the upper ballistic limit (maximum) shall not be greater than 141 ft/sec above the required lower ballistic limit (minimum).

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TABLE A-XI. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: caliber .50 M2 AP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
0.550	1901	0.765	2305	0.985	2658
0.555	1911	0.770	2314	0.990	2665
0.560	1922	0.775	2322	0.995	2673
0.565	1932	0.780	2331	1.000	2680
<u>1/</u> 0.566	1934	0.785	2339	1.005	2688
0.570	1942	0.790	2348	1.010	2695
0.575	1952	0.795	2356	1.015	2702
0.580	1962	0.800	2365	1.020	2710
0.585	1972	0.805	2373	1.025	2717
0.590	1982	0.810	2382	1.030	2724
0.595	1992	0.815	2390	1.035	2732
0.600	2002	0.820	2398	1.040	2739
0.605	2012	0.825	2406	1.045	2746
0.610	2022	0.830	2415	1.050	2754
0.615	2031	0.835	2423	1.055	2761
0.620	2041	0.840	2431	1.060	2768
0.625	2051	0.845	2439	1.065	2775
0.630	2060	0.850	2447	1.070	2782
0.635	2070	0.855	2455	1.075	2790
0.640	2079	0.860	2464	1.080	2797
0.645	2089	0.865	2472	1.085	2804
0.650	2098	0.870	2480	1.090	2811
0.655	2108	0.875	2488	1.095	2818
0.660	2117	0.880	2496	1.100	2825
0.665	2126	0.885	2504	1.105	2832
0.670	2136	0.890	2511	1.110	2839
0.675	2145	0.895	2519	1.115	2846
0.680	2154	0.900	2527	1.120	2853
0.685	2163	0.905	2535	<u>2/</u> 1.125	2860
0.690	2173	0.910	2543	1.130	2867
0.695	2182	0.915	2551	1.135	2874
0.700	2191	0.920	2559	1.140	2881
0.705	2200	0.925	2566	1.145	2888
0.710	2209	0.930	2574	1.150	2895
0.715	2218	0.935	2582	1.155	2902
0.720	2227	0.940	2590	1.160	2909
0.725	2235	0.945	2597	1.165	2915
0.730	2244	0.950	2605	1.170	2922

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TABLE A-XI. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: caliber .50 M2 AP- Continued.

0.735	2253	0.955	2612	1.175	2929
0.740	2262	0.960	2620	1.180	2936
0.745	2271	0.965	2628	1.185	2943
0.750	2279	0.970	2635	1.190	2949
0.755	2288	0.975	2643	1.195	2956
0.760	2297	0.980	2650	1.200	2963

1/ Specification requirements begin for this ordered thickness

2/ Specification requirements end for this ordered thickness.

Note 1: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

Note 2: For class 3 armor the upper ballistic limit (maximum) shall not be greater than 146 ft/sec above the required lower ballistic limit (minimum).

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TABLE A-XII. Minimum required ballistic limits (protection criteria) firing obliquity: 0°, projectile: caliber 20 mm M602 APIT.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
1.100	1933	1.370	2234	1.650	2505
1.110	1945	1.380	2244	1.660	2514
1.120	1957	1.390	2254	1.670	2524
<u>1/</u> 1.126	1964	1.400	2265	1.680	2533
1.130	1969	1.410	2275	1.690	2542
1.140	1981	1.420	2285	1.700	2551
1.150	1993	1.430	2295	1.710	2560
1.160	2004	1.440	2305	1.720	2568
1.170	2016	1.450	2315	1.730	2586
1.180	2027	1.460	2325	1.740	2595
1.190	2039	1.470	2335	1.750	2604
1.200	2050	1.480	2344	1.760	2613
1.210	2061	1.490	2354	1.770	2613
1.220	2073	1.500	2364	1.780	2621
1.230	2084	1.510	2374	1.790	2630
1.240	2095	1.520	2383	1.800	2639
1.250	2106	1.530	2393	1.810	2647
1.260	2117	1.540	2403	1.820	2656
1.270	2128	1.550	2412	1.830	2664
1.280	2139	1.560	2422	1.840	2673
1.290	2149	1.570	2431	1.850	2681
1.300	2160	1.580	2440	1.860	2690
1.310	2171	1.590	2450	1.870	2698
1.320	2181	1.600	2459	1.880	2707
1.330	2192	1.610	2468	1.890	2715
1.340	2203	1.620	2478	1.900	2723
1.350	2213	1.630	2487	1.910	2732
1.360	2223	1.640	2496	1.920	2740

1/ Specification requirements begin for this ordered thickness.

