

INCH-POUND

MIL-DTL-12560K (MR)
7 December 2013

SUPERSEDING
MIL-DTL-12560J (MR)
24 July 2009

DETAIL SPECIFICATION

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

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 wrought-steel homogeneous armor plate for ordered thicknesses from 0.098 inch (2.5 mm) up to an ordered thickness of 6.000 inches (152.4 mm), inclusive, for use in combat-vehicles and for ordered thicknesses from 0.250 inches (6.35 mm) up to an ordered thickness of 12.000 inches (304.8 mm), inclusive, for use in proof and acceptance testing of armor defeating ammunition (see 6.1, 6.2, and 6.3.3).

1.1.1 Cross-application. Plates produced to this revision can be used where previous revisions are specified. Revision K plates can be used where drawings call for prior revisions.

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

1.2.1 Class 1. Wrought armor plate with an ordered thickness of 0.098 to 6.000 inches (2.5 to 152.4 mm) which is heat treated to develop maximum resistance to penetration (see 6.1.1).

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

AMSC N/A

FSC 9515

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.2.2 Class 2. Wrought armor plate with an ordered thickness of 0.098 to 2.000 inches (2.5 to 50.8mm) which is heat treated to develop maximum resistance to shock (see 6.1.2).

1.2.3 Class 3. Wrought armor plate with an ordered thickness of 0.250 to 12.000 inches (6.35 to 304.8 mm) which is heat treated to develop specific hardness and impact values for evaluation of armor-defeating ammunition only. This class of armor is not intended for use in combat-vehicles. To meet the thickness tolerances of this class of armor special surface finishing may be required (see 6.1.3).

1.2.4 Class 4a. Wrought armor plate with an ordered thickness of 0.098 to 2.750 inches (2.5 to 69.9 mm) which is designed for better resistance to penetration with respect to Class 1 (see 6.1.4)

1.2.5 Class 4b. Wrought armor plate that is air hardened and auto-tempered with an ordered thickness of 0.098 to 2.750 inches (2.5 to 69.9 mm) which is designed for better resistance to penetration with respect to Class 1 (see 6.1.5)

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.

INTERNATIONAL STANDARDIZATION AGREEMENTS

ISO 9712 - Non-Destructive Testing - Qualification and Certification of NDT Personnel

(Copies of this document are available from <http://www.iso.ch> or from the International Organization for Standardization American National Standards Institute 11 West 42nd Street, 13th Floor New York, New York, United States, 10036.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129 - Military Marking for Shipment and Storage

(Copies of these documents are available online at <http://quicksearch.dla.mil/> or <https://assist.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.

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

(Application for copies is available online at <http://www.dtic.mil/> or from the Defense Technical Information Center, 8725 John J. Kingman Road, Suite 0944, Fort Belvoir, VA 22060-6218.)

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.

ASTM INTERNATIONAL

| | | |
|------------------|---|---|
| ASTM A6/A6M | - | Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling |
| ASTM A370 | - | Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| ASTM A578/ A578M | - | Standard Specification for Straight-Beam Ultrasonic 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 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 E290 | - | Standard Test Methods for Bend Testing of Material for Ductility |
| ASTM E1077 | - | Standard Test Methods for Estimating the Depth of Decarburization of Steel Specimens |
| ASTM E1444 | - | Standard Practice for Magnetic Particle Testing |

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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, 6.5 and 6.9), 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 4.4. The contractor shall comply with this requirement at the time of his first order or contract and at any time that the supplier has not furnished the same class of wrought armor plate 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 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 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.

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). If an analysis of Antimony, Arsenic or Lead is required, it shall be specified in the contract or purchase order (see 6.2). A single heat cannot be dual certified to both MIL-DTL-12560 and MIL-DTL-46100. 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, complete details of the heat treatment, and all mechanical properties of each lot of production plates 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 Rolled Homogeneous Armor Test Data Form (see Figure 1), or other certifications containing the same information.

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%.

TABLE I. Chemical composition and precision (product analysis)^{6/}.

| ELEMENT | COLUMN A MAXIMUM LIMIT for DECLARED CHEMISTRY (WEIGHT PERCENT) | COLUMN B ^{5/} ALLOWABLE RANGE for FUTURE PRODUCTION LOTS (WEIGHT PERCENT) |
|------------|---|---|
| Carbon | 0.27 up to 2" thick, incl 0.29 over 2" up to 4" 0.31 over 4" | ± 0.05 |
| Manganese | NONE REQUIRED, HOWEVER IF: ≤ 1.00 > 1.00 | ± 0.15 ± 0.20 |
| Phosphorus | 0.020 ^{1/} | ^{4/} |
| Sulfur | 0.010 ^{1/} | ^{4/} |
| Silicon | NONE REQUIRED, HOWEVER IF: ≤ 0.60 > 0.60 to ≤ 1.00 > 1.00 | ± 0.10 ± 0.15 ± 0.20 |
| Nickel | NONE REQUIRED ^{3/} | ± 0.25 |
| Chromium | NONE REQUIRED, HOWEVER IF: ≤ 1.25 ^{3/} > 1.25 | ± 0.15 ± 0.25 |
| Molybdenum | NONE REQUIRED, HOWEVER IF: ≤ 0.20 ^{3/} > 0.20 | ± 0.035 ± 0.075 |
| Vanadium | NONE REQUIRED ^{3/} | ± 0.05 |
| Niobium | NONE REQUIRED ^{3/} | ± 0.05 |
| Boron | --- ^{2/} | ^{4/} |
| Copper | 0.25 ^{3/} | ^{4/} |
| Nitrogen | 0.03 ^{3/} | ^{4/} |
| Titanium | 0.10 ^{3/} | ^{4/} |
| Aluminum | 0.10 ^{3/} | ^{4/} |
| Lead | 0.01 ^{3/} | ^{4/} |
| Tin | 0.02 ^{3/} | ^{4/} |

^{1/} Phosphorus and sulfur total shall not exceed 0.020 wt%.

^{2/} When the amount of boron is specified in the alloy, its content as 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 may be reported as [< 0.02 wt%].

^{4/} There are no limits on the allowable values for future lots; however, the values may not exceed those listed as the maximum limit.

^{5/} Values are actual tolerance limits NOT percent tolerances.

^{6/} Elements not listed in Table, but intentionally added, shall be reported.

| REQUEST FOR BALLISTIC TEST OF ROLLED HOMOGENEOUS ARMOR | | | | | | | | | |
|--|-------------------------------|--|--------------------------|--------------------------------|--|------------------------------|----|------------|----|
| SPECIFICATION: MIL-DTL-12560 | | | REVISION: K | | | 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. _____ | | RHA Classification CLASS: _____ | | | Austenizing Temp: _____ | | | | |
| Plate No. _____ | | Carbon Equivalence (CE): _____ | | | Tempering Temp. _____ | | | | |
| Bend Test: | Plate Thickness [Pass / Fail] | | | Inside Radius | | | | | |
| | 1) | 2) | | 1) | 2) | | | | |
| PURPOSE: <input type="checkbox"/> Acceptance <input type="checkbox"/> First Article <input type="checkbox"/> Reduced Testing | | | | | | | | | |
| SAMPLE: <input type="checkbox"/> Primary <input type="checkbox"/> Retest (Firing Record No. of Failed Sample _____) | | | | | | | | | |
| CHEMISTRY ANALYSIS | | C | Mn | P | S | Si | Ni | Cr | Mo |
| FIRST ARTICLE RESULTS: | | | | | | | | | |
| PRODUCTION RESULTS: | | | | | | | | | |
| ACCEPTANCE (Pass / Fail) | | | | | | | | | |
| V: | Nb: | B: | | N: | | | | | |
| Cu: | Ti: | Al: | | | | | | | |
| MECHANICAL PROPERTIES: CHARPY IMPACT @ -40 Degs. F. Specimen Size: | | | | | | | | | |
| HARDNESS: | | LT Direction: 1: _____ 2: _____ 3: _____ | | | TL Direction: 1: _____ 2: _____ 3: _____ | | | | |
| BALLISTIC TEST RESULTS: SEPARATELY HEAT TREATED TEST PLATE : YES <input type="checkbox"/> NO <input type="checkbox"/> | | | | | | | | | |
| Test: Projectile: | Obl. (deg) | Actual Thickness (in) | | Required V ₅₀ (fps) | | Actual V ₅₀ (fps) | | Pass/ Fail | |
| | | | | | | | | | |
| | | | | | | | | | |
| NOTES: | | | | | | | | | |
| Lot <input type="checkbox"/> met <input type="checkbox"/> failed to meet the ballistic requirements of specification MIL-DTL-12560 | | | | | | | | | |
| Government Representative: | | Date: | Supplier Representative: | | | | | Date: | |

FIGURE 1. Rolled Homogeneous Armor (RHA) Test Data Form

3.2.2.1 Class 1 & 2. Class 1 and 2 steel shall have a CE of less than 0.80 wt% for plates less than 2 inches in thickness. For plates 2 to 4 inches shall have a CE of less than 0.85 wt%. For plates greater than 4 inches in thickness shall have a CE of 0.90 wt% or less.

3.2.2.2 Class 3. Class 3 steel shall have no CE limit unless otherwise specified in the contract or purchase order (see 6.2).

3.2.2.3 Class 4a. Class 4a steel shall have a CE limit of less than 0.70 wt% unless otherwise specified in the contract or purchase order (see 6.2).

3.2.2.4 Class 4b. Class 4b steel shall have no CE limit unless otherwise specified in the contract or purchase order (see 6.2).

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 the plate surface exceed 1800°F (see 6.6).

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. If descaling is required it shall be as specified in the contract or purchase order (see 6.2). Plates shall not be pickled.

3.2.5 Processing controls.

3.2.5.1 Furnace survey 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.

3.2.5.2 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. Plates shall not be stress relieved in a temperature range of 500-700°F. After stress relieving, the plates shall be tested for hardness and shall meet the requirements of Table II.

3.2.5.3 Repairing.

3.2.5.3.1 Weld repair of mill defects after final heat treatment. Unless otherwise specified in the contract or purchase order (see 6.2), weld repair after final heat treatment shall be permitted for

plates with an ordered thickness greater than 2 inches. Mill imperfections may be repair welded by the contractor or referred to the contracting activity for acceptance with subsequent repair welding to be performed by the contracting activity. The following limitations shall apply to all weld repairs:

- a. The total area to be repaired shall not exceed 0.1 percent of the surface of one side of the plate.
- b. The depth of any area to be repaired shall not exceed one-tenth the ordered thickness of the plate or 1/4 inch, whichever is less. The depth of the area to be repaired shall be a minimum of 0.030 inch.
- c. Maximum size of each weld repaired area is 0.375" diameter.
- d. Areas to be welded shall be ground to assure that the welds are made on clean, sound metal.
- e. After preparation for repair and prior to welding, the depressed area shall be magnetic particle inspected in accordance with ASTM E1444, and shown to be free of linear discontinuities.
- f. Weld repairs shall be made in accordance with a welding procedure qualified in accordance with drawing 19207-12479550, entitled: "GROUND COMBAT VEHICLE WELDING CODE – STEEL" or MIL-HDBK-1941 or the applicable fabrication document.
- g. Weld filler metal shall have a minimum UTS of 100 ksi.
- h. The final repaired surface shall be ground smooth and flush with the adjacent surface. The finished weld surface shall also be free of under-fill.
- i. Surface weld repairs shall be magnetic particle inspected after final grinding (or subsequent heat treatment, if applicable) in accordance with ASTM E1444. Welds and adjacent heat affected zone surfaces shall be free of relevant linear indications longer than 1/8 inch.
- j. Repaired areas shall be marked. The markings shall remain legible and shall not be removed prior to performing all inspections specified herein.
- k. Notation of such repaired areas and the type of welding filler metal used to make the weld repair(s) shall be made on the plate inspection form as part of the records.
- l. If a non-heat treatable electrode is used, reheat treatment of the plate is prohibited.

TABLE II. Hardness requirements. (Inclusive).

| Specified nominal thickness of plate, inches From | To and incl. | Armor class | Brinell hardness range, HB |
|--|--------------|-------------|----------------------------|
| 0.098 | 0.249 | 1 | 360 - 410 |
| 0.250 | 0.624 | 1 | 340 - 390 |
| 0.625 | 1.125 | 1 & 3 | 330 - 380 |
| 1.126 | 1.999 | 1 & 3 | 310 - 360 |
| 2.000 | 3.999 | 1 & 3 | 270 - 320 |
| 4.000 | 6.000 | 1 & 3 | 250 - 300 |
| 6.001 | 9.000 | 3 | 230 - 280 |
| 9.001 | 12.00 | 3 | 210 - 260 |
| 0.098 | 2.000 | 2 | 260 - 310 |
| 0.098 | 2.750 | 4 | 420 - 470 |

3.2.5.3.2 Weld repairs of mill defects prior to heat treatment. Unless otherwise specified in the contract or purchase order (see 6.2), weld repair prior to final heat treatment shall be permitted for plates with an ordered thickness greater than 0.250 inch. Weld repairs of mill imperfections may be accomplished prior to heat treatment within the limitations as specified in 3.2.5.3.1, except such weld repairs shall be made using a heat-treatable filler material.

