

MIL-A-46099C
14 September 1987
SUPERSEDING
MIL-A-46099B
9 November 1976

MILITARY SPECIFICATION

ARMOR PLATE, STEEL, ROLL-BONDED, DUAL HARDNESS (0.187 INCHES TO 0.700 INCHES INCLUSIVE)

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

1. SCOPE

1.1 This specification covers roll-bonded, dual hardness, steel armor plate for lightweight armor applications (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards, form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation.

STANDARDS

FEDERAL

FED-STD-123 - Marking for Shipment (Civil Agencies)

MILITARY

MIL-STD-129 - Marking for Shipment and Storage

MIL-STD-163 - Steel Mill Products Preparation for Shipment and Storage

MIL-STD-367 - Armor Test Data Reporting

(Copies of specifications and standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMSC A4168

/PSC 9515/

DISTRIBUTION STATEMENT A Approved for Public Release; Distribution Unlimited.

MIL-A-46099C

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A370 - Mechanical Testing of Steel Products
ASTM D3951 - Standard Practice for Commercial Packaging
ASTM E18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E350 - Methods for Chemical Analysis of Carbon Steel, Low Alloy, Silicon Electrical Steel, Ingot Iron and Wrought Iron
ASTM E380 - Metric Practice

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede contract requirements, drawing notes or 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), a sample or samples of the armor plate shall be made available to the contracting officer or his authorized representative for approval. The approval of the first article samples authorizes the commencement of shipment but does not relieve the supplier of responsibility for compliance with all applicable provisions of this specification. The first article samples and test plates shall be manufactured by the process proposed by the manufacturer for use on production armor. The ballistic test agency will inspect the armor plate and conduct ballistic tests to establish conformance or non-conformance of the plates to the ballistic requirements of this specification. Unless otherwise specified (see 6.2b) test results will be provided to the procuring activity and the contractor.

3.1.1 First time producer. First time producers wishing to qualify to this specification should follow the instruction of 6.4.

3.2 Chemical composition. Unless otherwise specified (see 6.2), the chemical analysis of the armor plate shall be within the composition limits established by the contractor. Both the producer's proposed chemical composition and the actual chemical composition shall be reported on the Armor Test Data Report provided to the ballistic test facility (see 6.2.2).

3.3 Material and processing. The chemical composition of the steel, the heat treatment and methods of fabrication will be left entirely to the decision of the armor manufacturer. The process of manufacture and the heat treatment shall be such as to produce roll-bonded armor that will meet the requirements of this specification. No operation which may alter the

MIL-A-46099C

ballistic characteristics of the armor shall be employed after the ballistic test plate representing a lot has been selected.

The contractor shall declare the range of chemical composition of the steel used and details of the heat treatment and processing procedure for each lot of armor plate.

3.4 Hardness. The hardness of the armor plate surfaces when tested as specified in 4.7.2.2 shall be as follows:

	<u>Rockwell C</u> <u>Hardness</u>	or	<u>Brinell*</u> <u>Hardness No.</u>
Front Plate	58 Min. 64 Max.		601 Min. 712 Max.
Rear Plate	48 Min. 54 Max		461 Max. 534 Max.

*3000 KG Load - 10 MM Ball

Unless otherwise specified the cross-section hardness shall be determined and shall comply with the purchaser's requirements (see 4.7.2.2 and 6.2c).

3.5 Decarburization. The manufacturer shall produce with a practice designed to minimize complete and partial decarburization.

3.6 Bonding. The armor plate shall be composed of metallurgically bonded plates. Ultrasonic Evaluation shall be conducted to locate debond areas. Metallographic evaluation shall be conducted on corner samples to evaluate bond effectiveness and on samples of debond areas located by ultrasound. The presence of bond defects shall be reported to the purchaser. When specified (see 6.2e) additional testing or examination of bonds shall be conducted as agreed upon by the contractor and purchaser. Rejection of armor plate because of bond defects shall be as agreed upon by the purchaser and supplier (see 6.2e).

3.7 Ballistic requirements. The ballistic requirements of the armor plate shall be in accordance with the appendix of this specification.

3.7.1 Unless otherwise specified in the contractor order, ballistic test plates shall be forwarded to Commander, U.S. Army Aberdeen Proving Ground, ATTN: STEAP MT-A Aberdeen Proving Ground, MD 21005 for ballistic testing (see 6.2h)

3.8 Finish. Unless otherwise specified (see 6.2) plates shall be descaled after treatment.

3.9 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.

