

INCH-POUND

MIL-DTL-32332A (MR)
28 November 2018
SUPERSEDING
MIL-DTL-32332 (MR)
24 July 2009

DETAIL SPECIFICATION

ARMOR PLATE, STEEL, WROUGHT, ULTRA-HIGH-HARDNESS

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 quenched or quenched and tempered ultra-high-hardness (UHA) wrought steel armor plate for lightweight armor applications for ordered thicknesses from 0.098 inches (2.5 mm) up to an ordered thickness of 0.630 inches (16 mm), inclusive (see 6.1, 6.2, and 6.3). The major intent of UHA is an armor appliqué.

1.2 Classification. Wrought armor should be of the following classes as specified (see 6.2).

1.2.1 Class 1. Wrought armor plate which is designed for better resistance to penetration than MIL-DTL-46100 (see 6.1.1).

1.2.2 Class 2. Wrought armor plate which is designed for better resistance to penetration than Class 1 (see 6.1.2).

Comments, suggestions, or questions on this document should be addressed to: Director, U.S. Army Research Laboratory, Weapons and Materials Research Directorate, Specifications and Standards Office, Attn: RDRL-WMM-C, Aberdeen Proving Ground, MD 21005-5069. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil/>.

AMSC N/A

FSC 9515

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 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 and 4 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-129 - Military Marking for Shipment and Storage

(Copies of this document are available online at <https://quicksearch.dla.mil/>.)

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.

USADTC TOP 2-2-710 - Ballistic Tests of Armor Materials
ITOP 2-2-713 - Ballistic Testing of Armor

(Copies of these documents are available online at <http://www.dtic.mil/>.)

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

AMERICAN SOCIETY OF NONDESTRUCTIVE TESTING

ANSI/ASNT CP-189-2016 - ASNT Standard for Qualification and
Certification of Nondestructive Testing
Personnel

(Copies of this document are available online at <https://www.asnt.org/store>.)

ASTM INTERNATIONAL

ASTM A6/A6M - Standard Specification for General Requirements
for Rolled Structural Steel Bars, Plates, Shapes
and Sheet Piling

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ASTM A370	-	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A578/ A578M	-	Standard Specification for Straight-Beam Ultrasonic Examination of Rolled 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
ASTM E350	-	Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
ASTM E384	-	Standard Test Method for Microindentation Hardness of Materials

(Copies of these documents are available online at <https://www.astm.org>.)

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, 6.4, and 6.9), a sample or samples of the specified item shall be made available to the contracting officer or their authorized representative for approval in accordance with 4.4. The contractor shall comply with this requirement at the time of their first order or contract and at any time that the supplier has not furnished the same class of ultra high hard armor in the applicable thickness range under this specification within a period of 37 months. 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, namely conformance or production acceptance. The first article samples and test plates shall be manufactured by the process proposed for use on production armor. This process shall be inspected by a cognizant government representative to ensure compliance with the details of this specification. The manufacturer's declared chemical analysis shall be submitted to the contracting agency (or purchasing activity) and to the ballistic test agency. The ballistic test agency shall record the first article ballistic test plates submitted, showing the dates tested. Requests from the procuring

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activity to the ballistic test agency as to prior conformance with first article tests shall be accompanied by copies of the first article test firing records. Any deviation(s) noticed by the ballistic agency shall be brought to the attention of the contracting activity and to the manufacturer. After first article testing has been accepted by the contracting activity, the composition and processing shall be considered fixed. If either of these parameters change outside of the limitations allowed, then a new first article test shall be required.

3.1.1 First time producer. First time producers wishing to qualify to this specification shall follow the instructions of 6.7.

3.2 Production acceptance.

3.2.1 Chemical composition. A declared chemistry shall be submitted to the contracting agency or its authorized representative and to the ballistic test agency. The chemical composition of the declared chemistry shall conform to the requirements of Table I, column A, unless otherwise specified in the contract or purchase order (see 6.2). The chemical composition shall be determined by a product analysis (values shall be listed as weight percent) in accordance with 4.6.1.1 and 4.8.1. The first article samples and the production test plates shall utilize the same declared chemistry within the allowable ranges proposed for use in production. A statement showing the heat analysis of each melt and one product analysis of each lot and complete details of the heat treatment of each lot shall be furnished for the files of the purchaser at no cost. All elements of the chemical composition specified in Table I shall be shown in the statement. This statement shall be attached to the completed Ultra High Hard Armor Test Data Form (see Figure 1).

3.2.2 Carbon equivalence. Carbon equivalence (CE) shall be calculated for each heat per ASTM A6/A6M, i.e.

$$CE = C + [Mn/6] + [(Cr + Mo + V)/5] + [(Ni + Cu)/15]$$

where the elements are expressed in wt%.

There is no limit to CE for steels in this specification, but it shall be reported on the completed Ultra High Hard Armor Test Data Form (see Figure 1).

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. Unless otherwise specified in the contract or purchase order (see 6.2), local or general heating shall not be performed after the final heat treating operation. This does not include preheating for welding or flame cutting, as long as the tempering temperature is not exceeded (see 6.6 and 6.11). Tempering temperature shall be reported on Figure 1.