3.2.5.4 Grinding. Grinding is not required but may 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 Table III.

TABLE III. Thickness tolerances

| SPECIFIED THICKNESS, INCHES | | TOLERANCES OVER AND UNDER ORDERED THICKNESS FOR WIDTHS GIVEN, INCHES | | | | | | | |
|-----------------------------|------------------|--|------------|------------|------------|-------------|--------------|--------------|--------------|
| FROM | TO and INCLUDING | To 60 | > 60 to 72 | > 72 to 84 | > 84 to 96 | > 96 to 108 | > 108 to 120 | > 120 to 132 | > 132 to 144 |
| 0.0980 | 0.1249 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | --- | --- | --- |
| 0.1250 | 0.1874 | 0.012 | 0.012 | 0.015 | 0.015 | 0.017 | --- | --- | --- |
| 0.1875 | 0.2499 | 0.012 | 0.015 | 0.017 | 0.020 | 0.020 | --- | --- | --- |
| 0.2500 | 0.3749 | 0.015 | 0.017 | 0.017 | 0.020 | 0.022 | 0.025 | --- | --- |
| 0.3750 | 0.6249 | 0.017 | 0.017 | 0.017 | 0.020 | 0.025 | 0.027 | 0.030 | 0.030 |
| 0.6250 | 0.9990 | 0.020 | 0.020 | 0.020 | 0.025 | 0.030 | 0.030 | 0.035 | 0.035 |
| 1.0000 | 1.4990 | 0.030 | 0.030 | 0.030 | 0.030 | 0.035 | 0.040 | 0.050 | 0.050 |
| 1.5000 | 1.9990 | 0.040 | 0.040 | 0.040 | 0.040 | 0.045 | 0.050 | 0.055 | 0.060 |
| 2.0000 | 2.9990 | 0.055 | 0.055 | 0.055 | 0.065 | 0.065 | 0.065 | 0.065 | 0.075 |
| 3.0000 | 3.9990 | 0.060 | 0.060 | 0.060 | 0.070 | 0.070 | 0.070 | 0.070 | 0.075 |
| 4.0000 | 5.9990 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.075 | 0.085 |
| 6.0000 | 7.9990 | 0.090 | 0.090 | 0.090 | 0.090 | 0.090 | 0.090 | 0.095 | 0.105 |
| 8.0000 | 9.9990 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.105 | 0.120 | 0.135 |
| 10.0000 | 12.0000 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.135 | 0.145 | 0.160 |

3.2.6 Mechanical properties.

3.2.6.1 Surface hardness. The 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 when tested in accordance with 4.8.2.

3.2.6.2 Impact. The Charpy V-notch impact test results of armor plate submitted shall meet the requirements shown in Table IV for the applicable hardness and thickness when tested in accordance with 4.8.3. The Charpy V-notch impact specimens shall be obtained both in 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 (longitudinal to the major direction of rolling with the notch perpendicular to the plate surface so that the crack propagates in the transverse direction).

3.2.6.3 Bend test. Unless otherwise specified in the contract or purchase order (see 6.2), bend test samples shall be required for a given lot of plates with an ordered thickness of 0.500 inch and under, and shall be capable of being bent to the requirements specified in Table V without cracking (see 4.6.1.3, 4.6.2.4 and 4.8.4). For ordered thickness of greater than 0.500 inches a bend test shall be specified in the contract or purchase order (see 6.2). After bending, samples shall be free of cracks as determined by visual inspection unless otherwise specified in the contract or purchase order (see 6.2).

TABLE IV. Minimum Charpy V-notch impact requirements (at -40°F + 2°F)

| Brinell hardness, BHN | | Minimum impact values (average of three (3) test specimens), ft-lb | | | |
|-----------------------|-----------|--|---------|---------|---------|
| | | Specimen Size | | | |
| Inclusive | Exclusive | Standard | ¾ width | ½ width | ¼ width |
| 210 | 220 | 81 | 61 | 41 | 20 |
| 220 | 230 | 76 | 57 | 38 | 19 |
| 230 | 240 | 71 | 53 | 36 | 18 |
| 240 | 250 | 66 | 50 | 33 | 17 |
| 250 | 260 | 61 | 46 | 31 | 15 |
| 260 | 270 | 56 | 42 | 28 | 14 |
| 270 | 280 | 51 | 38 | 26 | 13 |
| 280 | 290 | 46 | 35 | 23 | 12 |
| 290 | 300 | 41 | 31 | 21 | 10 |
| 300 | 310 | 36 | 27 | 18 | 9 |
| 310 | 320 | 32 | 24 | 16 | 8 |
| 320 | 330 | 28 | 21 | 14 | 7 |
| 330 | 340 | 25 | 19 | 13 | 6 |
| 340 | 350 | 22 | 17 | 11 | 6 |
| 350 | 360 | 19 | 14 | 10 | 5 |
| 360 | 370 | 18 | 14 | 9 | 5 |
| 370 | 380 | 17 | 13 | 9 | 4 |
| 380 | 470 | 16 | 12 | 8 | 4 |

Table V. Bend test requirements.

| Ordered Plate Thickness (T) | Inside Radius | |
|----------------------------------|--|----------------|
| | Class 2 | Class 1, 3 & 4 |
| 0.098 to 0.500 inches, inclusive | 3T | 4T |
| Greater than 0.500 inches | as specified in contract or purchase order (see 6.2) | |

3.2.7 Ballistic requirements. Ballistic requirements shall be in accordance with the Appendix A of this specification. When a complete penetration cannot be obtained, 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 V₅₀ (which obviously cannot be specified) above the minimum requirement. There are no ballistic test requirements for class 2 plate thicker than 1.000 inch.

3.2.7.1 Ballistic test plate information. For each lot of armor plate a properly completed Rolled Homogeneous Armor (RHA) Test Data Form (see Figure 1) shall be submitted with each ballistic test plate that represents that particular processing lot.

3.2.8 Dimensions and tolerances.

3.2.8.1 Dimensions. Armor 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 Table III. Armor plate tolerances on length and width dimensions shall be plus 2 inches and minus zero.

3.2.8.2 Thickness.

3.2.8.2.1 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 III.

3.2.8.2.2 Thickness tolerances. The thickness tolerances of each plate, after final treatment, shall be in accordance with Table III. The contract or purchase order (see 6.2) shall specify the thickness tolerance when not specified in Table III.

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 one-half of the tolerance listed in ASTM A6/A6M (As of the release date of MIL-DTL-12560K (MR), the appropriate table is Table 14, however, this table may be re-numbered during a future revision or update, so caution should be taken by the user). 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. The permitted variation in waviness is a function of the permitted variation from a flat surface as obtained from Table 14 in ASTM A6/A6M. Unless otherwise specified in the contract or purchase order (see 6.2), the waviness tolerance of each plate shall be one-half the tolerance listed in ASTM A6/A6M Table 15, using the applicable full tolerance obtained from the flatness tolerance table (Table 14) for the appropriate plate thickness and width. The one-half tolerance reduction shall not be applied to both the flatness table and the waviness table to determine waviness tolerance. (As of the release date of MIL-DTL-12560K (MR), the appropriate table is Table 15, with reference to Table 14, however, these tables may be re-numbered during a future revision or update to ASTM A6/A6M, so caution should be taken by the user).

3.2.9 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. The primary plate rolling direction shall be identified.

3.2.9.1 Class 3 armor plate identification marking. Manufacturers supplying class 3 armor plate are additionally 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 III.
- b. Label each plate "RHA, class 3, MIL-A-12560, plate No. ____, heat No. ____." Labeling shall be approximately 1/2 inch high letters. Location of labeling for all plates shall be in the upper right hand corner.

3.2.9.2 Ballistic test plate identification marking. First article and acceptance ballistic test plates shall also be marked with unique melt and slab, the manufacturer's name or trademark, the number and class 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." All plate markings shall be approximately 1/2 inch high letters and highlighted with a highly visible paint. The primary plate rolling direction shall be identified.

3.2.10 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 in addition to the completed Rolled Homogeneous Armor (RHA) Test Data Form (see Figure 1). 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.

3.2.11 Workmanship.

3.2.11.1 Surface imperfections. When specified in the contract or purchase order (see 6.2), plates shall be inspected for surface imperfections in the de-scaled condition, only. 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 6.3). Imperfections listed above which are of such nature as to affect the fabrication of the material, are rejectable.

3.2.11.1.1 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 and not within 6 inches of each other and which do not violate the minimum allowable thickness, as specified in Table III or the applicable drawings and fabrication documents, are acceptable. Additionally, if isolated individual pits do not lie within 4 feet of each other and have a depth of less than 4% of ordered gage, and less than 0.25 inch in diameter, are acceptable.

3.2.11.2 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 plate's 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 and shall be as specified in the contract or purchase order (see 6.2). Supplier must demonstrate this capability to the procuring activity during First Article Testing.

3.2.11.3 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.

3.2.11.4 Internal soundness. Ultrasonic testing is not required for plates with an ordered thickness that is less than or equal to 0.625 inch gauge. Plates over 0.625 inch must be ultrasonically tested unless supplier can prove substantial plates in the 0.626 to 2.00 inch gauge range have been ultrasonically tested in the past without findings. If supplier can demonstrate excellent internal soundness history, then only one plate from every lot with an ordered thickness between 0.626 and 2.000 inches shall be ultrasonically examined for internal soundness in accordance with 4.7.3. Every plate from every lot that has an ordered thickness greater than 2 inches shall be ultrasonically examined for internal soundness in accordance with 4.7.3. The acceptance level shall be C, unless otherwise specified in the contract or purchase order (see 6.2).

3.2.11.4.1 Acceptance criteria.

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

3.2.11.4.1.2 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.

3.2.11.4.1.3 Cracks. All cracks shall be rejectable (see 6.3.18 for definition).

3.2.11.4.1.4 Removal of large indications. Large indications shall be removed by the manufacturer or processor by grinding, or weld repair as specified in 3.2.5.3.

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 his 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, 400 Colleran 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.

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), 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 and shall utilize the same requirements and test methods as the production acceptance inspection shown in 4.5.

4.4.1 First article tests. First article tests shall consist of all the tests specified in 4.8.

4.4.2 First article ballistic test. Unless otherwise specified (see 3.1, 6.2, and 6.5), 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 VI, 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.

4.5 Production acceptance inspection. The acceptance examination under 4.7 and the tests under 4.8 shall serve as a basis for the acceptance of individual production lots.

4.6 Sampling.

4.6.1 First article sampling.

4.6.1.1 Chemical composition. One sample for chemical analysis shall be taken from near each plate selected for the ballistic tests.

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

| Nominal thickness range, inches | Armor Class | Minimum size ^{1/} of test plates, inches | Test projectile and obliquity | TABLE |
|---------------------------------|-------------|---|-------------------------------|--------|
| 0.098 to 0.230 incl. | 1 & 4 | 12 x 36 | Cal .30 M2 Ball at 30° | A-I |
| 0.231 to 0.624 incl. | 1 | 12 x 36 | Cal .30 M2 AP at 0° | A-II |
| 0.250 to 0.624 incl. | 3 | 12 x 36 | Cal .30 M2 AP at 0° | A-II |
| 0.625 to 1.125 incl. | 1 & 3 | 12 x 36 | Cal .50 M2 AP at 0° | A-III |
| 1.126 to 2.750 incl. | 1, 3 & 4 | 12 x 36 | 20 mm M602 APIT at 0° | A-IV |
| 2.751 to 3.500 incl. | 1 & 3 | 60 x 72 | 90 mm M82 APC at 45° | A-V |
| 3.501 to 3.999 incl. | 1 & 3 | 60 x 72 | 90 mm M82 APC at 30° | A-VI |
| 4.000 to 6.000 incl. | 1 & 3 | 60 x 72 | 90 mm M318A1 AP at 0° | A-VII |
| Over 6.000 ^{2/} | 3 | --- | --- | --- |
| 0.098 to 0.249 incl. | 2 | 12 x 36 | Cal .30 FSP at 0° | A-VIII |
| 0.250 to 0.499 incl. | 2 | 12 x 36 | Cal .50 FSP at 0° | A-IX |
| 0.500 to 1.000 incl. | 2 | 12 x 36 | 20 mm FSP at 0° | A-X |
| Over 1.000 ^{2/} | 2 | --- | --- | --- |
| 0.231 to 0.354 incl. | 4 | 12 x 36 | Cal .30 M2 AP at 30° | A-XI |
| 0.355 to 0.590 incl. | 4 | 12 x 36 | Cal .50 M2 AP at 30° | A-XII |
| 0.591 to 0.765 incl. | 4 | 12 x 36 | 14.5 mm B32 API at 30° | A-XIII |
| 0.766 to 1.125 incl. | 4 | 12 x 36 | 14.5 mm BS41 API at 30° | A-XIV |

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

^{2/} No ballistic test required.

4.6.1.2 Impact samples. At least one impact test sample shall be taken from near each submitted test plate in accordance with 4.8.3.1 or 4.8.3.2 and each shall consist of enough material for six impact specimens.

4.6.1.3 Bend test. Two bend test samples shall be tested in the transverse direction.

4.6.1.4 Decarburization. At least one decarburization test sample shall be taken on each plate selected for the ballistic tests for plates with an ordered thickness of 0.500 inch and less. Complete and partial decarburization shall be less than 0.017 inch when tested in accordance with ASTM E1077 (see 4.8.5).