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

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TABLE A-XII. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: caliber 20 mm M602 APIT - Continued.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
1.930	2748	2.250	3000	2.570	3231
1.940	2757	2.260	3008	2.580	3238
1.950	2765	2.270	3015	2.590	3245
1.960	2773	2.280	3023	2.600	3252
1.970	2781	2.290	3030	2.610	3259
1.980	2789	2.300	3038	2.620	3265
1.990	2798	2.310	3045	2.630	3272
2.000	2806	2.320	3052	2.640	3279
2.010	2814	2.330	3060	2.650	3286
2.020	2822	2.340	3067	2.660	3293
2.030	2830	2.350	3075	2.670	3299
2.040	3838	2.360	3082	2.680	3306
2.050	3846	2.370	3089	2.690	3313
2.060	2854	2.380	3096	2.700	3320
2.070	2862	2.390	3104	2.710	3326
2.080	2870	2.400	3111	2.720	3333
2.090	2877	2.410	3118	2.730	3340
2.100	2885	2.420	3125	2.740	3346
2.110	2893	2.430	3132	<u>2/</u> 2.750	3353
2.120	2901	2.440	3140	2.760	3360
2.130	2909	2.450	3147	2.770	3366
2.140	2916	2.460	3154	2.780	3373
2.150	2924	2.470	3161	2.790	3380
2.160	2932	2.480	3168	2.800	3386
2.170	2940	2.490	3175	2.810	3393
2.180	2947	2.500	3182		
2.190	2955	2.510	3189		
2.200	2963	2.520	3196		
2.210	2970	2.530	3203		
2.220	2978	2.540	3210		
2.230	2985	2.550	3217		
2.240	2993	2.560	3224		

2/ Specification requirements end for this ordered thickness.

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



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TABLE A-XIIA. Upper ballistic limits for class 3 armor, firing obliquity: 0°, projectile: 20 mm M602 APIT.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
1.100	2042	1.490	2501	1.890	2902
1.110	2055	1.500	2512	1.900	2911
1.120	2068	1.510	2523	1.910	2921
1/ 1.126	2076	1.520	2534	1.920	2930
1.130	2081	1.530	2544	1.930	2939
1.140	2094	1.540	2555	1.940	2948
1.150	2106	1.550	2565	1.950	2958
1.160	2119	1.560	2576	1.960	2967
1.170	2131	1.570	2586	1.970	2976
1.180	2144	1.580	2597	1.980	2985
1.190	2156	1.590	2607	1.990	2994
1.200	2169	1.600	2617	2.000	3003
1.210	2181	1.610	2628	2.010	3012
1.220	2193	1.620	2638	2.020	3021
1.230	2205	1.630	2648	2.030	3030
1.240	2217	1.640	2658	2.040	3039
1.250	2229	1.650	2668	2.050	3048
1.260	2241	1.660	2678	2.060	3057
1.270	2253	1.670	2689	2.070	3066
1.280	2265	1.680	2699	2.080	3075
1.290	2277	1.690	2709	2.090	3084
1.300	2289	1.700	2719	2.100	3093
1.310	2300	1.710	2728	2.110	3102
1.320	2312	1.720	2738	2.120	3110
1.330	2323	1.730	2748	2.130	3119
1.340	2335	1.740	2758	2.140	3128
1.350	2346	1.750	2768	2.150	3137
1.360	2358	1.760	2778	2.160	3145
1.370	2369	1.770	2787	2.170	3154
1.380	2380	1.780	2797	2.180	3163
1.390	2392	1.790	2807	2.190	3171
1.400	2403	1.800	2816	2.200	3180
1.410	2414	1.810	2826	2.210	3188
1.420	2425	1.820	2836	2.220	3197
1.430	2436	1.830	2845	2.230	3206
1.440	2447	1.840	2855	2.240	3214
2.450	2458	1.850	2864	2.250	3223
2.460	2469	1.860	2874	2.260	3231

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TABLE A-XIIA. Upper ballistic limits for class 3 armor, firing obliquity: 0°, projectile: 20 mm M602 APIT – Continued.

2.470	2480	1.870	2883	2.270	3240
2.480	2491	1.880	2892	2.280	3248

1/ Specification requirements begin for this ordered thickness.