3.10 Dimensions and tolerances. The dimensions shall be as specified in the contract or order (see 6.2). Unless otherwise specified or permitted in the contract or order, the following tolerances shall apply:

MIL-A-46099C

Flatness: Within $3/4$ inch from a straight line 6 feet in length.
Thickness: ± 0.016 inch for plate thicknesses 0.187 to 0.500 inch inclusive and ± 0.019 inch for plate thicknesses over 0.500 through 0.700 inch.

3.11 Marking. Each plate shall be marked with the DLA contract number, the NSN, manufacturer's name or trademark, the number of this specification, the plate thickness in inches and the lot number. The marking shall be such as to identify the higher hardness side. Unless otherwise specified (see 6.2) or permitted on the contract or order, impression stamping shall not be used except for proper heat and hard-soft side identification during the rolling process. If impression stamping is permitted, it shall be made on the softer surface only.

3.12 Ballistic test plate information. When specified in the contract or order, armor data shall be prepared in accordance with MIL-STD-367, format I (see 6.2.2).

3.13 Workmanship. All plates shall be free from scale blisters, crazing cracks, gouges, laps, pits, roll marks, rolled in refractory, scabs, scratches, seams, slivers, snakes and other defects of such severity that are detrimental to fabrication or performance of the armor plate.

4. QUALITY ASSURANCE

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

- a. First article inspection (see 3.1, 4.4.1 and 4.7.1).
- b. Quality conformance inspection (see 4.7.2).

4.3 Lot. A lot shall consist of all plate from the same heat, of the same thickness having the same heat treatment, manufactured under the same processing conditions and submitted for inspection in approximately the same time periods.

MIL-A-46099C

4.4 Sampling.

4.4.1 First article sampling.

4.4.1.1 Ballistic test samples. Two samples of armor plate of the thickness to be supplied on the contract, shall be submitted for ballistic tests. One sample shall be taken from the first plate fabricated and one from the last plate fabricated in the initial lot produced. When only one plate is fabricated, the samples shall be taken from opposite ends of the plate. The samples shall be 18 inches by 24 inches.

4.4.1.1.1 The first article test samples shall be forwarded to a Government facility selected by the procuring activity (see 6.2h).

4.4.1.2 Samples for chemical analysis. Two samples for chemical analysis shall be taken from each ballistic test plate. Samples shall be taken from the hard and softer sides of the armor plate and each shall be identified accordingly.

4.5 Quality conformance inspection sampling.

4.5.1 For chemical analysis. Representative samples shall be taken for chemical analyses from each lot. Samples shall be taken from the hard and the softer sides of the armor plate and each shall be clearly identified.

4.5.2 For surface hardness. The location and number of samples to be taken from each lot shall be in accordance with applicable drawings or as otherwise specified (see 6.2).

4.5.3 For microscopic examination. Two samples, each of the full thickness of the annealed plate and with both top and bottom surfaces preserved shall be taken from each lot. Samples shall be approximately 1 X 3 inches and shall be taken from diagonal corners of an armor plate representative of the rolling operation. One sample only will be required from one end when a single plate is rolled.

4.5.4 Sampling for ballistic testing. One plate shall be taken from each lot. The plate size shall be 18 inches by 24 inches.

4.6 Examination.

4.6.1 Visual. Each plate in each lot shall be visually examined for compliance with the requirements for workmanship (see 3.13). Ballistic test plates shall also be examined after testing to assure soundness of bonding.

4.6.2 Dimensional. Each plate in each lot shall be measured for compliance with the requirements for dimensions and tolerances (see 3.10).

4.6.3 Packaging. Prior to shipment, examination shall be made to determine compliance with the requirements of section 5.

4.7 Tests.

4.7.1 First article and quality conformance ballistic testing. Ballistic test plates shall be tested at a Government facility designated by the

MIL-A-46099C

procuring activity. Plate thickness as determined by the ballistic test agency shall be used to determine the required protection ballistic limit for the plate and shall be taken as the average of 4 thickness measurements read to the nearest 0.001 inch with the average reported to the nearest 0.001 inch. At least one measurement will be taken along each edge of the plate at a distance of at least one inch from the edge.

4.7.1.1 Surface hardness test on ballistic plates. Surface hardness of ballistic test plates shall be determined in accordance with 4.7.2.2.