4.6.1.5 Ultrasonic examination. Each submitted test plate greater than 0.625 inch in thickness shall be ultrasonically examined in accordance with 4.7.3.

4.6.1.6 Ballistic test plates. Two ballistic test plates for each nominal thickness range (see Table VI) 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 two plates submitted shall be of the same ordered thickness. The average thickness of each test plate shall be determined at the test site by the test agency as indicated in 4.6.2.5.

4.6.1.7 Heat Affected Zone. Supplier must demonstrate ability to produce plates with edge condition that satisfies 3.2.12.2

4.6.2 Sampling for production acceptance inspection.

4.6.2.1 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 6.4).

4.6.2.2 For hardness test.

4.6.2.2.1 Manual method. The Brinell hardness of each plate as heat treated in each lot up to 1.5 inches thick shall be measured in two places, one at each end of a diagonal on one plate surface. The Brinell hardness of each plate as heat treated in each lot over 1.5 inches thick shall be measured in four places, one at each end of a diagonal on both surfaces.

4.6.2.2.2 Image analysis method. Image analysis systems may be used to read the indentation and compute the hardness value and if the heat treating process is continuous (not batch or oscillation), then the amount of testing may be reduced to one surface measurement per plate up to 1.5 inches. Plates over 1.5 inches shall be tested on both surfaces.

4.6.2.3 For Charpy V-notch impact tests. For each lot, at least one sample shall be taken for Charpy V-notch impact tests. This sample shall be extracted from the plate near the ballistic test sample representing the same lot. The sample shall be large enough to obtain at least three specimens, in each direction, from each sample in accordance with 4.8.3.

4.6.2.4 Bend test. Two bend test samples shall be tested in the transverse direction.

4.6.2.5 Ultrasonic examination. All ballistic test plates greater than 0.625 inch in thickness shall be ultrasonically examined in accordance with 4.7.3.

4.6.2.6 For ballistic acceptance samples. Unless otherwise specified in the contract or order (see 6.2), one test plate shall be submitted from each lot. The minimum plate size shall be as shown in Table VI for the applicable thickness. 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 ASTM A6/A6M or Tables III), the procuring activity shall be notified. A Rolled Homogeneous Armor (RHA) 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 thickness, 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 VI, then each of the ordered thicknesses shall be ballistically tested.

4.7 Examination.

4.7.1 Visual. All steel plate shall be subject to visual inspection for compliance with the requirements for surface conditions (see 3.2.12.1), edge quality (see 3.2.12.3 and 3.2.12.4) and identification marking (see 3.2.10).

4.7.2 Dimensions. All steel plates shall be subject to inspection for compliance with dimensional and tolerance requirements (3.2.8). 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.

4.7.3 Ultrasonic examination.

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

4.7.3.2 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).
- (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.

4.7.3.3 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 ISO 9712. Personnel making accept/reject decisions in accordance with the process described by this specification shall be qualified to at least a level II (See 6.3.19).

4.8 Tests.

4.8.1 Chemical analysis. Chemical analysis shall be conducted in accordance with the applicable method specified in ASTM A751 (see 6.4). The analysis shall comply with the declared composition established in accordance with the requirement of Table I (see 3.2.1).

4.8.2 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. 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 requirement for the thickness as specified in Table II.

4.8.2.1 Hardness tests for thin gauge. For plates less than 0.187 inches (4.75 mm) in thickness, a Brinell hardness test shall be conducted in accordance with ASTM E10 using a 5 mm carbide ball and a 750 kilogram load or a 10 mm carbide ball and a 1500 kilogram load.

4.8.2.2 Hardness tests for impact test specimens. Samples for all classifications shall be examined on a lot by lot basis. Except as provided in 4.8.2.2.1, each sample from which impact test specimens are taken shall have a hardness check made upon it as follows: For samples 0.098 to 0.500 inch inclusive at least one hardness check shall be made on the surface. For samples greater than 1/2 inch up to 4 inches (inclusive) 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.

4.8.2.3 Hardness traverse test. Prior to production to assure compliance to paragraph 3.2.11.2, the size of the heat affected zone for thermally-cut edges shall be determined by taking 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.

4.8.3 Charpy V-notch impact tests. Three (3) Charpy V-notch impact test specimens per direction for a total of six (6) Charpy V-notch impact 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 transverse (TL) orientation and longitudinal (LT) orientation from each sample as obtained in accordance with 4.8.3.1 or 4.8.3.2, and shall be prepared and tested in accordance with ASTM E23 and A370. The largest attainable sub-size Charpy V-notch impact test specimens shown in Figure 7 of ASTM E23 shall be used.

4.8.3.1 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 transverse (TL) orientation and longitudinal (LT) orientation (see 3.2.7.2) 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 thermally-cut edge. When the amount of materials available is insufficient to obtain standard specimens, the largest attainable sub-size Charpy V-notch impact specimens shown in Figure 4 of ASTM E23 shall be used and the results compared to the applicable requirements of Table IV. There are no Charpy V-notch impact test requirements for plates less than 0.140 inches thick.

4.8.3.2 For sample 4 inches or greater in thickness. Charpy V-notch impact test specimens from samples 4 inches or greater in thickness shall be taken in both the transverse (TL) orientation and longitudinal (LT) orientation 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.

4.8.4 Bend test. Bend test samples shall be tested in the transverse direction per ASTM E290, at room temperature through an included angle of 90 degrees (unrestrained) to the inside radii shown in Table V.

4.8.5 Decarburization tests. At least one decarburization test sample shall be taken on each plate selected for the ballistic tests for plates with an ordered thickness of 0.500 inch and less (see 4.6.1.4). ASTM E1077 shall be used to ensure that the depth of decarburization does not exceed 0.017 inch.

4.8.6 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 the Appendix A.

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 (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.

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, and failure of the acceptance samples to meet the requirements of this specification shall be cause for rejection of the lot (see 4.10.2).

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 correction in the processing of the material to the satisfaction of the procuring activity.

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 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 plate is intended for use in those areas where maximum resistance to penetration by armor piercing types of ammunition is required. Please note that MIL-DTL-46177, entitled, "Armor, Steel Plate and Sheet, Wrought, Homogeneous (1/8 to less than 1/4 inch thick)" was incorporated into this document for new design. MIL-DTL-46177C has been in-activated for new designs; therefore, legacy designs/items (contracts/drawings) which used MIL-DTL-46177C in the past can continue to use MIL-DTL-46177C. The current thickness of this specification was even further reduced to 0.098 inches.

6.1.2 Class 2. Class 2 wrought armor plate 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 plate 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 4a. Class 4a wrought armor plate has the same maximum carbon content as the other classes, but is tempered at lower temperatures (in Stage I) to give higher hardness. This higher hardness gives the armor enhanced resistance to ballistic penetration.

6.1.5 Class 4b. Class 4b wrought armor has the same maximum carbon content as the other classes, but is tempered at lower temperatures (in Stage I) to give higher hardness. This higher hardness gives the armor enhanced resistance to ballistic penetration. Class 4b has air hardening ability which may lend itself to applications requiring heat treatment after fabrication by forming or other operations.

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 3.2.8.1) and classification (see 1.2).
- c. If first article samples are required (see 3.1, 4.4, and 4.4.2).
- d. If the declared chemistry composition can be different (see 3.2.1).
- e. If an analysis of Antimony, Arsenic or Lead is required (see 3.2.1)
- f. If a CE limit for Class 3 material, is required (see 3.2.2.2).
- g. If a different CE is required for Class 4a material (see 3.2.2.3).
- h. If a CE limit for Class 4b material, is required (see 3.2.2.4).
- i. If the condition of the plates is different (see 3.2.4 and 3.2.11.1).
- j. If descaling is required (see 3.2.4).
- k. If weld repair is not permitted (see 3.2.5.3.1 and 3.2.5.3.2).
- l. If a bend test is not required for material less than 1/2 inch in thickness (see 3.2.6.3).
- m. If a bend test is required for material greater than 1/2 inch in thickness (see 3.2.6.3 and Table V).
- n. If visual inspection requirement is different (see 3.2.6.3).

- o. Specify dimensions (see 3.2.8.1).
- p. If dimensional tolerances can be other than that specified in Table III (see 3.2.8.1).
- q. Specify thickness tolerances for plates greater than 168 inches in width (see 3.2.8.2.2).
- r. If the flatness tolerance is different than those specified (see 3.2.8.3).
- s. If tighter flatness tolerance requirements are to be specified (see 3.2.8.3).
- t. If the waviness tolerance is different than those specified (see 3.2.8.4).
- u. If inspection for surface imperfections is required (see 3.2.11.1.1).
- v. If the limits specified for heat affected zone need to be exceeded (see 3.2.11.2).
- w. Specify the acceptance level for internal soundness if other than Level C as defined in ASTM A578/A578M (see 3.2.11.4)
- x. If someone other than the contractor is responsible for the performance of all the requirements of the specification (see 4.2).
- y. If the contractor can't use his own facility or any other facility for testing (see 4.2).
- z. If the ballistic tests are to be conducted at another location (see 4.2.1 and 4.8.6).
 - aa. If production and ballistic test plates can be heat treated separately (see 4.3).
 - ab. If the number of test plates per lot for ballistic acceptance testing is different (see 4.6.2.6).
 - ac. If ultrasonic examination is to be different (see 4.7.3.2).
 - ad. If certification of inspection personnel is different (see 4.7.3.3).
 - ae. Specify reduced testing plan when applicable (see 4.9).
 - af. If rejection requirements differ (see 4.10.1).
 - ag. If retest requirements differ (see 4.10.2).
 - ah. Packaging requirements (see 5.1).
 - ai. If definition of a crack is different (see 6.3.18)

6.3 Definitions.

6.3.1 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.

6.3.2 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 or her authority.

6.3.3 Rolled homogeneous armor. Rolled homogeneous armor is armor having uniform composition heat treatment.

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

6.3.5 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.

6.3.6 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.

6.3.7 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.

6.3.8 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. They are also called check marks, checking, and heat checks.

6.3.9 Seams. A seam is an un-welded fold or lap that appears as a crack, usually resulting from a discontinuity on a metal surface.

6.3.10 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.

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

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

6.3.13 Burning. Burning is permanently damaged metal due to overheating enough to cause incipient melting or intergranular oxidations. Note: this condition is usually obscured by normal cleaning methods and would require deep pickling and/or metallography to note the continuous oxidation (chicken wire effect) of the enlarged grain boundaries.

6.3.14 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.

6.3.15 Pit. A pit is a cavity or depressed area on the surface of a plate.

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

6.3.17 Thickness. The symbol "T" is used throughout this specification to indicate the nominal thickness of the plate under consideration.

6.3.18 Crack. A crack is a planar discontinuity in the metal that has length and is at least 0.002 inch deep. Cracks may be surface cracks or through cracks. For the purposes of this specification, a crack is identifiable by the unaided eye unless otherwise specified in the contract or purchase order (see 6.2).

6.3.19 Level II certification, as defined by ISO 9712. A Level II individual should be capable of demonstrating competence to perform non-destructive testing according to established procedures. Within the scope of the competence defined on the certificate, Level II personnel may be authorized by their employer to:

- a) Select the NDT technique for the test method to be used,
- b) Define the limitations of application of the testing method,

- c) Translate NDT codes, standards, specifications and procedures into NDT instructions adapted to the actual working conditions,
- d) Set up and verify equipment settings,
- e) Perform and supervise tests,
- f) Interpret and evaluate results according to applicable codes, standards, specifications or procedures,
- g) Prepare NDT instructions,
- h) Carry out and supervise all tasks at or below Level II,
- i) Provide guidance for personnel at or below Level II, and
- j) Report the results of non-destructive tests.

6.4 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.

6.4.1 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.

6.4.2 Changes from prior chemical analysis requirements. The compositions of elements antimony, arsenic, lead, or zirconium are not required in the chemical composition report.

6.5 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.

6.6 Production plates. Material made to this specification has a 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 to MIL-DTL-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, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059. The armor manufacturing process should be inspected by a cognizant government representative to ensure compliance with the details of this specification.

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. 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 ATC project have been completed in preparation for the test. The contracting government agency is to initiate the new project through a letter to Commander, USA ATC, ATTN: TEDT-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059 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.

6.9 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.

6.10 Forming. Cold forming after the final quenching and tempering operations may be performed if dye penetrant or magnetic particle inspection of the formed area finds it to be free of linear indications. The supplier should practice such necessary process controls to prevent this condition.

6.11 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 VII.

TABLE VII. 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."

6.12 Subject term (key word) listing.

| | | |
|-----------------|-----------------|----------------|
| Ballistic limit | M70 projectile | M82 projectile |
| Ballistic plate | M318 projectile | M2 projectile |
| Bend test | M602 projectile | |

6.13 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.

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 API-T. 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 have 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. A gap is 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 Protection ballistic limit, BL (P).

APPENDIX A

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 60 ft/sec or a 6 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 ± 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 A-I through A-VIII.

A.3.1.1 Class 3 armor plate. For class 3 armor plate, upper ballistic limit (maximum) values shall be in accordance with the values shown in Tables A-III through A-VIII.