3.2.3.1 Thermal processing. The material shall be able to withstand thermal processing for preheating, stress relieving or similar operations at a maximum temperature of 350 degrees F without affecting mechanical or ballistic properties.

3.2.4 Condition. Unless otherwise specified in the contract or purchase order (see 6.2), plates shall be in the as-heat treated condition; surfaces shall not be pickled.

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TABLE I. Chemical composition and precision (product analysis).^{4/}

ELEMENT	COLUMN A MAXIMUM LIMIT for FIRST ARTICLE & PRODUCTION CHEMISTRY (WEIGHT PERCENT)	COLUMN B^{5/} ALLOWABLE RANGE for FUTURE PRODUCTION LOTS (WEIGHT PERCENT)
Carbon	0.55	^{3/}
Manganese	NONE REQUIRED, HOWEVER IF: ≤ 1.00 > 1.00	± 0.15 ± 0.20
Phosphorus	0.010 ^{1/}	^{3/}
Sulfur	0.020 ^{1/}	^{3/}
Silicon	NONE REQUIRED, HOWEVER IF: ≤ 0.60 > 0.60 to ≤ 1.00 > 1.00	± 0.10 ± 0.15 ± 0.20
Nickel	NONE REQUIRED ^{2/}	± 0.25
Chromium	NONE REQUIRED, HOWEVER IF: ≤ 1.25 ^{2/} > 1.25	± 0.15 ± 0.25
Molybdenum	NONE REQUIRED, HOWEVER IF: ≤ 0.20 ^{2/} > 0.20	± 0.035 ± 0.075
Vanadium	NONE REQUIRED ^{2/}	± 0.075
Niobium	NONE REQUIRED ^{2/}	± 0.075
Boron	0.003	^{3/}
Copper	0.75 ^{2/}	^{3/}
Nitrogen	0.03 ^{2/}	^{3/}
Titanium	0.10 ^{2/}	^{3/}
Zirconium	0.10 ^{2/}	^{3/}
Aluminum	0.10 ^{2/}	^{3/}

^{1/} Phosphorus and sulfur should be controlled to the lowest attainable levels, but in no case shall the combined phosphorus and sulfur contents exceed 0.020 wt%.

^{2/} When the amount of an element is less than 0.02 wt% the analysis may be reported as [< 0.02 wt%].

^{3/} Product analysis values may not exceed those listed as the maximum limit.

^{4/} Elements not listed in table, but intentionally added, shall be reported.

^{5/} Values are actual tolerance limits NOT percent tolerances. The analysis from the First Article sample is the "Declared Chemistry" which is used to calculate the range.

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REQUEST FOR BALLISTIC TEST OF ULTRA HIGH HARD ARMOR									
SPECIFICATION: MIL-DTL-32332 (MR)			REVISION: A			AMENDMENT:			
FIRING RECORD:			DATE:			TEST CONTRACT NO:			
	PLATE/COIL MELTED		PLATE/COIL ROLLED			PLATE/COIL HEAT TREATED			
Name:									
Address:									
POC:									
Phone No:									
Fax No:									
TEST ITEM IDENTIFICATION:					Ordered Thickness:				
Lot No.: _____		UHA Classification CLASS: _____			Austenizing Temp: _____				
Plate No.:		Carbon Equivalence (CE)			Tempering Temp:				
PURPOSE:	Acceptance	First Article	Development	Reduced Testing					
SAMPLE:	Primary	Retest (Firing Record No. of Failed Sample _____)							
CHEMISTRY ANALYSIS	C	Mn	P	S	Si	Ni	Cr	Mo	V
FIRST ARTICLE RESULTS:									
PRODUCTION RESULTS:									
ACCEPTANCE (Pass / Fail)									
B:	Ti:	Al:	N:	Cu:	Zr:	Nb:			
MECHANICAL PROPERTIES: CHARPY IMPACT @ -40 Degs. F.					Specimen Size: _____				
HARDNESS (HBW)		LT Direction:1: _____ 2: _____ 3: _____			TL Direction:1: _____ 2: _____ 3: _____				
BALLISTIC TEST RESULTS: SEPARATELY HEAT TREATED TEST PLATE : YES _____ NO _____									
Test:				Projectile:					
Obl. (deg)	Actual Thickness (in)		Required V50 (fps)		Actual V50 (fps)		Pass/Fail		
NOTES:									
Lot [met] [failed to meet] the ballistic requirements of specification MIL-DTL-32332A (MR).									
Government Representative			Date		Supplier Representative			Date	

FIGURE 1. Ultra High Hard Armor Test Data Form.

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3.2.5 Processing controls.

3.2.5.1 Requirements of heat treating furnaces. All furnaces that are used to heat treat plates must be thermally surveyed. The initial survey is done once using the thinnest and thickest gage plate. This shall be followed with annual surveys using any gage.

3.2.5.1.1 Thermal survey requirements of heat treating furnaces. Thermal surveys are conducted as follows:

- a. Three contact thermocouples must be used, both edges and in the middle across the width of the plate.
- b. A calibrated recording device and thermocouples must be used.
- c. The test plate is run through the furnace using standard hold times.
- d. Trial starts when plate exits heat-up zones, and ends when plate exits furnace.
- e. Maximum temperature variability when plate is in soaking zones is +/- 25°F for tempering furnaces and +/- 50°F for austenitizing furnaces.