4.7.2 Quality conformance tests.

4.7.2.1 Chemical analysis. Chemical analysis shall be conducted in accordance with ASTM E350, or other approved analytical method. In case of dispute, the analysis as presented in ASTM E350 shall be the basis for acceptance or rejection.

4.7.2.2 Rockwell hardness or Brinell hardness tests. Hardness test specimens shall be prepared and tested in accordance with ASTM A370. At least three hardness tests shall be taken on each surface and the average value determined for each surface of each ballistic plate.

4.7.2.3 Microscopic examination. Specimens for microscopic examination shall be suitably mounted and etched to reveal the microstructure of the cross section perpendicular to the rolling direction. Examination shall be conducted at X100. The etched surface of the annealed armor plate shall be examined for decarburization and bonding defects (see 3.5 and 3.6).

4.8 Rejection and retests.

4.8.1 Rejection. Unless otherwise specified (see 6.2) where one or more test specimens fail to meet the requirements of the specification the lot represented by the specimen or specimens shall be subject to the rejection.

4.8.2 Retest. When no sampling plan is provided or approved by the procuring agency (see 6.2) and where there is evidence that indicates that the specimen was not representative of the lot of material, and when the detail specification does not otherwise specify, at least two specimens shall be selected to replace each test specimen which failed. All specimens so selected for retest shall meet the requirements of the specification or the lot shall be subject to rejection.

4.8.3 First article ballistic test failure. In the event of a first article ballistic test failure the supplier must submit two new first article test samples as in 4.4.1.1 and both must pass the ballistic test requirements in order that the first article armor plate be considered ballistically acceptable.

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

MIL-A-46099C

5. PACKAGING

5.1 Preservation-packaging. Preservation and packaging shall be level A or C as specified (see 6.2).

5.1.1 Level A. When level A is specified, preservation for shipment shall be in accordance with MIL-STD-163.

5.1.2 Level C. Cleaning, drying, preservation, and packaging shall be in accordance with ASTM D3951.

5.2 Packing. Unless otherwise specified in the contract or order, packing shall be level C (see 6.2).

5.2.1 Level C. Plates shall be packed in such a manner that will afford adequate protection against damage during direct shipment from the supply source to the first receiving activity.

5.3 Marking. In addition to any special marking specified in the contract or order, shipments shall be marked in accordance with the requirements of MIL-STD-129. When specified (see 6.2) the marking of domestic shipments for civil agencies shall be in accordance with FED-STD-123.

6. NOTES

6.1 Intended use. The roll-bonded steel armor covered by this specification is intended for use in aircraft and lightweight vehicular applications where maximum resistance to armor piercing types of ammunition and multiple hit capability are required. It is normally furnished in thicknesses of 0.187 inch to 0.700 inch.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. When first article sample is required but ballistic test agency shall not report test results to contractor
- c. Requirements on cross-section hardness (see 3.4).
- d. Limits on decarburization (see 3.5).
- e. Evaluation of bonding requirements and plate acceptance (see 3.6 and 4.7.2.3).
- f. When plates are not to be descaled (see 3.8).
- g. When impression stamping is permitted (see 3.9)
- h. Designation of first article test plates (see 4.1.1 and 4.7.1)
- i. Sampling for surface hardness tests (see 4.5.2).
- j. Retest requirements if different than specified in 4.8.
- k. Packaging requirements if different than specified in Section 5.

6.2.2 Contract data requirements. When this standard is used in an acquisition which incorporates a DD Form 1423, Contract Data Requirements List (CDRL), the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved CDRL, incorporated into the contract. When the

MIL-A-46099C

provisions of DOD FAR Supplement, Part 27, Sub-Part 27.410-6 are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification are cited in the following paragraphs.

<u>Paragraph No.</u>	<u>Data Requirements</u>	<u>Applicable DID No.</u>	<u>Option</u>
3.2, 3.12	Armor Material Test Report	DI-MISC-80073	Format I

(Copies of data item descriptions related to this specification, and identified in section 6 will be approved and listed as such in DOD 5010.12L, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.3 Potential suppliers. Potential suppliers who have not previously supplied armor plate to MIL-A-46099 and wish to have their material ballistically tested may do so at their own expense. It is recommended that inquiries for such testing be directed to Commander, U.S. Army Combat Systems Test Activity (CSTA), Aberdeen Proving Grounds, MD 21005.