A.3.2 Back spalling.

APPENDIX A

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 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 diameter.

A.3.3.2 Oblique attack. Immediately after ballistic testing, plates subjected 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 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. V₅₀ 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 A-I through A-VIII.

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 3 armor which are less than 2.751 inches ordered thicknesses 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 A-1.

A.4.1.3 Rejection and retest of ballistic plates.

APPENDIX A

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

APPENDIX A

TABLE A-I. Minimum required V50 ballistic limits (protection criteria) for class 1 & 4 armor, firing obliquity: 30°; projectile: caliber .30 M2 ball.

| Thickness, inches | Required BL(P), ft/sec CLASS 1 & 4 | Thickness, inches | Required BL(P), ft/sec CLASS 1 & 4 | Thickness, inches | Required BL(P), ft/sec CLASS 1 & 4 |
|---------------------|---------------------------------------|-------------------|---------------------------------------|-------------------|---------------------------------------|
| 0.087 | 1455 | 0.120 | 1762 | 0.153 | 2071 |
| 0.088 | 1464 | 0.121 | 1771 | 0.154 | 2080 |
| 0.089 | 1473 | 0.122 | 1781 | 0.155 | 2090 |
| 0.090 | 1482 | 0.123 | 1790 | 0.156 | 2099 |
| 0.091 | 1491 | 0.124 | 1799 | 0.157 | 2109 |
| 0.092 | 1500 | 0.125 | 1809 | 0.158 | 2118 |
| 0.093 | 1509 | 0.126 | 1818 | 0.159 | 2127 |
| 0.094 | 1519 | 0.127 | 1828 | 0.160 | 2137 |
| 0.095 | 1528 | 0.128 | 1837 | 0.161 | 2141 |
| 0.096 | 1537 | 0.129 | 1846 | 0.162 | 2146 |
| 0.097 | 1546 | 0.130 | 1856 | 0.163 | 2151 |
| 0.098 ^{1/} | 1556 | 0.131 | 1865 | 0.164 | 2156 |
| 0.099 | 1565 | 0.132 | 1874 | 0.165 | 2161 |
| 0.100 | 1574 | 0.133 | 1884 | 0.166 | 2166 |
| 0.101 | 1584 | 0.134 | 1893 | 0.167 | 2171 |
| 0.102 | 1593 | 0.135 | 1903 | 0.168 | 2176 |
| 0.103 | 1603 | 0.136 | 1912 | 0.169 | 2180 |
| 0.104 | 1612 | 0.137 | 1921 | 0.170 | 2185 |
| 0.105 | 1622 | 0.138 | 1931 | 0.171 | 2190 |
| 0.106 | 1631 | 0.139 | 1940 | 0.172 | 2195 |
| 0.107 | 1640 | 0.140 | 1949 | 0.173 | 2200 |
| 0.108 | 1650 | 0.141 | 1959 | 0.174 | 2204 |
| 0.109 | 1659 | 0.142 | 1968 | 0.175 | 2209 |
| 0.110 | 1668 | 0.143 | 1977 | 0.176 | 2214 |
| 0.111 | 1678 | 0.144 | 1987 | 0.177 | 2219 |
| 0.112 | 1687 | 0.145 | 1996 | 0.178 | 2224 |
| 0.113 | 1696 | 0.146 | 2006 | 0.179 | 2228 |
| 0.114 | 1706 | 0.147 | 2015 | 0.180 | 2233 |
| 0.115 | 1715 | 0.148 | 2024 | 0.181 | 2238 |
| 0.116 | 1725 | 0.149 | 2034 | 0.182 | 2242 |
| 0.117 | 1734 | 0.150 | 2043 | 0.183 | 2247 |
| 0.118 | 1743 | 0.151 | 2052 | 0.184 | 2252 |
| 0.119 | 1753 | 0.152 | 2062 | 0.185 | 2257 |

^{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.

APPENDIX A

TABLE A-I. Minimum required V50 ballistic limits (protection criteria) for class 1 and 4 armor, firing obliquity: 30°; projectile: caliber .30 M2 ball. (Continued)

| Thickness, inches | Required BL(P), ft/sec CLASS 1 & 4 | Thickness, inches | Required BL(P), ft/sec CLASS 1 & 4 |
|-------------------|---------------------------------------|---------------------|---------------------------------------|
| 0.186 | 2261 | 0.215 | 2393 |
| 0.187 | 2266 | 0.216 | 2398 |
| 0.188 | 2271 | 0.217 | 2402 |
| 0.189 | 2275 | 0.218 | 2407 |
| 0.190 | 2280 | 0.219 | 2411 |
| 0.191 | 2285 | 0.220 | 2416 |
| 0.192 | 2289 | 0.221 | 2420 |
| 0.193 | 2294 | 0.222 | 2424 |
| 0.194 | 2298 | 0.223 | 2428 |
| 0.195 | 2303 | 0.224 | 2433 |
| 0.196 | 2308 | 0.225 | 2437 |
| 0.197 | 2312 | 0.226 | 2441 |
| 0.198 | 2317 | 0.227 | 2446 |
| 0.199 | 2321 | 0.228 | 2450 |
| 0.200 | 2326 | 0.229 | 2454 |
| 0.201 | 2330 | 0.230 ^{2/} | 2459 |
| 0.202 | 2335 | 0.231 | 2463 |
| 0.203 | 2339 | 0.232 | 2467 |
| 0.204 | 2344 | 0.233 | 2472 |
| 0.205 | 2348 | 0.234 | 2476 |
| 0.206 | 2353 | 0.235 | 2480 |
| 0.207 | 2357 | 0.236 | 2484 |
| 0.208 | 2362 | 0.237 | 2489 |
| 0.209 | 2366 | 0.238 | 2493 |
| 0.210 | 2371 | 0.239 | 2497 |
| 0.211 | 2375 | 0.240 | 2501 |
| 0.212 | 2380 | 0.241 | 2506 |
| 0.213 | 2384 | 0.242 | 2510 |
| 0.214 | 2389 | 0.243 | 2514 |

^{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.

APPENDIX A

TABLE A-II. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .30 M2 AP.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|---------------------|--------------------|-------|-------------------|---------------|-------|---------------------|---------------|-------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 0.205 | 1386 ^{1/} | N/A | 0.355 | 1994 | 2135 | 0.505 | 2456 | 2597 | | |
| 0.210 | 1411 ^{1/} | N/A | 0.360 | 2011 | 2152 | 0.510 | 2470 | 2611 | | |
| 0.215 | 1435 ^{1/} | N/A | 0.365 | 2028 | 2169 | 0.515 | 2484 | 2625 | | |
| 0.220 | 1458 ^{1/} | N/A | 0.370 | 2045 | 2186 | 0.520 | 2498 | 2639 | | |
| 0.225 | 1482 | 1623 | 0.375 | 2062 | 2203 | 0.525 | 2512 | 2653 | | |
| 0.231 ^{2/} | 1509 | 1650 | 0.380 | 2078 | 2219 | 0.530 | 2525 | 2666 | | |
| 0.235 | 1532 | 1673 | 0.385 | 2095 | 2236 | 0.535 | 2539 | 2680 | | |
| 0.240 | 1554 | 1695 | 0.390 | 2111 | 2252 | 0.540 | 2552 | 2693 | | |
| 0.245 | 1575 | 1716 | 0.395 | 2127 | 2268 | 0.545 | 2566 | 2707 | | |
| 0.250 ^{3/} | 1596 | 1737 | 0.400 | 2143 | 2284 | 0.550 | 2579 | 2720 | | |
| 0.255 | 1618 | 1759 | 0.405 | 2159 | 2300 | 0.555 | 2593 | 2734 | | |
| 0.260 | 1638 | 1779 | 0.410 | 2175 | 2316 | 0.560 | 2606 | 2747 | | |
| 0.265 | 1659 | 1800 | 0.415 | 2191 | 2332 | 0.565 | 2619 | 2760 | | |
| 0.270 | 1679 | 1820 | 0.420 | 2206 | 2347 | 0.570 | 2632 | 2773 | | |
| 0.275 | 1699 | 1840 | 0.425 | 2222 | 2363 | 0.575 | 2645 | 2786 | | |
| 0.280 | 1719 | 1860 | 0.430 | 2237 | 2378 | 0.580 | 2658 | 2799 | | |
| 0.285 | 1739 | 1880 | 0.435 | 2252 | 2393 | 0.585 | 2671 | 2812 | | |
| 0.290 | 1758 | 1899 | 0.440 | 2267 | 2408 | 0.590 | 2684 | 2825 | | |
| 0.295 | 1778 | 1919 | 0.445 | 2282 | 2423 | 0.595 | 2697 | 2838 | | |
| 0.300 | 1797 | 1938 | 0.450 | 2297 | 2438 | 0.600 | 2710 | 2851 | | |
| 0.305 | 1815 | 1956 | 0.455 | 2312 | 2453 | 0.605 | 2723 | 2864 | | |
| 0.310 | 1834 | 1975 | 0.460 | 2327 | 2468 | 0.610 | 2736 | 2877 | | |
| 0.315 | 1853 | 1994 | 0.465 | 2342 | 2483 | 0.615 | 2749 | 2890 | | |
| 0.320 | 1871 | 2012 | 0.470 | 2356 | 2497 | 0.620 | 2762 | 2903 | | |
| 0.325 | 1889 | 2030 | 0.475 | 2371 | 2512 | 0.624 ^{4/} | 2772 | 2913 | | |
| 0.330 | 1907 | 2048 | 0.480 | 2385 | 2526 | 0.625 | 2775 | 2916 | | |
| 0.335 | 1925 | 2066 | 0.485 | 2400 | 2541 | 0.630 | 2788 | 2929 | | |
| 0.340 | 1942 | 2083 | 0.490 | 2414 | 2555 | 0.635 | 2801 | 2942 | | |
| 0.345 | 1960 | 2101 | 0.495 | 2428 | 2569 | 0.640 | 2814 | 2955 | | |
| 0.350 | 1977 | 2118 | 0.500 | 2442 | 2583 | 0.645 | 2827 | 2968 | | |

^{1/} Values only apply to Class 1^{2/} Specification requirements begin for this ordered thickness for Class 1.^{3/} Specification requirements begin for this ordered thickness for Class 3.^{4/} Specification requirements end for this ordered thickness for Classes 1 & 3.

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

APPENDIX A

TABLE A-III. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .50 M2 AP.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 0.550 | 1901 | 2047 | 0.695 | 2182 | 2328 | 0.845 | 2439 | 2585 | | |
| 0.555 | 1911 | 2057 | 0.700 | 2191 | 2337 | 0.850 | 2447 | 2593 | | |
| 0.560 | 1922 | 2068 | 0.705 | 2200 | 2346 | 0.855 | 2455 | 2601 | | |
| 0.565 | 1932 | 2078 | 0.710 | 2209 | 2355 | 0.860 | 2464 | 2610 | | |
| 0.566 | 1934 | 2080 | 0.715 | 2218 | 2364 | 0.865 | 2472 | 2618 | | |
| 0.570 | 1942 | 2088 | 0.720 | 2227 | 2373 | 0.870 | 2480 | 2626 | | |
| 0.575 | 1952 | 2098 | 0.725 | 2235 | 2381 | 0.875 | 2488 | 2634 | | |
| 0.580 | 1962 | 2108 | 0.730 | 2244 | 2390 | 0.880 | 2496 | 2642 | | |
| 0.585 | 1972 | 2118 | 0.735 | 2253 | 2399 | 0.885 | 2504 | 2650 | | |
| 0.590 | 1982 | 2128 | 0.740 | 2262 | 2408 | 0.890 | 2511 | 2657 | | |
| 0.595 | 1992 | 2138 | 0.745 | 2271 | 2417 | 0.895 | 2519 | 2665 | | |
| 0.600 | 2002 | 2148 | 0.750 | 2279 | 2425 | 0.900 | 2527 | 2673 | | |
| 0.605 | 2012 | 2158 | 0.755 | 2288 | 2434 | 0.905 | 2535 | 2681 | | |
| 0.610 | 2022 | 2168 | 0.760 | 2297 | 2443 | 0.910 | 2543 | 2689 | | |
| 0.615 | 2031 | 2177 | 0.765 | 2305 | 2451 | 0.915 | 2551 | 2697 | | |
| 0.620 | 2041 | 2187 | 0.770 | 2314 | 2460 | 0.920 | 2559 | 2705 | | |
| 0.625 ^{1/} | 2051 | 2197 | 0.775 | 2322 | 2468 | 0.925 | 2566 | 2712 | | |
| 0.630 | 2060 | 2206 | 0.780 | 2331 | 2477 | 0.930 | 2574 | 2720 | | |
| 0.635 | 2070 | 2216 | 0.785 | 2339 | 2485 | 0.935 | 2582 | 2728 | | |
| 0.640 | 2079 | 2225 | 0.790 | 2348 | 2494 | 0.940 | 2590 | 2736 | | |
| 0.645 | 2089 | 2235 | 0.795 | 2356 | 2502 | 0.945 | 2597 | 2743 | | |
| 0.650 | 2098 | 2244 | 0.800 | 2365 | 2511 | 0.950 | 2605 | 2751 | | |
| 0.655 | 2108 | 2254 | 0.805 | 2373 | 2519 | 0.955 | 2612 | 2758 | | |
| 0.660 | 2117 | 2263 | 0.810 | 2382 | 2528 | 0.960 | 2620 | 2766 | | |
| 0.665 | 2126 | 2272 | 0.815 | 2390 | 2536 | 0.965 | 2628 | 2774 | | |
| 0.670 | 2136 | 2282 | 0.820 | 2398 | 2544 | 0.970 | 2635 | 2781 | | |
| 0.675 | 2145 | 2291 | 0.825 | 2406 | 2552 | 0.975 | 2643 | 2789 | | |
| 0.680 | 2154 | 2300 | 0.830 | 2415 | 2561 | 0.980 | 2650 | 2796 | | |
| 0.685 | 2163 | 2309 | 0.835 | 2423 | 2569 | 0.985 | 2658 | 2804 | | |
| 0.690 | 2173 | 2319 | 0.840 | 2431 | 2577 | 0.990 | 2665 | 2811 | | |

^{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.