TABLE A-XIIA. Upper ballistic limits for class 3 armor, firing obliquity: 0°, projectile: 20 mm M602 APIT – Continued.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
2.290	3257	2.470	3405	2.650	3548
2.300	3265	2.480	3413	2.660	3556
2.310	3273	2.490	3421	2.670	3563
2.320	3282	2.500	3429	2.680	3571
2.330	3290	2.510	3437	2.690	3579
2.340	3298	2.520	3445	2.700	3586
2.350	3307	2.530	3453	2.710	3594
2.360	3315	2.540	3461	2.720	3602
2.370	3323	2.550	3469	2.730	3610
2.380	3331	2.560	3477	2.740	3617
2.390	3340	2.570	3485	<u>2</u> / 2.750	3625
2.400	3348	2.580	3493	2.760	3632
2.410	3356	2.590	3501	2.770	3640
2.420	3364	2.600	3509	2.780	3648
2.430	3372	2.610	3516	2.790	3655
2.440	3381	2.620	3524	2.800	3663
2.450	3389	2.630	3532	2.810	3670
2.460	3397	2.640	3540		

2/ Specification requirements end for this ordered thickness.

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TABLE A-XIII. Minimum required ballistic limits (protection criteria), firing obliquity: 45°, projectile: caliber 90 mm M82 APC.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
2.700	2095	2.980	2260	3.270	2420
2.710	2101	2.990	2265	3.280	2425
2.720	2107	3.000	2271	3.290	2430
2.730	2113	3.010	2277	3.300	2436
2.740	2119	3.020	2282	3.310	2441
2.750	2125	3.030	2288	3.320	2446
<u>1/</u> 2.751	2126	3.040	2294	3.330	2451
2.760	2131	3.050	2299	3.340	2457
2.770	2137	3.060	2305	3.350	2462
2.780	2143	3.070	2310	3.360	2467
2.790	2149	3.080	2316	3.370	2472
2.800	2155	3.090	2322	3.380	2478
2.810	2161	3.100	2327	3.390	2483
2.820	2167	3.110	2333	3.400	2488
2.830	2173	3.120	2338	3.410	2493
2.840	2179	3.130	2344	3.420	2498
2.850	2185	3.140	2349	3.430	2404
2.860	2190	3.150	2355	3.440	2509
2.870	2196	3.160	2360	3.450	2514
2.880	2202	3.170	2366	3.460	2519
2.890	2208	3.180	2371	3.470	2524
2.900	2214	3.190	2376	3.480	2529
2.910	2220	3.200	2382	3.490	2534
2.920	2225	3.210	2387	<u>2/</u> 3.500	2540
2.930	2231	3.220	2393	3.510	2545
2.940	2237	3.230	2398	3.520	2550
2.950	2243	3.240	2404	3.530	2555
2.960	2248	3.250	2409	3.540	2560
2.970	2254	3.260	2414	3.550	2565
				3.560	2570

1/ Specification requirements begin at 2.751 inches ordered thickness.

2/ Specification requirements end at 3.500 inches ordered thickness.

NOTE: For class 3 armor the upper ballistic limit (maximum) shall not be greater than 293 ft/sec above the required lower ballistic limit (minimum).

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TABLE A-XIV. Minimum required ballistic limits (protection criteria), firing obliquity: 30°, projectile: 90 mm M82 APC.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
3.425	1924	3.620	2007	3.820	2089
3.430	1926	3.625	2009	3.825	2091
3.435	1929	3.630	2011	3.830	2093
3.440	1931	3.635	2013	3.835	2095
3.445	1933	3.640	2015	3.840	2097
3.450	1935	3.645	2018	3.845	2099
3.455	1937	3.650	2020	3.850	2101
3.460	1939	3.655	2022	3.855	2103
3.465	1942	3.660	2024	3.860	2105
3.470	1944	3.665	2026	3.865	2107
3.475	1946	3.670	2028	3.870	2109
3.480	1948	3.675	2030	3.875	2111
3.485	1950	3.680	2032	3.880	2113
3.490	1952	3.685	2034	3.885	2115
3.495	1954	3.690	2036	3.890	2117
3.500	1957	3.695	2038	3.895	2119
*3.501	1957	3.700	2040	3.900	2121
3.505	1959	3.705	2042	3.905	2123
3.510	1961	3.710	2044	3.910	2125
3.515	1963	3.715	2046	3.915	2127
3.520	1965	3.720	2048	3.920	2129
3.525	1967	3.725	2051	3.925	2131
3.530	1969	3.730	2053	3.930	2133
3.535	1971	3.735	2055	3.935	2135
3.540	1974	3.740	2057	3.940	2137
3.545	1976	3.745	2069	3.945	2139
3.550	1978	3.750	2061	3.950	2141
3.555	1980	3.755	2063	3.955	2143
3.560	1982	3.760	2065	3.960	2144
3.565	1984	3.765	2067	3.965	2146
3.570	1986	3.770	2069	3.970	2148
3.575	1988	3.775	2071	3.975	2150
3.580	1990	3.780	2073	3.980	2152
3.585	1993	3.785	2075	3.985	2154
3.590	1995	3.790	2077	3.990	2156
3.595	1997	3.795	2079	3.995	2158
3.600	1999	3.800	2081	<u>2/</u> 3.999	2160
3.605	2001	3.805	2083	4.000	2160

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TABLE A-XIV. Minimum required ballistic limits (protection criteria), firing obliquity: 30°, projectile: 90 mm M82 APC – Continued.