3.2.6 Mechanical properties.

3.2.6.1 Hardness. The surface hardness of each plate, including first article samples, shall be a minimum of HBW 570. The diameters of Brinell hardness impressions on any individual plate shall not vary by more than 0.10 mm (see 4.8.2).

3.2.6.2 Impact resistance. The minimum average Charpy V-notch impact resistance requirement of the armor plate shall be as shown in Table II. The Charpy V-notch specimens shall be obtained in both the TL orientation (i.e., transverse to the major direction of rolling with the notch perpendicular to the plate surface so that the crack shall propagate in the longitudinal direction) and the LT orientation (i.e., parallel to the major direction of rolling).

TABLE II. Minimum Charpy V-notch impact resistance requirements at -40°F ± 2°F.

SPECIMEN ORIENTATION	IMPACT RESISTANCE FOR STANDARD DEPTH SPECIMENS (ft. lbs.)			
	Standard width	3/4 width	1/2 width	1/4 width
Transverse (TL)	6.0	4.5	3.0	1.5
Longitudinal (LT)	7.0	5.25	3.5	1.75

3.2.7 Ballistic requirements. Ballistic requirements shall be in accordance with the Appendix A of this specification.

3.2.7.1 Ballistic test plate information. For each lot of ultra high hard armor plate a properly completed Ultra High Hard Armor Test Data Form (see Figure 1) shall be submitted with each ballistic test plate that represents that particular processing lot. If another form, such as a Material Test Report or a Test Certificate, that contains the same information as in Figure 1, is available, it can be used in combination with Figure 1, unless otherwise specified in the contract or purchase order (see 6.2). This additional form shall be attached to Figure 1 and submitted with each ballistic test plate.

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3.2.8 Dimensions and tolerances.

3.2.8.1 Dimensions. Plates shall comply with the dimensions specified in the applicable drawings or in the contract or purchase order (see 6.2). Unless otherwise specified in the contract or order (see 6.2), dimensional tolerances will be in accordance with ASTM A6/A6M.

3.2.8.2 Thickness. The thickness tolerance of each plate, after final treatment, shall be in accordance with Table III for the thickness specified.

3.2.8.3 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 ASTM A6/A6M for hot rolled or thermally treated plates. Tighter tolerance requirements shall be specified in the contract or purchase order (see 6.2) and shall be as agreed upon between the contractor and the procuring activity.

3.2.8.4 Waviness. Unless otherwise specified in the contract or purchase order (see 6.2), the waviness tolerance of each plate shall be within the requirements of ASTM A6/A6M.

TABLE III. Thickness tolerances for ordered thickness ^{1/}, inches (over and under). ^{2/}

Specified Thickness, inches	Tolerances over and under ordered thickness for widths given, inches						
	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 incl.
0.098	0.012	0.012	0.014	0.014	0.017	---	---
0.1180	0.012	0.012	0.014	0.014	0.017	---	---
0.1250	0.012	0.012	0.014	0.014	0.017	---	---
0.1875	0.012	0.012	0.014	0.014	0.017	---	---
0.2500	0.012	0.012	0.014	0.014	0.017	---	---
0.3125	0.012	0.014	0.014	0.014	0.017	0.02	---
0.3750	0.012	0.014	0.014	0.017	0.017	0.02	---
0.4375	0.012	0.014	0.014	0.017	0.02	0.02	0.023
0.5000	0.012	0.014	0.014	0.017	0.02	0.02	0.023
0.5625	0.014	0.014	0.014	0.017	0.02	0.023	0.023
0.6300	0.014	0.014	0.014	0.017	0.02	0.023	0.023

^{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 tolerance shall apply.

3.2.9 Identification marking. Identification marking shall be legibly painted 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. Marking shall be approximately six inches in from the edge of the plate. The key to identification symbols shall be furnished to the inspector prior to submittal for inspection. First article and acceptance ballistic test plates shall also be marked with the manufacturer's name or trademark, the number of this

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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."

3.2.9.1 Identification by stamping. Stamping is not allowed unless the finished rolled plates are stamped "hot" (>600° F for plates greater than 3/8 inch thick and >500° F for plates 3/8 inch thick and under.) with a stamp having a minimal surface distortion or residual stress. The plate shall be hot stamped prior to austenization.

3.2.10 Workmanship.

3.2.10.1 Surface condition. 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, mechanical seams, mechanical gouges and laminations (see 6.10). 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 a nature as to affect the fabrication of the materials, shall be rejected.

3.2.10.1.1 Depth of imperfections. The depth of rolled-in scale, scale pitting 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 Internal soundness. One plate from every lot that has an ordered thickness greater than 0.500 inch shall be ultrasonically examined for internal soundness in accordance with 4.8.5. The acceptance level shall be Level C as defined in ASTM A578/A578M, unless otherwise specified in the contract or purchase order (see 6.2).