APPENDIX A

TABLE A-III. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: caliber .50 M2 AP-
Continued.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 0.995 | 2673 | 2819 | 1.065 | 2775 | 2921 | 1.135 | 2874 | 3020 | | |
| 1.000 | 2680 | 2826 | 1.070 | 2782 | 2928 | 1.140 | 2881 | 3027 | | |
| 1.005 | 2688 | 2834 | 1.075 | 2790 | 2936 | 1.145 | 2888 | 3034 | | |
| 1.010 | 2695 | 2841 | 1.080 | 2797 | 2943 | 1.150 | 2895 | 3041 | | |
| 1.015 | 2702 | 2848 | 1.085 | 2804 | 2950 | 1.155 | 2902 | 3048 | | |
| 1.020 | 2710 | 2856 | 1.090 | 2811 | 2957 | 1.160 | 2909 | 3055 | | |
| 1.025 | 2717 | 2863 | 1.095 | 2818 | 2964 | 1.165 | 2915 | 3061 | | |
| 1.030 | 2724 | 2870 | 1.100 | 2825 | 2971 | 1.170 | 2922 | 3068 | | |
| 1.035 | 2732 | 2878 | 1.105 | 2832 | 2978 | 1.175 | 2929 | 3075 | | |
| 1.040 | 2739 | 2885 | 1.110 | 2839 | 2985 | 1.180 | 2936 | 3082 | | |
| 1.045 | 2746 | 2892 | 1.115 | 2846 | 2992 | 1.185 | 2943 | 3089 | | |
| 1.050 | 2754 | 2900 | 1.120 | 2853 | 2999 | 1.190 | 2949 | 3095 | | |
| 1.055 | 2761 | 2907 | 1.125 ^{2/} | 2860 | 3006 | 1.195 | 2956 | 3102 | | |
| 1.060 | 2768 | 2914 | 1.130 | 2867 | 3013 | 1.200 | 2963 | 3109 | | |

^{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.

APPENDIX A

TABLE A-IV. Minimum required ballistic limits (protection criteria) for class 1, 3 and 4 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 20 mm M602 API-T.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|-----------------|----------|----------------------|-----------------|----------|----------------------|-----------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1, 3 & 4 Min | 3 Max | | 1, 3 & 4 Min | 3 Max | | 1, 3 & 4 Min | 3 Max | | |
| 1.080 | 1909 | 2016 | 1.400 | 2265 | 2403 | 1.730 | 2586 | 2748 | | |
| 1.090 | 1921 | 2029 | 1.410 | 2275 | 2414 | 1.740 | 2595 | 2758 | | |
| 1.100 | 1933 | 2042 | 1.420 | 2285 | 2425 | 1.750 | 2604 | 2768 | | |
| 1.110 | 1945 | 2055 | 1.430 | 2295 | 2436 | 1.760 | 2613 | 2778 | | |
| 1.120 | 1957 | 2068 | 1.440 | 2305 | 2447 | 1.770 | 2613 | 2787 | | |
| 1.126 ^{1/} | 1964 | 2076 | 1.450 | 2315 | 2458 | 1.780 | 2621 | 2797 | | |
| 1.130 | 1969 | 2081 | 1.460 | 2325 | 2469 | 1.790 | 2630 | 2807 | | |
| 1.140 | 1981 | 2094 | 1.470 | 2335 | 2480 | 1.800 | 2639 | 2816 | | |
| 1.150 | 1993 | 2106 | 1.480 | 2344 | 2491 | 1.810 | 2647 | 2826 | | |
| 1.160 | 2004 | 2119 | 1.490 | 2354 | 2501 | 1.820 | 2656 | 2836 | | |
| 1.170 | 2016 | 2131 | 1.500 | 2364 | 2512 | 1.830 | 2664 | 2845 | | |
| 1.180 | 2027 | 2144 | 1.510 | 2374 | 2523 | 1.840 | 2673 | 2855 | | |
| 1.190 | 2039 | 2156 | 1.520 | 2383 | 2534 | 1.850 | 2681 | 2864 | | |
| 1.200 | 2050 | 2169 | 1.530 | 2393 | 2544 | 1.860 | 2690 | 2874 | | |
| 1.210 | 2061 | 2181 | 1.540 | 2403 | 2555 | 1.870 | 2698 | 2883 | | |
| 1.220 | 2073 | 2193 | 1.550 | 2412 | 2565 | 1.880 | 2707 | 2892 | | |
| 1.230 | 2084 | 2205 | 1.560 | 2422 | 2576 | 1.890 | 2715 | 2902 | | |
| 1.240 | 2095 | 2217 | 1.570 | 2431 | 2586 | 1.900 | 2723 | 2911 | | |
| 1.250 | 2106 | 2229 | 1.580 | 2440 | 2597 | 1.910 | 2732 | 2921 | | |
| 1.260 | 2117 | 2241 | 1.590 | 2450 | 2607 | 1.920 | 2740 | 2930 | | |
| 1.270 | 2128 | 2253 | 1.600 | 2459 | 2617 | 1.930 | 2748 | 2939 | | |
| 1.280 | 2139 | 2265 | 1.610 | 2468 | 2628 | 1.940 | 2757 | 2948 | | |
| 1.290 | 2149 | 2277 | 1.620 | 2478 | 2638 | 1.950 | 2765 | 2958 | | |
| 1.300 | 2160 | 2289 | 1.630 | 2487 | 2648 | 1.960 | 2773 | 2967 | | |
| 1.310 | 2171 | 2300 | 1.640 | 2496 | 2658 | 1.970 | 2781 | 2976 | | |
| 1.320 | 2181 | 2312 | 1.650 | 2505 | 2668 | 1.980 | 2789 | 2985 | | |
| 1.330 | 2192 | 2323 | 1.660 | 2514 | 2678 | 1.990 | 2798 | 2994 | | |
| 1.340 | 2203 | 2335 | 1.670 | 2524 | 2689 | 2.000 | 2806 | 3003 | | |
| 1.350 | 2213 | 2346 | 1.680 | 2533 | 2699 | 2.010 | 2814 | 3012 | | |
| 1.360 | 2223 | 2358 | 1.690 | 2542 | 2709 | 2.020 | 2822 | 3021 | | |
| 1.370 | 2234 | 2369 | 1.700 | 2551 | 2719 | 2.030 | 2830 | 3030 | | |
| 1.380 | 2244 | 2380 | 1.710 | 2560 | 2728 | 2.040 | 2838 | 3039 | | |
| 1.390 | 2254 | 2392 | 1.720 | 2568 | 2738 | 2.050 | 2846 | 3048 | | |

^{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.

APPENDIX A

TABLE A-IV. Minimum required ballistic limits (protection criteria) for class 1, 3 and 4 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 20 mm M602 API-T.
Continued.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|-------------------|-----------------|----------|-------------------|-----------------|----------|---------------------|-----------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1, 3 & 4 Min | 3 Max | | 1, 3 & 4 Min | 3 Max | | 1, 3 & 4 Min | 3 Max | | |
| 2.060 | 2854 | 3057 | 2.320 | 3052 | 3282 | 2.580 | 3238 | 3493 | | |
| 2.070 | 2862 | 3066 | 2.330 | 3060 | 3290 | 2.590 | 3245 | 3501 | | |
| 2.080 | 2870 | 3075 | 2.340 | 3067 | 3298 | 2.600 | 3252 | 3509 | | |
| 2.090 | 2877 | 3084 | 2.350 | 3075 | 3307 | 2.610 | 3259 | 3516 | | |
| 2.100 | 2885 | 3093 | 2.360 | 3082 | 3315 | 2.620 | 3265 | 3524 | | |
| 2.110 | 2893 | 3102 | 2.370 | 3089 | 3323 | 2.630 | 3272 | 3532 | | |
| 2.120 | 2901 | 3110 | 2.380 | 3096 | 3331 | 2.640 | 3279 | 3540 | | |
| 2.130 | 2909 | 3119 | 2.390 | 3104 | 3340 | 2.650 | 3286 | 3548 | | |
| 2.140 | 2916 | 3128 | 2.400 | 3111 | 3348 | 2.660 | 3293 | 3556 | | |
| 2.150 | 2924 | 3137 | 2.410 | 3118 | 3356 | 2.670 | 3299 | 3563 | | |
| 2.160 | 2932 | 3145 | 2.420 | 3125 | 3364 | 2.680 | 3306 | 3571 | | |
| 2.170 | 2940 | 3154 | 2.430 | 3132 | 3372 | 2.690 | 3313 | 3579 | | |
| 2.180 | 2947 | 3163 | 2.440 | 3140 | 3381 | 2.700 | 3320 | 3586 | | |
| 2.190 | 2955 | 3171 | 2.450 | 3147 | 3389 | 2.710 | 3326 | 3594 | | |
| 2.200 | 2963 | 3180 | 2.460 | 3154 | 3397 | 2.720 | 3333 | 3602 | | |
| 2.210 | 2970 | 3188 | 2.470 | 3161 | 3405 | 2.730 | 3340 | 3610 | | |
| 2.220 | 2978 | 3197 | 2.480 | 3168 | 3413 | 2.740 | 3346 | 3617 | | |
| 2.230 | 2985 | 3206 | 2.490 | 3175 | 3421 | 2.750 ^{2/} | 3353 | 3625 | | |
| 2.240 | 2993 | 3214 | 2.500 | 3182 | 3429 | 2.760 | 3360 | 3632 | | |
| 2.250 | 3000 | 3223 | 2.510 | 3189 | 3437 | 2.770 | 3366 | 3640 | | |
| 2.260 | 3008 | 3231 | 2.520 | 3196 | 3445 | 2.780 | 3373 | 3648 | | |
| 2.270 | 3015 | 3240 | 2.530 | 3203 | 3453 | 2.790 | 3380 | 3655 | | |
| 2.280 | 3023 | 3248 | 2.540 | 3210 | 3461 | 2.800 | 3386 | 3663 | | |
| 2.290 | 3030 | 3257 | 2.550 | 3217 | 3469 | 2.810 | 3393 | 3670 | | |
| 2.300 | 3038 | 3265 | 2.560 | 3224 | 3477 | 2.820 | 3400 | 3678 | | |
| 2.310 | 3045 | 3273 | 2.570 | 3231 | 3485 | 2.830 | 3406 | 3686 | | |

^{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.