3.610	2003	3.810	2085	4.005	2162
3.615	2005	3.815	2087	4.010	2164
4.015	2166	4.035	2174	4.055	2181
4.020	2168	4.040	2176	4.060	2183
4.025	2170	4.045	2178	4.065	2185
4.030	2172	4.050	2179	4.070	2187

1/ Specification requirements begin for this ordered thickness.

2/ Specification requirements end for this ordered thickness.

Note 1: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements for undersize or oversize plates.

Note 2: For class 3 armor the upper ballistic limit (5% rejection) shall not be greater than 192 ft/sec above the required lower ballistic limit.

TABLE A-XV. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: 90 mm M318A1 AP.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
3.940	1583	4.340	1725	4.740	1856
3.950	1586	4.350	1728	4.750	1860
3.960	1590	4.360	1731	4.760	1863
3.970	1594	4.370	1735	4.770	1866
3.980	1597	4.380	1738	4.780	1869
3.990	1601	4.390	1742	4.790	1872
<u>1</u> / 4.000	1605	4.400	1745	4.800	1875
4.010	1608	4.410	1748	4.810	1878
4.020	1612	4.420	1752	4.820	1882
4.030	1616	4.430	1755	4.830	1885
4.040	1619	4.440	1758	4.840	1888
4.050	1623	4.450	1762	4.850	1891
4.060	1627	4.460	1765	4.860	1894
4.070	1630	4.470	1768	4.870	1897
4.080	1634	4.480	1772	4.880	1900
4.090	1637	4.490	1775	4.890	1903
4.100	1641	4.500	1778	4.900	1907
4.110	1644	4.510	1782	4.910	1910

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TABLE A-XV. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

4.120	1648	4.520	1788	4.920	1913
4.130	1652	4.530	1792	4.930	1916
4.140	1655	4.540	1795	4.940	1919
4.150	1659	4.550	1798	4.950	1922
4.160	1662	4.560	1783	4.960	1925
4.170	1666	4.570	1801	4.970	1928
4.180	1669	4.580	1805	4.980	1931
4.190	1673	4.590	1808	4.990	1934
4.200	1676	4.600	1811	5.000	1937
4.210	1680	4.610	1815	4.010	1940
4.220	1683	4.620	1818	5.020	1943
4.230	1687	4.630	1821	5.030	1946
4.240	1690	4.640	1824	5.040	1950
4.250	1694	4.650	1827	5.050	1953
4.260	1697	4.660	1831	5.060	1956
4.270	1701	4.670	1834	5.070	1959
4.280	1704	4.680	1837	5.080	1962
4.290	1708	4.690	1840	5.090	1965
4.300	1711	4.700	1844	5.110	1968
4.310	1714	4.710	1847	5.110	1971
4.320	1718	4.720	1850	5.120	1974
4.330	1721	4.730	1853	5.130	1977

1/ Specification requirements begin for this ordered thickness.

TABLE A-XV. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec	Thickness, inches	Required BL(P), ft/sec
5.140	1980	5.530	2093	5.920	2201
5.150	1983	5.540	2096	5.930	2204
5.160	1986	5.550	2099	5.940	2207
5.170	1989	5.560	2102	5.950	2209
5.180	1992	5.570	2105	5.960	2212
5.190	1995	5.580	2107	5.970	2215
5.200	1998	5.590	2110	5.980	2217
5.210	2001	5.600	2113	5.990	2220
5.220	2003	5.610	2116	6.000	2223

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TABLE A-XV. Minimum required ballistic limits (protection criteria), firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