3.2.10.3 Edge preparation and quality.

3.2.10.3.1 Plate. Thermal cutting of production plate 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 0.500 inches in thickness) shall not exceed 1.2 times the plate's thickness from the cut edge. For plates over 0.500 inches thick, the heat affected zone shall not exceed 0.625 inches from the cut edge. Approval shall be obtained from the procuring activity and shall be as specified in the contract or purchase order (see 6.2) in order to have the heat affected zone exceed these limits. To reduce the potential for plate cracking, plates shall not be cut by cold shearing after final heat treatment, unless otherwise specified in the contract or purchase order (see 6.2). For plates that will be cut with a pattern of piece parts from within the edges of the plate, the condition of the discarded material shall not require inspection as long as cracks do not infringe into the pattern.

3.2.10.3.2 Piece parts cut from plate. For sections of production plate that are cut to size for a specific order from the vehicle fabricator, the supplier shall practice such necessary process controls to prevent edge cracking. For all piece parts, the supplier shall institute such necessary process inspection such that any cut edges shall comply with the requirements of 3.2.10.3.2.1.1

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and 3.2.10.3.2.1.2 using magnetic particle inspection, or liquid penetrant inspection. If the supplier can demonstrate excellent edge integrity history, then NDT inspection can be reduced to 1 out of every 25 parts with 100% visual inspection on all parts.

3.2.10.3.2.1 Acceptance criteria.

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

3.2.10.3.2.1.2 Multiple linear indications. Multiple linear indications shall not exceed 1.5 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.

3.2.10.3.2.1.3 Removal of large indications. Rejectable indications shall be removed by the manufacturer or processor by grinding, provided the resulting cavity does not exceed 10 % of the ordered thickness. Weld repair is acceptable as long as it is done before the final heat treatment. Weld repair shall not be done after final heat treatment.

4. VERIFICATION

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

- a. First article inspection (see 4.4).
- b. Production acceptance inspection (see 4.5).

4.2 Testing responsibility and facilities. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all the requirements as specified herein. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor may use their own or any other facilities suitable for the performance of the requirements specified herein, except ballistic tests (see 4.2.1), unless disapproved by the Government. The Government reserves the right to perform or check any of the inspections set forth in this specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements and to determine the validity of the certifications.

4.2.1 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, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 6850 Lanyard Road, APG, MD 21005-5059 or to an approved Government facility for ballistic testing for first article or production acceptance.

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 and 6.2), production and ballistic test plates shall be allowed to be heat treated separately. The test plate shall be heat treated in a production furnace.

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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 4.3), it shall be so stated in the data (see 6.6).

4.4 First article inspection. When required (see 6.2) first article inspection, except as otherwise indicated in this specification, shall utilize the same requirements and test methods as the production acceptance inspection shown in 4.5.

4.5 Production acceptance inspection. Production acceptance inspection shall include the examination of 4.7 and the tests of 4.8.

4.6 Sampling.

4.6.1 For first article inspection.

4.6.1.1 Chemical analysis samples. One sample for chemical analysis shall be taken from near each plate selected for the ballistic tests in accordance with ASTM E350.

4.6.1.2 Impact samples. At least three (3) impact test specimens in each direction (TL & LT) shall be taken from each test plate submitted for ballistic testing.

4.6.1.3 Ballistic samples. Two (2) ballistic test plates of the same ordered thickness for each nominal thickness range shown in Table IV shall be submitted for ballistic testing and shall represent any other thickness in the range. One sample shall be taken from the first plate heat treated and one from the last plate heat treated in the initial lot produced. When only one plate is heat treated, a sample shall be taken from each end of the plate. The ballistic test plates shall be 12 inches by 36 inches.

TABLE IV. Nominal thickness ranges and corresponding test projectiles for first article and acceptance testing.

Nominal thickness range, in	Obliquity, degrees	Test Projectile	Table
0.098 to 0.157 incl.	0	7.62-mm M80 ball	A-I
0.158 to 0.300 incl.	30	Cal .30 AP, M2	A-II
0.301 to 0.630 incl.	30	Cal .50 AP, M2	A-III

4.6.2 Sampling for production acceptance inspection.

4.6.2.1 For chemical analysis. At least one (1) sample for chemical analysis shall be taken from each heat in accordance with the applicable method specified in ASTM A751 (see 6.5).

4.6.2.2 For hardness tests. The Brinell hardness of each plate, as heat treated, shall be measured in two places, one at each end of a diagonal on one surface of the plate. Image analysis systems may be used to read the indent and compute the hardness and if the heat treating process is continuous (not batch or oscillation), then the amount of testing may be reduced to one measurement per plate.

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4.6.2.3 For Charpy V-notch impact tests. A 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 it represents and large enough to obtain at least six specimens from the sample in accordance with 4.8.3.

4.6.2.4 For ballistic acceptance testing. Unless otherwise specified in the contract or order (see 6.2), one test plate shall be submitted from each heat for each nominal thickness range (see Table IV). 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 shall be read to the nearest 0.001 inch. If a producer submits plates outside the specified plate tolerances (see Table III), the procuring activity shall be notified. An Ultra High Hard Armor (UHA) Test Data Form (see Figure 1) shall be completed and submitted with each ballistic test plate. In the event that plates of the same heat rolled to a different ordered thickness but with overlapping thickness tolerance ranges can be represented by one ballistic test plate, then only one of the ordered thicknesses need be submitted for acceptance testing. The other ordered thicknesses, however, shall be included on the applicable reporting form with the words indicating that it is represented by the sample to be tested. However, if the two ordered thicknesses are such that each thickness requires testing with a different type projectile as shown in Table IV, then each of the ordered thicknesses shall be ballistically tested. Unless otherwise specified in the contract or purchase order (see 6.2), the plates shall be 12 inches by 36 inches.