APPENDIX A

TABLE A-V. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 45°, projectile: caliber 90 mm M82 APC.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 2.690 | 2089 | 2382 | 2.980 | 2260 | 2553 | 3.280 | 2425 | 2718 | | |
| 2.700 | 2095 | 2388 | 2.990 | 2265 | 2558 | 3.290 | 2430 | 2723 | | |
| 2.710 | 2101 | 2394 | 3.000 | 2271 | 2564 | 3.300 | 2436 | 2729 | | |
| 2.720 | 2107 | 2400 | 3.010 | 2277 | 2570 | 3.310 | 2441 | 2734 | | |
| 2.730 | 2113 | 2406 | 3.020 | 2282 | 2575 | 3.320 | 2446 | 2739 | | |
| 2.740 | 2119 | 2412 | 3.030 | 2288 | 2581 | 3.330 | 2451 | 2744 | | |
| 2.750 | 2125 | 2418 | 3.040 | 2294 | 2587 | 3.340 | 2457 | 2750 | | |
| 2.751 ^{1/} | 2126 | 2419 | 3.050 | 2299 | 2592 | 3.350 | 2462 | 2755 | | |
| 2.760 | 2131 | 2424 | 3.060 | 2305 | 2598 | 3.360 | 2467 | 2760 | | |
| 2.770 | 2137 | 2430 | 3.070 | 2310 | 2603 | 3.370 | 2472 | 2765 | | |
| 2.780 | 2143 | 2436 | 3.080 | 2316 | 2609 | 3.380 | 2478 | 2771 | | |
| 2.790 | 2149 | 2442 | 3.090 | 2322 | 2615 | 3.390 | 2483 | 2776 | | |
| 2.800 | 2155 | 2448 | 3.100 | 2327 | 2620 | 3.400 | 2488 | 2781 | | |
| 2.810 | 2161 | 2454 | 3.110 | 2333 | 2626 | 3.410 | 2493 | 2786 | | |
| 2.820 | 2167 | 2460 | 3.120 | 2338 | 2631 | 3.420 | 2498 | 2791 | | |
| 2.830 | 2173 | 2466 | 3.130 | 2344 | 2637 | 3.430 | 2504 | 2797 | | |
| 2.840 | 2179 | 2472 | 3.140 | 2349 | 2642 | 3.440 | 2509 | 2802 | | |
| 2.850 | 2185 | 2478 | 3.150 | 2355 | 2648 | 3.450 | 2514 | 2807 | | |
| 2.860 | 2190 | 2483 | 3.160 | 2360 | 2653 | 3.460 | 2519 | 2812 | | |
| 2.870 | 2196 | 2489 | 3.170 | 2366 | 2659 | 3.470 | 2524 | 2817 | | |
| 2.880 | 2202 | 2495 | 3.180 | 2371 | 2664 | 3.480 | 2529 | 2822 | | |
| 2.890 | 2208 | 2501 | 3.190 | 2376 | 2669 | 3.490 | 2534 | 2827 | | |
| 2.900 | 2214 | 2507 | 3.200 | 2382 | 2675 | 3.500 ^{2/} | 2540 | 2833 | | |
| 2.910 | 2220 | 2513 | 3.210 | 2387 | 2680 | 3.510 | 2545 | 2838 | | |
| 2.920 | 2225 | 2518 | 3.220 | 2393 | 2686 | 3.520 | 2550 | 2843 | | |
| 2.930 | 2231 | 2524 | 3.230 | 2398 | 2691 | 3.530 | 2555 | 2848 | | |
| 2.940 | 2237 | 2530 | 3.240 | 2404 | 2697 | 3.540 | 2560 | 2853 | | |
| 2.950 | 2243 | 2536 | 3.250 | 2409 | 2702 | 3.550 | 2565 | 2858 | | |
| 2.960 | 2248 | 2541 | 3.260 | 2414 | 2707 | 3.560 | 2570 | 2863 | | |
| 2.970 | 2254 | 2547 | 3.270 | 2420 | 2713 | 3.570 | 2575 | 2868 | | |

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

APPENDIX A

TABLE A-VI. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 30°, projectile: 90 mm M82 APC.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|---------------------|---------------|-------|-------------------|---------------|-------|-------------------|---------------|-------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 3.425 | 1924 | 2116 | 3.570 | 1986 | 2178 | 3.720 | 2048 | 2240 | | |
| 3.430 | 1926 | 2118 | 3.575 | 1988 | 2180 | 3.725 | 2051 | 2243 | | |
| 3.435 | 1929 | 2121 | 3.580 | 1990 | 2182 | 3.730 | 2053 | 2245 | | |
| 3.440 | 1931 | 2123 | 3.585 | 1993 | 2185 | 3.735 | 2055 | 2247 | | |
| 3.445 | 1933 | 2125 | 3.590 | 1995 | 2187 | 3.740 | 2057 | 2249 | | |
| 3.450 | 1935 | 2127 | 3.595 | 1997 | 2189 | 3.745 | 2059 | 2251 | | |
| 3.455 | 1937 | 2129 | 3.600 | 1999 | 2191 | 3.750 | 2061 | 2253 | | |
| 3.460 | 1939 | 2131 | 3.605 | 2001 | 2193 | 3.755 | 2063 | 2255 | | |
| 3.465 | 1942 | 2134 | 3.610 | 2003 | 2195 | 3.760 | 2065 | 2257 | | |
| 3.470 | 1944 | 2136 | 3.615 | 2005 | 2197 | 3.765 | 2067 | 2259 | | |
| 3.475 | 1946 | 2138 | 3.620 | 2007 | 2199 | 3.770 | 2069 | 2261 | | |
| 3.480 | 1948 | 2140 | 3.625 | 2009 | 2201 | 3.775 | 2071 | 2263 | | |
| 3.485 | 1950 | 2142 | 3.630 | 2011 | 2203 | 3.780 | 2073 | 2265 | | |
| 3.490 | 1952 | 2144 | 3.635 | 2013 | 2205 | 3.785 | 2075 | 2267 | | |
| 3.495 | 1954 | 2146 | 3.640 | 2015 | 2207 | 3.790 | 2077 | 2269 | | |
| 3.500 | 1957 | 2149 | 3.645 | 2018 | 2210 | 3.795 | 2079 | 2271 | | |
| 3.501 ^{1/} | 1957 | 2149 | 3.650 | 2020 | 2212 | 3.800 | 2081 | 2273 | | |
| 3.505 | 1959 | 2151 | 3.655 | 2022 | 2214 | 3.805 | 2083 | 2275 | | |
| 3.510 | 1961 | 2153 | 3.660 | 2024 | 2216 | 3.810 | 2085 | 2277 | | |
| 3.515 | 1963 | 2155 | 3.665 | 2026 | 2218 | 3.815 | 2087 | 2279 | | |
| 3.520 | 1965 | 2157 | 3.670 | 2028 | 2220 | 3.820 | 2089 | 2281 | | |
| 3.525 | 1967 | 2159 | 3.675 | 2030 | 2222 | 3.825 | 2091 | 2283 | | |
| 3.530 | 1969 | 2161 | 3.680 | 2032 | 2224 | 3.830 | 2093 | 2285 | | |
| 3.535 | 1971 | 2163 | 3.685 | 2034 | 2226 | 3.835 | 2095 | 2287 | | |
| 3.540 | 1974 | 2166 | 3.690 | 2036 | 2228 | 3.840 | 2097 | 2289 | | |
| 3.545 | 1976 | 2168 | 3.695 | 2038 | 2230 | 3.845 | 2099 | 2291 | | |
| 3.550 | 1978 | 2170 | 3.700 | 2040 | 2232 | 3.850 | 2101 | 2293 | | |
| 3.555 | 1980 | 2172 | 3.705 | 2042 | 2234 | 3.855 | 2103 | 2295 | | |
| 3.560 | 1982 | 2174 | 3.710 | 2044 | 2236 | 3.860 | 2105 | 2297 | | |
| 3.565 | 1984 | 2176 | 3.715 | 2046 | 2238 | 3.865 | 2107 | 2299 | | |

^{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.

APPENDIX A

TABLE A-VI. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 30°, projectile: 90 mm M82 APC – Continued.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 3.870 | 2109 | 2301 | 3.940 | 2137 | 2329 | 4.005 | 2162 | 2354 | | |
| 3.875 | 2111 | 2303 | 3.945 | 2139 | 2331 | 4.010 | 2164 | 2356 | | |
| 3.880 | 2113 | 2305 | 3.950 | 2141 | 2333 | 4.015 | 2166 | 2358 | | |
| 3.885 | 2115 | 2307 | 3.955 | 2143 | 2335 | 4.020 | 2168 | 2360 | | |
| 3.890 | 2117 | 2309 | 3.960 | 2144 | 2336 | 4.025 | 2170 | 2362 | | |
| 3.895 | 2119 | 2311 | 3.965 | 2146 | 2338 | 4.030 | 2172 | 2364 | | |
| 3.900 | 2121 | 2313 | 3.970 | 2148 | 2340 | 4.035 | 2174 | 2366 | | |
| 3.905 | 2123 | 2315 | 3.975 | 2150 | 2342 | 4.040 | 2176 | 2368 | | |
| 3.910 | 2125 | 2317 | 3.980 | 2152 | 2344 | 4.045 | 2178 | 2370 | | |
| 3.915 | 2127 | 2319 | 3.985 | 2154 | 2346 | 4.050 | 2179 | 2371 | | |
| 3.920 | 2129 | 2321 | 3.990 | 2156 | 2348 | 4.055 | 2181 | 2373 | | |
| 3.925 | 2131 | 2323 | 3.995 | 2158 | 2350 | 4.060 | 2183 | 2375 | | |
| 3.930 | 2133 | 2325 | 3.999 ^{2/} | 2160 | 2352 | 4.065 | 2185 | 2377 | | |
| 3.935 | 2135 | 2327 | 4.000 | 2160 | 2352 | 4.070 | 2187 | 2379 | | |

^{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.

APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 90 mm M318A1 AP.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 3.940 | 1583 | 1785 | 4.260 | 1697 | 1899 | 4.580 | 1805 | 2007 | | |
| 3.950 | 1586 | 1788 | 4.270 | 1701 | 1903 | 4.590 | 1808 | 2010 | | |
| 3.960 | 1590 | 1792 | 4.280 | 1704 | 1906 | 4.600 | 1811 | 2013 | | |
| 3.970 | 1594 | 1796 | 4.290 | 1708 | 1910 | 4.610 | 1815 | 2017 | | |
| 3.980 | 1597 | 1799 | 4.300 | 1711 | 1913 | 4.620 | 1818 | 2020 | | |
| 3.990 | 1601 | 1803 | 4.310 | 1714 | 1916 | 4.630 | 1821 | 2023 | | |
| 4.000 ^{1/} | 1605 | 1807 | 4.320 | 1718 | 1920 | 4.640 | 1824 | 2026 | | |
| 4.010 | 1608 | 1810 | 4.330 | 1721 | 1923 | 4.650 | 1827 | 2029 | | |
| 4.020 | 1612 | 1814 | 4.340 | 1725 | 1927 | 4.660 | 1831 | 2033 | | |
| 4.030 | 1616 | 1818 | 4.350 | 1728 | 1930 | 4.670 | 1834 | 2036 | | |
| 4.040 | 1619 | 1821 | 4.360 | 1731 | 1933 | 4.680 | 1837 | 2039 | | |
| 4.050 | 1623 | 1825 | 4.370 | 1735 | 1937 | 4.690 | 1840 | 2042 | | |
| 4.060 | 1627 | 1829 | 4.380 | 1738 | 1940 | 4.700 | 1844 | 2046 | | |
| 4.070 | 1630 | 1832 | 4.390 | 1742 | 1944 | 4.710 | 1847 | 2049 | | |
| 4.080 | 1634 | 1836 | 4.400 | 1745 | 1947 | 4.720 | 1850 | 2052 | | |
| 4.090 | 1637 | 1839 | 4.410 | 1748 | 1950 | 4.730 | 1853 | 2055 | | |
| 4.100 | 1641 | 1843 | 4.420 | 1752 | 1954 | 4.740 | 1856 | 2058 | | |
| 4.110 | 1644 | 1846 | 4.430 | 1755 | 1957 | 4.750 | 1860 | 2062 | | |
| 4.120 | 1648 | 1850 | 4.440 | 1758 | 1960 | 4.760 | 1863 | 2065 | | |
| 4.130 | 1652 | 1854 | 4.450 | 1762 | 1964 | 4.770 | 1866 | 2068 | | |
| 4.140 | 1655 | 1857 | 4.460 | 1765 | 1967 | 4.780 | 1869 | 2071 | | |
| 4.150 | 1659 | 1861 | 4.470 | 1768 | 1970 | 4.790 | 1872 | 2074 | | |
| 4.160 | 1662 | 1864 | 4.480 | 1772 | 1974 | 4.800 | 1875 | 2077 | | |
| 4.170 | 1666 | 1868 | 4.490 | 1775 | 1977 | 4.810 | 1878 | 2080 | | |
| 4.180 | 1669 | 1871 | 4.500 | 1778 | 1980 | 4.820 | 1882 | 2084 | | |
| 4.190 | 1673 | 1875 | 4.510 | 1782 | 1984 | 4.830 | 1885 | 2087 | | |
| 4.200 | 1676 | 1878 | 4.520 | 1785 | 1987 | 4.840 | 1888 | 2090 | | |
| 4.210 | 1680 | 1882 | 4.530 | 1788 | 1990 | 4.850 | 1891 | 2093 | | |
| 4.220 | 1683 | 1885 | 4.540 | 1792 | 1994 | 4.860 | 1894 | 2096 | | |
| 4.230 | 1687 | 1889 | 4.550 | 1795 | 1997 | 4.870 | 1897 | 2099 | | |
| 4.240 | 1690 | 1892 | 4.560 | 1798 | 2000 | 4.880 | 1900 | 2102 | | |
| 4.250 | 1694 | 1896 | 4.570 | 1801 | 2003 | 4.890 | 1903 | 2105 | | |

^{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.

APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|-------------------|---------------|-------|-------------------|---------------|-------|-------------------|---------------|-------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 4.900 | 1907 | 2109 | 5.230 | 2006 | 2208 | 5.560 | 2102 | 2304 | | |
| 4.910 | 1910 | 2112 | 5.240 | 2009 | 2211 | 5.570 | 2105 | 2307 | | |
| 4.920 | 1913 | 2115 | 5.250 | 2012 | 2214 | 5.580 | 2107 | 2309 | | |
| 4.930 | 1916 | 2118 | 5.260 | 2015 | 2217 | 5.590 | 2110 | 2312 | | |
| 4.940 | 1919 | 2121 | 5.270 | 2018 | 2220 | 5.600 | 2113 | 2315 | | |
| 4.950 | 1922 | 2124 | 5.280 | 2021 | 2223 | 5.610 | 2116 | 2318 | | |
| 4.960 | 1925 | 2127 | 5.290 | 2024 | 2226 | 5.620 | 2119 | 2321 | | |
| 4.970 | 1928 | 2130 | 5.300 | 2027 | 2229 | 5.630 | 2121 | 2323 | | |
| 4.980 | 1931 | 2133 | 5.310 | 2030 | 2232 | 5.640 | 2124 | 2326 | | |
| 4.990 | 1934 | 2136 | 5.320 | 2033 | 2235 | 5.650 | 2127 | 2329 | | |
| 5.000 | 1937 | 2139 | 5.330 | 2036 | 2238 | 5.660 | 2130 | 2332 | | |
| 5.010 | 1940 | 2142 | 5.340 | 2039 | 2241 | 5.670 | 2133 | 2335 | | |
| 5.020 | 1943 | 2145 | 5.350 | 2042 | 2244 | 5.680 | 2135 | 2337 | | |
| 5.030 | 1946 | 2148 | 5.360 | 2045 | 2247 | 5.690 | 2138 | 2340 | | |
| 5.040 | 1950 | 2152 | 5.370 | 2047 | 2249 | 5.700 | 2141 | 2343 | | |
| 5.050 | 1953 | 2155 | 5.380 | 2050 | 2252 | 5.710 | 2144 | 2346 | | |
| 5.060 | 1956 | 2158 | 5.390 | 2053 | 2255 | 5.720 | 2147 | 2349 | | |
| 5.070 | 1959 | 2161 | 5.400 | 2056 | 2258 | 5.730 | 2149 | 2351 | | |
| 5.080 | 1962 | 2164 | 5.410 | 2059 | 2261 | 5.740 | 2152 | 2354 | | |
| 5.090 | 1965 | 2167 | 5.420 | 2062 | 2264 | 5.750 | 2155 | 2357 | | |
| 5.110 | 1968 | 2170 | 5.430 | 2065 | 2267 | 5.760 | 2158 | 2360 | | |
| 5.110 | 1971 | 2173 | 5.440 | 2068 | 2270 | 5.770 | 2160 | 2362 | | |
| 5.120 | 1974 | 2176 | 5.450 | 2070 | 2272 | 5.780 | 2163 | 2365 | | |
| 5.130 | 1977 | 2179 | 5.460 | 2073 | 2275 | 5.790 | 2166 | 2368 | | |
| 5.140 | 1980 | 2182 | 5.470 | 2076 | 2278 | 5.800 | 2169 | 2371 | | |
| 5.150 | 1983 | 2185 | 5.480 | 2079 | 2281 | 5.810 | 2171 | 2373 | | |
| 5.160 | 1986 | 2188 | 5.490 | 2082 | 2284 | 5.820 | 2174 | 2376 | | |
| 5.170 | 1989 | 2191 | 5.500 | 2085 | 2287 | 5.830 | 2177 | 2379 | | |
| 5.180 | 1992 | 2194 | 5.510 | 2088 | 2290 | 5.840 | 2180 | 2382 | | |
| 5.190 | 1995 | 2197 | 5.520 | 2090 | 2292 | 5.850 | 2182 | 2384 | | |
| 5.200 | 1998 | 2200 | 5.530 | 2093 | 2295 | 5.860 | 2185 | 2387 | | |
| 5.210 | 2001 | 2203 | 5.540 | 2096 | 2298 | 5.870 | 2188 | 2390 | | |
| 5.220 | 2003 | 2205 | 5.550 | 2099 | 2301 | 5.880 | 2190 | 2392 | | |

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

APPENDIX A

TABLE A-VII. Minimum required ballistic limits (protection criteria) for class 1 and 3 armor and the upper ballistic limits for class 3 armor; firing obliquity: 0°, projectile: 90 mm M318A1 AP – Continued.

| Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | Thickness, inches | BL(P), ft/sec | | | |
|----------------------|---------------|----------|----------------------|---------------|----------|----------------------|---------------|----------|--|--|
| | CLASS | | | CLASS | | | CLASS | | | |
| | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | 1 & 3 Min | 3 Max | | |
| 5.890 | 2193 | 2395 | 5.950 | 2209 | 2411 | 6.010 | 2226 | 2428 | | |
| 5.900 | 2196 | 2398 | 5.960 | 2212 | 2414 | 6.020 | 2228 | 2430 | | |
| 5.910 | 2199 | 2401 | 5.970 | 2215 | 2417 | 6.030 | 2231 | 2433 | | |
| 5.920 | 2201 | 2403 | 5.980 | 2217 | 2419 | 6.040 | 2234 | 2436 | | |
| 5.930 | 2204 | 2406 | 5.990 | 2220 | 2422 | 6.050 | 2236 | 2438 | | |
| 5.940 | 2207 | 2409 | 6.000 ^{2/} | 2223 | 2425 | 6.060 | 2239 | 2441 | | |

^{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.

APPENDIX A

TABLE A-VIII. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .30 FSP.

| Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec |
|---------------------|------------------------|-------------------|------------------------|-------------------|------------------------|
| 0.087 | 1102 | 0.120 | 1489 | 0.153 | 1875 |
| 0.088 | 1114 | 0.121 | 1500 | 0.154 | 1887 |
| 0.089 | 1125 | 0.122 | 1512 | 0.155 | 1899 |
| 0.090 | 1137 | 0.123 | 1524 | 0.156 | 1911 |
| 0.091 | 1149 | 0.124 | 1536 | 0.157 | 1922 |
| 0.092 | 1160 | 0.125 | 1547 | 0.158 | 1934 |
| 0.093 | 1172 | 0.126 | 1559 | 0.159 | 1946 |
| 0.094 | 1184 | 0.127 | 1571 | 0.160 | 1958 |
| 0.095 | 1196 | 0.128 | 1582 | 0.161 | 1969 |
| 0.096 | 1207 | 0.129 | 1594 | 0.162 | 1981 |
| 0.097 | 1219 | 0.130 | 1606 | 0.163 | 1993 |
| 0.098 ^{1/} | 1231 | 0.131 | 1618 | 0.164 | 2004 |
| 0.099 | 1242 | 0.132 | 1629 | 0.165 | 2016 |
| 0.100 | 1254 | 0.133 | 1641 | 0.166 | 2028 |
| 0.101 | 1266 | 0.134 | 1653 | 0.167 | 2040 |
| 0.102 | 1278 | 0.135 | 1664 | 0.168 | 2051 |
| 0.103 | 1289 | 0.136 | 1676 | 0.169 | 2063 |
| 0.104 | 1301 | 0.137 | 1688 | 0.170 | 2075 |
| 0.105 | 1313 | 0.138 | 1700 | 0.171 | 2086 |
| 0.106 | 1325 | 0.139 | 1711 | 0.172 | 2098 |
| 0.107 | 1336 | 0.140 | 1723 | 0.173 | 2110 |
| 0.108 | 1348 | 0.141 | 1735 | 0.174 | 2122 |
| 0.109 | 1360 | 0.142 | 1747 | 0.175 | 2133 |
| 0.110 | 1371 | 0.143 | 1758 | 0.176 | 2145 |
| 0.111 | 1383 | 0.144 | 1770 | 0.177 | 2157 |
| 0.112 | 1395 | 0.145 | 1782 | 0.178 | 2169 |
| 0.113 | 1407 | 0.146 | 1793 | 0.179 | 2180 |
| 0.114 | 1418 | 0.147 | 1805 | 0.180 | 2192 |
| 0.115 | 1430 | 0.148 | 1817 | 0.181 | 2204 |
| 0.116 | 1442 | 0.149 | 1829 | 0.182 | 2215 |
| 0.117 | 1453 | 0.150 | 1840 | 0.183 | 2227 |
| 0.118 | 1465 | 0.151 | 1852 | 0.184 | 2239 |
| 0.119 | 1477 | 0.152 | 1864 | 0.185 | 2251 |

^{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.

APPENDIX A

TABLE A-VIII. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .30 FSP - Continued.

| Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec |
|-------------------|------------------------|-------------------|------------------------|---------------------|------------------------|
| 0.186 | 2262 | 0.215 | 2602 | 0.244 | 2942 |
| 0.187 | 2274 | 0.216 | 2614 | 0.245 | 2954 |
| 0.188 | 2286 | 0.217 | 2626 | 0.246 | 2966 |
| 0.189 | 2297 | 0.218 | 2637 | 0.247 | 2977 |
| 0.190 | 2309 | 0.219 | 2649 | 0.248 | 2989 |
| 0.191 | 2321 | 0.220 | 2661 | 0.249 ^{2/} | 3001 |
| 0.192 | 2333 | 0.221 | 2673 | 0.250 | 3013 |
| 0.193 | 2344 | 0.222 | 2684 | 0.251 | 3024 |
| 0.194 | 2356 | 0.223 | 2696 | 0.252 | 3036 |
| 0.195 | 2368 | 0.224 | 2708 | 0.253 | 3048 |
| 0.196 | 2380 | 0.225 | 2719 | 0.254 | 3059 |
| 0.197 | 2391 | 0.226 | 2731 | 0.255 | 3071 |
| 0.198 | 2403 | 0.227 | 2743 | 0.256 | 3083 |
| 0.199 | 2415 | 0.228 | 2755 | 0.257 | 3095 |
| 0.200 | 2426 | 0.229 | 2766 | 0.258 | 3106 |
| 0.201 | 2438 | 0.230 | 2778 | 0.259 | 3118 |
| 0.202 | 2450 | 0.231 | 2790 | 0.260 | 3130 |
| 0.203 | 2462 | 0.232 | 2802 | 0.261 | 3141 |
| 0.204 | 2473 | 0.233 | 2813 | 0.262 | 3153 |
| 0.205 | 2485 | 0.234 | 2825 | 0.263 | 3165 |
| 0.206 | 2497 | 0.235 | 2837 | 0.264 | 3177 |
| 0.207 | 2508 | 0.236 | 2848 | 0.265 | 3188 |
| 0.208 | 2520 | 0.237 | 2860 | 0.266 | 3200 |
| 0.209 | 2532 | 0.238 | 2872 | 0.267 | 3212 |
| 0.210 | 2544 | 0.239 | 2884 | 0.268 | 3223 |
| 0.211 | 2555 | 0.240 | 2895 | 0.269 | 3235 |
| 0.212 | 2567 | 0.241 | 2907 | 0.270 | 3247 |
| 0.213 | 2579 | 0.242 | 2919 | 0.271 | 3259 |
| 0.214 | 2591 | 0.243 | 2930 | 0.272 | 3270 |

^{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.

APPENDIX A

TABLE A-IX. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: caliber .50 FSP.

| Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec |
|---------------------|------------------------|-------------------|------------------------|---------------------|------------------------|
| 0.230 | 1730 | 0.340 | 2466 | 0.450 | 3202 |
| 0.235 | 1763 | 0.345 | 2499 | 0.455 | 3235 |
| 0.240 | 1797 | 0.350 | 2532 | 0.460 | 3268 |
| 0.245 | 1830 | 0.355 | 2566 | 0.465 | 3302 |
| 0.250 ^{1/} | 1864 | 0.360 | 2599 | 0.470 | 3335 |
| 0.255 | 1897 | 0.365 | 2633 | 0.475 | 3369 |
| 0.260 | 1930 | 0.370 | 2666 | 0.480 | 3402 |
| 0.265 | 1964 | 0.375 | 2700 | 0.485 | 3436 |
| 0.270 | 1997 | 0.380 | 2733 | 0.490 | 3469 |
| 0.275 | 2031 | 0.385 | 2767 | 0.495 | 3503 |
| 0.280 | 2064 | 0.390 | 2800 | 0.499 ^{2/} | 3529 |
| 0.285 | 2098 | 0.395 | 2834 | 0.500 | 3536 |
| 0.290 | 2131 | 0.400 | 2867 | 0.505 | 3569 |
| 0.295 | 2165 | 0.405 | 2900 | 0.510 | 3603 |
| 0.300 | 2198 | 0.410 | 2934 | 0.515 | 3636 |
| 0.305 | 2231 | 0.415 | 2967 | 0.520 | 3670 |
| 0.310 | 2265 | 0.420 | 3001 | 0.525 | 3703 |
| 0.315 | 2298 | 0.425 | 3034 | 0.530 | 3737 |
| 0.320 | 2332 | 0.430 | 3068 | 0.535 | 3770 |
| 0.325 | 2365 | 0.435 | 3101 | 0.540 | 3804 |
| 0.330 | 2399 | 0.440 | 3135 | 0.545 | 3837 |
| 0.335 | 2432 | 0.445 | 3168 | 0.550 | 3871 |

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

APPENDIX A

TABLE A-X. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: 20 mm FSP.

| Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec |
|---------------------|------------------------|-------------------|------------------------|-------------------|------------------------|
| 0.445 | 1937 | 0.590 | 2417 | 0.740 | 2914 |
| 0.450 | 1954 | 0.595 | 2434 | 0.745 | 2931 |
| 0.455 | 1971 | 0.600 | 2451 | 0.750 | 2947 |
| 0.460 | 1987 | 0.605 | 2467 | 0.755 | 2964 |
| 0.465 | 2004 | 0.610 | 2484 | 0.760 | 2980 |
| 0.470 | 2020 | 0.615 | 2500 | 0.765 | 2997 |
| 0.475 | 2037 | 0.620 | 2517 | 0.770 | 3013 |
| 0.480 | 2053 | 0.625 | 2533 | 0.775 | 3030 |
| 0.485 | 2070 | 0.630 | 2550 | 0.780 | 3047 |
| 0.490 | 2086 | 0.635 | 2566 | 0.785 | 3063 |
| 0.495 | 2103 | 0.640 | 2583 | 0.790 | 3080 |
| 0.500 ^{1/} | 2120 | 0.645 | 2600 | 0.795 | 3096 |
| 0.505 | 2136 | 0.650 | 2616 | 0.800 | 3113 |
| 0.510 | 2153 | 0.655 | 2633 | 0.805 | 3129 |
| 0.515 | 2169 | 0.660 | 2649 | 0.810 | 3146 |
| 0.520 | 2186 | 0.665 | 2666 | 0.815 | 3162 |
| 0.525 | 2202 | 0.670 | 2682 | 0.820 | 3179 |
| 0.530 | 2219 | 0.675 | 2699 | 0.825 | 3196 |
| 0.535 | 2235 | 0.680 | 2715 | 0.830 | 3212 |
| 0.540 | 2252 | 0.685 | 2732 | 0.835 | 3229 |
| 0.545 | 2268 | 0.690 | 2749 | 0.840 | 3245 |
| 0.550 | 2285 | 0.695 | 2765 | 0.845 | 3262 |
| 0.555 | 2302 | 0.700 | 2782 | 0.850 | 3278 |
| 0.560 | 2318 | 0.705 | 2798 | 0.855 | 3295 |
| 0.565 | 2335 | 0.710 | 2815 | 0.860 | 3311 |
| 0.566 | 2338 | 0.715 | 2831 | 0.865 | 3328 |
| 0.570 | 2351 | 0.720 | 2848 | 0.870 | 3345 |
| 0.575 | 2368 | 0.725 | 2864 | 0.875 | 3361 |
| 0.580 | 2384 | 0.730 | 2881 | 0.880 | 3378 |
| 0.585 | 2401 | 0.735 | 2898 | 0.885 | 3394 |

^{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.