5.230	2006	5.620	2119	6.010	2226
5.240	2009	5.630	2121	6.020	2228
5.250	2012	5.640	2124	6.030	2231
5.260	2015	5.650	2127	6.040	2234
5.270	2018	5.660	2130	6.050	2236
5.280	2021	5.670	2133	6.060	2239
5.290	2024	5.680	2135	6.070	2242
5.300	2027	5.690	2138	6.080	2244
5.310	2030	5.700	2141	6.090	2247
5.320	2033	5.710	2144	6.100	2249
5.330	2036	5.720	2147	6.110	2252
5.340	2039	5.730	2149	6.120	2255
5.350	2042	5.740	2152	6.130	2257
5.360	2045	5.750	2155	6.140	2260
5.370	2047	5.760	2158	6.150	2263
5.380	2050	5.770	2160	6.160	2265
5.390	2053	5.780	2163	6.170	2268
5.400	2056	5.790	2166	6.180	2272
5.410	2059	5.800	2169	6.190	2273
5.420	2062	5.810	2171	6.200	2276
5.430	2065	5.820	2174	6.210	2278
5.440	2068	5.830	2177	6.220	2281
5.450	2070	5.840	2180	6.230	2284
5.460	2073	5.850	2182	6.240	2286
5.470	2076	5.860	2185	<u>2/</u> 6.250	2289
5.480	2079	5.870	2188	6.260	2291
5.490	2082	5.880	2190	6.270	2294
5.500	2085	5.890	2193	6.280	2297
5.510	2088	5.900	2196	6.290	2299
5.520	2090	5.910	2199	6.300	2302

2/ Specification requirements end for this ordered thickness.

Note 1: Tabulated values on either side of the specification requirements are for interpolation of BL(P) requirements on undersize or oversize plates.

Note 2: For class 3 armor the upper ballistic limit (5% rejection) shall not be greater than 202 ft/sec above the required lower limit (minimum).

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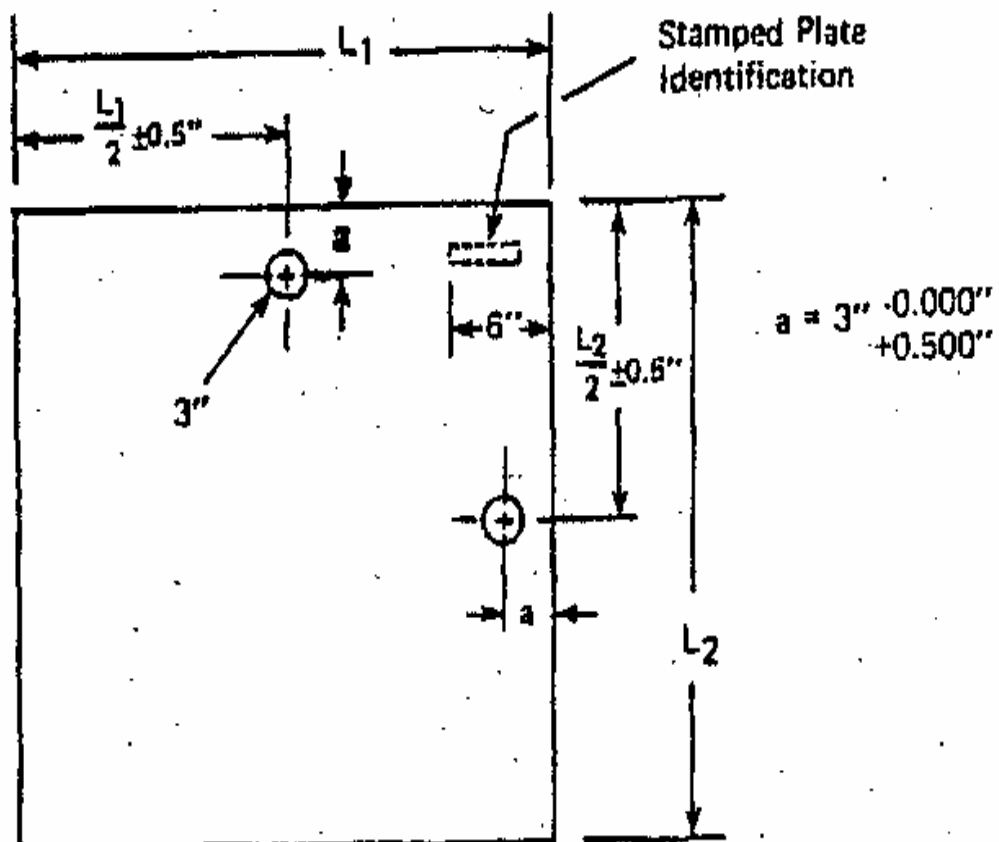


FIGURE 1. Lifting holes for ballistic acceptance test plates 2.751 through 6.25 inches thick.



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CONCLUDING MATERIAL

Custodian:  
Army - MR

Preparing activity:  
Army - MR

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

Project 9515-2007-005

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 <http://assist.daps.dla.mil/>.