4.7 Examination.

4.7.1 Visual. All steel plate shall be subject to visual inspection for compliance with the requirements for identification marking (see 3.2.9) and for workmanship (see 3.2.10).

4.7.2 Dimensional. All steel plate shall be subject to inspection for compliance with dimensional and tolerance requirements (see 3.2.8).

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

4.8 Tests.

4.8.1 Chemical analysis. Chemical analysis shall be conducted in accordance with the applicable method specified in ASTM A751 (see 6.5). The analysis shall comply with the declared composition established in accordance with the requirements of Table I (see 3.2.1).

4.8.2 Hardness tests. Brinell hardness tests (HBW) shall be conducted in accordance with ASTM E10 or ASTM E110 (for portable testing). Surface scale and decarburization shall be removed from the areas where the tests are to be made. However, no more than 0.040 inches shall be removed from the test area. Test area is exempt from thickness tolerance requirement. All hardness readings shall fall within the minimum value as specified in 3.2.6.1.

4.8.2.1 Hardness traverse test. Prior to production to assure compliance to paragraph 3.2.10.3.1, the size of the heat affected zone for thermally cut edges shall be determined by taking Rockwell C or Vickers Hardness hardness tests at 0.040 inch (1.0 mm) increments from the edge in

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accordance with ASTM E18 or ASTM E384 respectively. 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.

4.8.3 Charpy V-notch impact tests. At least three (3) Charpy V-notch impact test specimens per direction for a total of at least six (6) Charpy V-notch impact test specimens shall be taken from the sample and shall be prepared and tested in accordance with ASTM E23 and ASTM A370. Charpy V-notch impact test specimens shall be taken in both the TL orientation and in the LT orientation from locations 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 thermally-cut edge. The largest attainable sub-size Charpy V-notch impact specimens shown in Figure 7 of ASTM E23 shall be used. There are no Charpy V-notch impact test requirements for plates less than 0.140 inches thick.

4.8.4 Ballistic tests. Ballistic testing of armor plate shall be conducted at a Government approved test facility specified in 4.2.1, unless otherwise specified in the contract or purchase order (see 6.2). Testing shall be conducted in accordance with the requirements of Appendix A of this specification.

4.8.5 Ultrasonic examination.

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

4.8.5.2 Procedure. Unless otherwise specified in the contract or purchase order (see 6.2), the ultrasonic examination shall be carried out in accordance with ASTM A578/A578M (see 3.2.10.2) 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).
- 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.

4.8.5.3 Certification of inspection personnel. Unless otherwise specified in the contract or purchase order (see 6.2), personnel performing ultrasonic inspection shall comply with the qualification requirements of ANSI/ASNT CP-189-2016.

4.9 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 and shall be specified in the contract or

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purchase order (see 6.2). Reduced testing shall be in accordance with a system previously approved or established by the procuring activity involved.

4.10 Rejection and retest for non-ballistic requirements.

4.10.1 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, failure of the acceptance sample to meet the requirements of this specification shall be cause for rejection of the lot (see 4.10.2). For ballistic rejection procedures, see A.4.1.2.

4.10.2 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 corrections in the processing of the material to the satisfaction of the procuring activity. For ballistic retest procedures, see A.4.1.2.

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 is 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 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.

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 steel armor covered by this specification is intended for lightweight applications where resistance to ball and armor piercing types of ammunition and multiple hit capabilities are required. Although the major intent of UHA is an armor appliqué, UHA could be utilized as a welded structural plate if welded by special techniques. Because of the high carbon equivalence (CE) of the type of steel specified, it will be more difficult to weld than MIL-DTL-46100E.

6.1.1 Class 1. Class 1 wrought armor is intended for use in those areas where more resistance to penetration by armor piercing types of ammunition than MIL-DTL-46100E (MR) is required. Generally, this is a monolithic material.

6.1.2 Class 2. Class 2 wrought armor is intended for use in those areas where more resistance to penetration by armor piercing types of ammunition than Class 1 is required. This may be, but is not limited to, a roll-bonded material such as that described in MIL-A-46099C.