APPENDIX A

TABLE A-X. Minimum required ballistic limits (protection criteria) for class 2 armor, firing obliquity: 0°, projectile: 20 mm FSP - Continued.

| Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec | Thickness, inches | Required BL(P), ft/sec |
|-------------------|------------------------|-------------------|------------------------|--------------------|------------------------|
| 0.890 | 3411 | 0.945 | 3593 | 1.000 ² | 3775 |
| 0.895 | 3427 | 0.950 | 3609 | 1.005 | 3792 |
| 0.900 | 3444 | 0.955 | 3626 | 1.010 | 3808 |
| 0.905 | 3460 | 0.960 | 3643 | 1.015 | 3825 |
| 0.910 | 3477 | 0.965 | 3659 | 1.020 | 3841 |
| 0.915 | 3494 | 0.970 | 3676 | 1.025 | 3858 |
| 0.920 | 3510 | 0.975 | 3692 | 1.030 | 3874 |
| 0.925 | 3527 | 0.980 | 3709 | 1.035 | 3891 |
| 0.930 | 3543 | 0.985 | 3725 | 1.040 | 3907 |
| 0.935 | 3560 | 0.990 | 3742 | 1.045 | 3924 |
| 0.940 | 3576 | 0.995 | 3758 | 1.050 | 3941 |

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.

APPENDIX A

TABLE A-XI. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, 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 |
|---------------------|---------------------------|---------------------|---------------------------|---------------------|---------------------------|
| 0.210 | 1927 | 0.265 | 2329 | 0.325 | 2650 |
| 0.215 | 1969 | 0.270 | 2359 | 0.330 | 2674 |
| 0.220 | 2010 | 0.275 | 2389 | 0.335 | 2697 |
| 0.225 | 2050 | 0.280 | 2418 | 0.340 | 2719 |
| 0.230 | 2088 | 0.285 | 2447 | 0.345 | 2741 |
| 0.231 ^{1/} | 2096 | 0.290 | 2474 | 0.350 | 2763 |
| 0.235 | 2126 | 0.295 | 2501 | 0.354 ^{2/} | 2780 |
| 0.240 | 2162 | 0.300 | 2527 | 0.355 | 2785 |
| 0.245 | 2197 | 0.305 | 2553 | 0.360 | 2807 |
| 0.250 | 2232 | 0.310 | 2578 | 0.365 | 2829 |
| 0.255 | 2265 | 0.315 | 2603 | 0.370 | 2851 |
| 0.260 | 2297 | 0.320 | 2627 | 0.375 | 2873 |

^{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.

APPENDIX A

TABLE A-XII. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, 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 |
|---------------------|---------------------------|---------------------|---------------------------|---------------------|---------------------------|
| 0.320 | 1690 | 0.420 | 2045 | 0.520 | 2400 |
| 0.325 | 1708 | 0.425 | 2063 | 0.525 | 2418 |
| 0.330 | 1726 | 0.430 | 2080 | 0.530 | 2435 |
| 0.335 | 1743 | 0.435 | 2098 | 0.535 | 2453 |
| 0.340 | 1761 | 0.440 | 2116 | 0.540 | 2471 |
| 0.345 | 1779 | 0.445 | 2134 | 0.545 | 2489 |
| 0.350 | 1796 | 0.450 | 2151 | 0.550 | 2506 |
| 0.355 ^{1/} | 1814 | 0.455 | 2169 | 0.555 | 2524 |
| 0.360 | 1832 | 0.460 | 2187 | 0.560 | 2542 |
| 0.365 | 1850 | 0.465 | 2205 | 0.565 | 2560 |
| 0.370 | 1867 | 0.470 | 2222 | 0.570 | 2577 |
| 0.375 | 1885 | 0.475 | 2240 | 0.575 | 2595 |
| 0.380 | 1903 | 0.480 | 2258 | 0.580 | 2613 |
| 0.385 | 1921 | 0.485 | 2276 | 0.585 | 2631 |
| 0.390 | 1938 | 0.490 | 2293 | 0.590 ^{2/} | 2648 |
| 0.395 | 1956 | 0.495 | 2311 | 0.595 | 2666 |
| 0.400 | 1974 | 0.500 | 2329 | 0.600 | 2684 |
| 0.405 | 1992 | 0.505 | 2347 | 0.605 | 2702 |
| 0.410 | 2009 | 0.510 | 2364 | 0.610 | 2719 |
| 0.415 | 2027 | 0.515 | 2382 | 0.615 | 2737 |

^{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.

APPENDIX A

TABLE A-XIII. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: 14.5 mm B32 API.

| Thickness inches | Required BL(P), ft/sec | Thickness inches | Required BL(P), ft/sec | Thickness inches | Required BL(P), ft/sec |
|---------------------|---------------------------|---------------------|---------------------------|---------------------|---------------------------|
| 0.575 | 2220 | 0.645 | 2369 | 0.720 | 2521 |
| 0.580 | 2231 | 0.650 | 2380 | 0.725 | 2530 |
| 0.585 | 2242 | 0.655 | 2390 | 0.730 | 2540 |
| 0.590 | 2253 | 0.660 | 2400 | 0.735 | 2550 |
| 0.591 ^{1/} | 2255 | 0.665 | 2411 | 0.740 | 2559 |
| 0.595 | 2264 | 0.670 | 2421 | 0.745 | 2569 |
| 0.600 | 2274 | 0.675 | 2431 | 0.750 | 2579 |
| 0.605 | 2285 | 0.680 | 2441 | 0.755 | 2588 |
| 0.610 | 2296 | 0.685 | 2451 | 0.760 | 2598 |
| 0.615 | 2307 | 0.690 | 2461 | 0.765 ^{2/} | 2607 |
| 0.620 | 2317 | 0.695 | 2471 | 0.770 | 2617 |
| 0.625 | 2328 | 0.700 | 2481 | 0.775 | 2626 |
| 0.630 | 2338 | 0.705 | 2491 | 0.780 | 2636 |
| 0.635 | 2349 | 0.710 | 2501 | 0.785 | 2645 |
| 0.640 | 2359 | 0.715 | 2511 | 0.790 | 2654 |

^{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.

APPENDIX A

TABLE A-XIV. Minimum required ballistic limits (protection criteria) for class 4 armor, firing obliquity: 30°, projectile: 14.5 mm BS41 API.

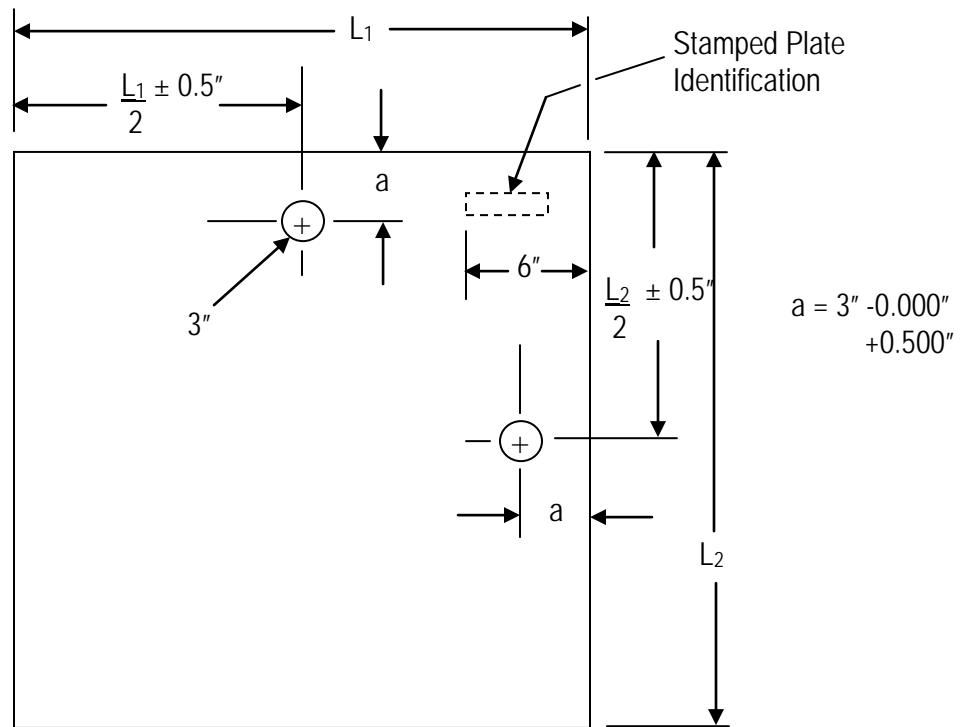
| Thickness inches | Required BL(P), ft/sec | Thickness inches | Required BL(P), ft/sec | Thickness inches | Required BL(P), ft/sec |
|---------------------|---------------------------|---------------------|---------------------------|---------------------|---------------------------|
| 0.740 | 2112 | 0.875 | 2452 | 1.015 | 2765 |
| 0.745 | 2125 | 0.880 | 2464 | 1.020 | 2775 |
| 0.750 | 2139 | 0.885 | 2476 | 1.025 | 2786 |
| 0.755 | 2152 | 0.890 | 2488 | 1.030 | 2796 |
| 0.760 | 2165 | 0.895 | 2499 | 1.035 | 2807 |
| 0.765 | 2178 | 0.900 | 2511 | 1.040 | 2817 |
| 0.766 ^{1/} | 2181 | 0.905 | 2522 | 1.045 | 2827 |
| 0.770 | 2192 | 0.910 | 2534 | 1.050 | 2838 |
| 0.775 | 2205 | 0.915 | 2545 | 1.055 | 2848 |
| 0.780 | 2218 | 0.920 | 2557 | 1.060 | 2858 |
| 0.785 | 2231 | 0.925 | 2568 | 1.065 | 2868 |
| 0.790 | 2243 | 0.930 | 2579 | 1.070 | 2879 |
| 0.795 | 2256 | 0.935 | 2590 | 1.075 | 2888 |
| 0.800 | 2269 | 0.940 | 2602 | 1.080 | 2898 |
| 0.805 | 2282 | 0.945 | 2613 | 1.085 | 2908 |
| 0.810 | 2294 | 0.950 | 2624 | 1.090 | 2918 |
| 0.815 | 2307 | 0.955 | 2635 | 1.095 | 2927 |
| 0.820 | 2319 | 0.960 | 2646 | 1.100 | 2936 |
| 0.825 | 2331 | 0.965 | 2657 | 1.105 | 2946 |
| 0.830 | 2344 | 0.970 | 2668 | 1.110 | 2956 |
| 0.835 | 2356 | 0.975 | 2679 | 1.115 | 2965 |
| 0.840 | 2368 | 0.980 | 2690 | 1.120 | 2975 |
| 0.845 | 2381 | 0.985 | 2700 | 1.125 ^{2/} | 2984 |
| 0.850 | 2393 | 0.990 | 2711 | 1.130 | 2994 |
| 0.855 | 2405 | 0.995 | 2722 | 1.135 | 3003 |
| 0.860 | 2417 | 1.000 | 2732 | 1.140 | 3012 |
| 0.865 | 2429 | 1.005 | 2743 | 1.145 | 3022 |
| 0.870 | 2440 | 1.010 | 2754 | 1.150 | 3031 |

^{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.

APPENDIX A



Not to Scale

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

CONCLUDING MATERIAL

Custodian:
Army - MR

Preparing activity:
Army - MR

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

Project 9515-2012-001

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