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6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number and date of this specification.
- b. Specify ordered thickness (see 1.1 and 3.2.8.2) and classification (see 1.2).
- c. If issues of documents are different (see 2.2.1).
- d. If a different issue is to be used (see 2.2.2 and 2.3)
- e. If first article samples are required (see 3.1 and 4.4).
- f. If the declared chemistry composition can be different (see 3.2.1).
- g. If local or general heating can be performed after final heat treating (see 3.2.3).
- h. If plates may be furnished in a condition other than that specified (see 3.2.4).
- i. If a substitute form cannot be used in place of Figure 1 (see 3.2.7.1).
- j. If dimensional tolerances can be other than in accordance with ASTM A6/A6M (see 3.2.8.1).
- k. If the flatness tolerance is different than those specified (see 3.2.8.3).
- l. If tighter flatness tolerance requirements are to be specified (see 3.2.8.3).
- m. If the waviness tolerance is different than those specified (see 3.2.8.4).
- n. Specify the acceptance level for internal soundness if other than Level C as defined in ASTM A578/A578M (see 3.2.10.2)
- o. If the limits specified for heat affected zone can be exceeded (see 3.2.10.3.1).
- p. If plates can be cut by cold shearing after final heat treatment (see 3.2.10.3.1).
- q. If someone other than the contractor is responsible for the performance of all the requirements of the specification (see 4.2).
- r. If the contractor cannot use their own facility or any other facility for testing (see 4.2).
- s. If the ballistic tests are to be conducted at another location (see 4.2.1 and 4.8.4).
- t. If production and ballistic test plates can be heat treated separately (see 4.3).
- u. If the size of the ballistic test plates can be different (see 4.6.2.4).
- v. If the ultrasonic test procedures are different than that specified (see 4.8.5.2).
- w. If a different certification for inspection personnel is required (see 4.8.5.3).
- x. Specify reduced testing plan when applicable (see 4.9).
- y. If rejection requirements differ (see 4.10.1).
- z. If retest requirements differ (see 4.10.2).
- aa. Preparation for delivery requirements (see section 5).

6.3 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 MIL-STD-3040, entitled: "Arc Welding of Armor Grade Steel". The long dimension of the plate is typically the rolling direction. If a forming operation is to be performed, the rolling direction should be tracked so that bending is preferably not performed longitudinal to the rolling direction.

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

6.5 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.

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6.6 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.

6.7 Potential suppliers. Potential suppliers who have not previously supplied armor plate 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, USA ATC, ATTN: TEDT-AT-SLV, Building 358, 6850 Lanyard Road, APG, MD 21005-5059.

6.8 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 (see 6.2). A lead time of 60 days after the contract has been signed is to be allowed prior to shipment of the first ballistic test(s) to APG to ensure that all administrative functions for the establishment of a new ATC project have been completed in preparation for the test. The contracting government activity is to initiate the new project through a letter to Commander, USA ATC, ATTN: TEDT-AT-SLV, Building 358, 6850 Lanyard Road, APG, MD 21005-5059 requesting a cost estimate for the ballistic testing of the applicable number and sizes of plates. In the case of increases in scope of existing projects, similar correspondence is needed.

6.9 Definitions.

6.9.1 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.

6.9.2 Laps. A surface imperfection with the 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.

6.9.3 Checks. Checks are 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, heat checks.

6.9.4 Seams. Seams are an unwelded fold or lap that appears as a crack, usually resulting from a discontinuity on a metal surface.

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

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

6.9.7 Cold shuts. A lap on the surface of a forging or billet that was closed without fusion during deformation.

6.9.8 Burning. Permanently damaged metal due to overheating enough to cause incipient melting or intergranular oxidation. 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. This defect is usually not limited to the surface and may be sub-surface or at interior locations when associated with heavy mechanical working. Metal with this condition will be scrapped.

6.9.9 Laminations. 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.

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

6.9.11 Autotempering. When the martensite start temperature (M_s) lies well above room temperature, carbide precipitation (tempering) occurs upon quenching, after the transformation to martensite. Also called quench tempering.

6.9.12 Crack. A crack is a planar discontinuity in the metal that has length and depth. Cracks may be surface cracks or through cracks.

6.9.13 Quenched and Tempered. Processing of armor plate utilizing a process to cool from austenitic-phase field through the martensitic transformation utilizing air and/or liquid quenching media followed by tempering.

6.10 Tempering. Any tempering should be performed as soon as possible after quenching. It is recommended that the delay after quenching be no greater than 24 hours to avoid cracking.

6.11 Plates in the as-rolled condition. When the fabricator performs the final quench and temper of plates, it will be their responsibility that the mechanical and ballistic requirements of the plates, meet this specification.

6.12 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 listed in Table V.

TABLE V. 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/sec	0.3048	=	meter per second (m/s)
Fahrenheit (°F)	$(t^{\circ}\text{F} - 32)/1.8 = t^{\circ}\text{C}$		Centigrade (°C)

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

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6.13 Subject term (key word) listing.

Ballistic testing	Heat treated	M80 projectile
Batch tempering	Lightweight material	
Continuous tempering	M2 projectile	

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

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APPENDIX A

BALLISTIC TESTING OF ARMOR PLATE, STEEL, WROUGHT ULTRA HIGH
HARDNESS

A.1 SCOPE

A.1.1 This appendix covers the requirements for ballistic testing of ultra high hardness steel armor plate.

A.2 DEFINITIONS

A.2.1 Fair impact. 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 the edge of the plate, hole, crack, or spalled area by an undisturbed area of at least three inches.

A.2.2 Witness sheet. A witness sheet is normally a 0.014 inch thick sheet of 5052 H36 aluminum alloy (or a 0.020 inch thick sheet of 2024 -T3 aluminum alloy) placed 6 inches (+ 0.5 inch) behind and parallel to the test plate or other ballistic sample.

A.2.3 Complete penetration, protection, CP(P). A protection complete penetration is a penetration in which the projectile or one or more fragments of the projectile or plate pass beyond the back of the test plate and perforates the witness plate.

A.2.4 Partial penetration, protection, PP(P). 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.

A.2.6 V₅₀ protection ballistic limit, BL(P). The protection V₅₀ ballistic limit is defined as the average of 6 fair impact velocities comprising the three lowest velocities resulting in complete penetration and the three highest velocities resulting in partial penetration. A maximum spread of 150 feet per second (fps) shall be permitted between the lowest and highest velocities employed in determination of ballistic limits. In only those cases where the lowest complete penetration velocity is lower than the highest partial penetration velocity by more than 150 fps shall the ballistic limit be based on 10 velocities (the 5 lowest velocities that resulted in complete penetration and the 5 highest velocities that resulted in partial penetrations). When the 10-round excessive spread, ballistic limit is used, the velocity spread shall be reduced to the lowest practical level (as close to 150 fps as possible). When a 10-round ballistic limit is used, this shall be noted in all reports. The normal up-and-down firing method shall be used in the determination of all BL(P)'s, all velocities being corrected to striking velocity. In the event that the ballistic limit computed is less than 30 fps above the minimum required and if a gap (high partial penetration velocity below the low complete penetration velocity) of 30 fps or more exists, firing shall

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continue as needed to reduce this gap to 25 fps or less. (This procedure shall insure better evaluation of the steel when the ballistic limit is near the minimum required.)

A.2.7 Thickness, impact area. The thickness of ballistic test plates used for determining ballistic limits shall be that of the area subjected to the ballistic testing.

A.3 REQUIREMENTS

A.3.1 Resistance to penetration. The minimum ballistic limits shall be in accordance with the values shown in Tables A-I, A-II, or A-III, as applicable.

A.3.2 Impact spacing. All testing shall be conducted on only one plate per V_{50} in accordance with A.4.1 with all impacts at least 3 inches from an edge, a crack, or a previous impact. Failure to meet these conditions shall be cause for rejection of that plate.

A.4 TESTS

A.4.1 Ballistic tests. V_{50} ballistic tests shall be performed in accordance with USADTC TOP 2-2-710, Ballistic Tests of Armor Materials or ITOP 2-2-713, Ballistic Testing of Armor to determine compliance with the requirements of Tables A-I through A-III.

A.4.1.1 Plate thickness. Plate thickness as measured by the ballistic test agency shall be used to determine the required ballistic limit for the plate. Individual thickness measurements are to be read from a micrometer to the nearest 0.001 inch and the average of these readings reported to the nearest 0.001 inch. At least one measurement shall be taken along each edge of the plate at a distance of at least one inch from the edge, but preferably in the area which shall be impacted. The average of the measurements to the nearest 0.001 inch shall be used to determine the minimum ballistic limit requirements in the appropriate tables (Tables A-I through A-III). The required ballistic limit shall be determined by interpolation, if necessary, in the Tables in the Appendix.

A.4.1.2 Rejection and retest of ballistic plates.

A.4.1.2.1 First article tests (rejection). Unless noted otherwise in the contract or order, failure of either of the first article test plates to meet the minimum ballistic requirements as specified in the Appendix to this specification indicates failure of the product and process.

A.4.1.2.2 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 must be submitted for first article testing and both must pass.

A.4.1.2.3 Acceptance tests (rejection). Unless otherwise noted 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.

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A.4.1.2.4 Acceptance tests (retests). If a test plate representing a lot fails to meet the ballistic requirements, 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 reheat treat (quenching and tempering) the lot and then submit a test plate from the retreated 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) meets the requirements, then the lot represented is acceptable. If option (1) is chosen and one or both of the retest plates fail, the manufacturer may reheat treat the lot and submit a test plate from the retreated lot. If this plate fails, the lot is rejected. If option (3) is chosen and the test plate fails, any one of the three options may be chosen again. The manufacturer shall report the processing used on the failed plates.

A.4.1.3 Disposition of ballistic test plates.

A.4.1.3.1 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 their expense, unless the plates were destroyed in testing.

A.4.1.3.2 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 rejected lot does. The failed plates shall be returned, upon request, as in A.4.1.3.1.

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TABLE A-I. Minimum required ballistic limits - 7.62-mm M80 ball projectile at 0 degrees obliquity.

Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2	Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2
0.090	1513	1713	0.122	1921	2121
0.091	1525	1725	0.123	1934	2134
0.092	1538	1738	0.124	1947	2147
0.093	1551	1751	0.125	1960	2160
0.094	1564	1764	0.126	1973	2173
0.095	1577	1777	0.127	1985	2185
0.096	1589	1789	0.128	1998	2198
0.097	1602	1802	0.129	2011	2211
0.098 ^{1/}	1615	1815	0.130	2024	2224
0.099	1628	1828	0.131	2036	2236
0.100	1640	1840	0.132	2049	2249
0.101	1653	1853	0.133	2062	2262
0.102	1666	1866	0.134	2075	2275
0.103	1679	1879	0.135	2088	2288
0.104	1692	1892	0.136	2100	2300
0.105	1704	1904	0.137	2113	2313
0.106	1717	1917	0.138	2126	2326
0.107	1730	1930	0.139	2139	2339
0.108	1743	1943	0.140	2151	2351
0.109	1755	1955	0.141	2164	2364
0.110	1768	1968	0.142	2177	2377
0.111	1781	1981	0.143	2190	2390
0.112	1794	1994	0.144	2203	2403
0.113	1806	2006	0.145	2215	2415
0.114	1819	2019	0.146	2228	2428
0.115	1832	2032	0.147	2241	2441
0.116	1845	2045	0.148	2254	2454
0.117	1858	2058	0.149	2266	2466
0.118	1870	2070	0.150	2279	2479
0.119	1883	2083	0.151	2292	2492
0.120	1896	2096	0.152	2305	2505
0.121	1909	2109	0.153	2317	2517

^{1/} Specification 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-I. Minimum required ballistic limits - 7.62-mm M80 ball projectile at 0 degrees obliquity - Continued.

Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2	Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2
0.154	2330	2530	0.162	2432	2632
0.155	2343	2543	0.163	2445	2645
0.156	2356	2556	0.164	2458	2658
0.157 ^{2/}	2369	2569	0.165	2471	2671
0.158	2381	2581	0.166	2484	2684
0.159	2394	2594	0.167	2496	2696
0.160	2407	2607	0.168	2509	2709
0.161	2420	2620	0.169	2522	2722

^{2/} Specification 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 .30 AP M2 projectile at 30 degrees obliquity.

Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2	Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2
0.140	1478	1678	0.240	2400	2600
0.145	1535	1735	0.245	2433	2633
0.150	1592	1792	0.250	2465	2665
0.155	1647	1847	0.255	2496	2696
0.158 ^{1/}	1680	1880	0.260	2526	2726
0.160	1702	1902	0.265	2554	2754
0.165	1754	1954	0.270	2581	2781
0.170	1806	2006	0.275	2607	2807
0.175	1857	2057	0.280	2631	2831
0.180	1906	2106	0.285	2654	2854
0.185	1954	2154	0.290	2676	2876
0.190	2001	2201	0.295	2697	2897
0.195	2046	2246	0.300 ^{2/}	2717	2917
0.200	2090	2290	0.305	2735	2935
0.205	2133	2333	0.310	2752	2952
0.210	2175	2375	0.315	2768	2968
0.215	2216	2416	0.320	2783	2983
0.220	2255	2455	0.325	2796	2996
0.225	2293	2493	0.330	2809	3009
0.230	2330	2530	0.335	2820	3020
0.235	2366	2566	0.340	2829	3029

^{1/} Specification requirements begin for this ordered thickness.

^{2/} Specification 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 - caliber .50 AP M2 projectile at 30 degrees obliquity.

Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2	Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2
0.290	2056	2256	0.435	2446	2646
0.295	2069	2269	0.440	2459	2659
0.300	2083	2283	0.445	2472	2672
0.301 ^{1/}	2086	2286	0.450	2486	2686
0.305	2096	2296	0.455	2499	2699
0.310	2110	2310	0.460	2512	2712
0.315	2124	2324	0.465	2525	2725
0.320	2137	2337	0.470	2538	2738
0.325	2151	2351	0.475	2552	2752
0.330	2164	2364	0.480	2565	2765
0.335	2178	2378	0.485	2578	2778
0.340	2191	2391	0.490	2591	2791
0.345	2205	2405	0.495	2604	2804
0.350	2218	2418	0.500	2617	2817
0.355	2232	2432	0.505	2630	2830
0.360	2245	2445	0.510	2643	2843
0.365	2259	2459	0.515	2656	2856
0.370	2272	2472	0.520	2669	2869
0.375	2286	2486	0.525	2682	2882
0.380	2299	2499	0.530	2695	2895
0.385	2313	2513	0.535	2708	2908
0.390	2326	2526	0.540	2721	2921
0.395	2339	2539	0.545	2734	2934
0.400	2353	2553	0.550	2747	2947
0.405	2366	2566	0.555	2760	2960
0.410	2379	2579	0.560	2773	2973
0.415	2393	2593	0.565	2786	2986
0.420	2406	2606	0.570	2799	2999
0.425	2419	2619	0.575	2812	3012
0.430	2433	2633	0.580	2825	3025

^{1/} Specification 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-III. Minimum required ballistic limits - caliber .50 AP M2 projectile at 30 degrees obliquity - Continued.

Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2	Thickness inches	Required BL(P), ft/sec Class 1	Required BL(P), ft/sec Class 2
0.585	2838	3038	0.625	2940	3140
0.590	2851	3051	0.630 ^{2/}	2953	3153
0.595	2863	3063	0.635	2966	3166
0.600	2876	3076	0.640	2978	3178
0.605	2889	3089	0.645	2991	3191
0.610	2902	3102	0.650	3004	3204
0.615	2915	3115	0.655	3016	3216
0.620	2927	3127	0.660	3028	3228

^{2/} Specification 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-32332A (MR)

CONCLUDING MATERIAL

Custodian:
Army - MR

Preparing activity:
Army - MR

Review activities:
Army - AR, AT, TE
DLA - CQ

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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 accuracy of the information above using the ASSIST Online database at <https://assist.dla.mil/>.