6.4 Metric units. When metric dimensions are required, conversion factors can be obtained from ASTM E380, Metric Practice.

6.5 Key words.

Steel armor
Dual-hardness
Plate
Roll bonded

Custodian:

Army - MR
Air Force - 99

Preparing activity:

Army - MR

Project 9515-0615

Review activities:

Navy - AS
Air Force - 20, 84
DLA - IS

User activities:

Army - AT, TE

(KBWP# ID 0237A/DISK 0141A. FOR MTL USE ONLY)

MIL-A-46099C

APPENDIX

BALLISTIC TESTING OF ARMOR, STEEL PLATE,
ROLL-BONDED, DUAL-HARDNESS

10 SCOPE

10.1 This appendix covers the requirements for ballistic testing of roll-bonded, dual-hardness steel armor plate.

20 DEFINITIONS

20.1 Fair impact. A fair impact results when an unyawed projectile strikes an unsupported area of the ballistic test plate sample at such a location that there is at least three inches of undisturbed metal between this impact and any previous impact, hole, crack, plate edge, or spalled area.

20.2 Witness plate. A witness plate is normally a 0.014 inch thick sheet of 5052-H36 aluminum alloy (or a 0.020 inch thick sheet of 2024-T3 aluminum alloy) placed 6 inches (+ 1/2 inch) behind and parallel to the test plates or other ballistic sample.

20.3 Complete penetration, protection, CP(P). 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 perforate the witness plate.

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

20.5 V50 protection ballistic limit, BL(P). The protection V₅₀ ballistic limit is defined as the average of 6 fair impact velocities comprising the three lowest velocities resulting in complete penetration and the three highest velocities resulting in partial penetration. A maximum spread of 150 feet per second shall be permitted between the lowest and highest velocities employed in determination of ballistic limits. In cases where the lowest velocity resulting in a complete penetration is 150 feet per second or more below the highest velocity resulting in a partial penetration, the ballistic limit will be based on 10 velocities comprising the five lowest velocities which resulted in complete penetration, and the five highest velocities which resulted in partial penetrations. When the 10-round, excessive spread, ballistic limit is used, the velocity spread will be reduced to the lowest practical level (as close to 150 fps as possible). When a 10-round ballistic limit is used, this will be noted in all reports. All velocities shall be corrected to striking velocity.

20.6 Backspall. Fragment(s) of the back of the plate detached from the plate by projectile impact on the front.

20.7 Exit diameter. The average of the minimum and maximum distances across the exit hole made by a complete penetration impact (see figure A-1).

MIL-A-46099C

APPENDIX

20.8 Overall average exit diameter. The overall average exit diameter is defined as the average of the three exit diameters on the three complete penetrations used in the computation of the ballistic limit (see figure A-2)

30 REQUIREMENTS

30.1 Resistance to penetration. The minimum ballistic limits shall be in accordance with the values shown in tables I and II.

30.2 Resistance to spalling.

30.2.1 For plates 0.187 through 0.400 inch thickness. The overall average exit diameter, (paragraph 20.8 and figure A-2), shall not exceed 0.500 inch. The exit holes on the three complete penetrations used in the computation of the six round ballistic limit will be measured.

30.2.2 For plates 0.401 through 0.700 inch in thickness. The overall average exit diameter, (paragraph 20.8 and figure A-2), shall not exceed 0.750 inch. The exit holes on the three complete penetrations used in the computation of the six round ballistic limit will be measured.

30.2.3 Measurement of borderline overall average exit diameter. In those situations in which the overall average exit diameter is borderline, a planimeter will be used to determine the overall average exit diameter (figure 3-A).

40 TESTS

40.1 Ballistic tests. The V_{50} ballistic tests shall be performed in accordance with the procedures outlined in this appendix to determine compliance with the minimum ballistic requirements of tables I and II and with the maximum allowable back spall requirements of paragraphs 3.2.1 and 3.2.2.

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

40.1.2 Identifying markings shall be provided on all test and production plates submitted under this specification as specified in 3.9.

40.1.3 Rejection and retest of ballistic plates.

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

40.1.3.2 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. Two retest plates must be submitted for first article testing and both must pass.

MIL-A-46099C

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

40.1.3.4 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, he may:

(1) At his own expense submit two additional test plates from the same lot for ballistic retest, or

(2) He may first re-heat treat (quenching and tempering) the lot and then submit a test plate from the re-treated lot, or

(3) He may scrap the lot and submit a plate representing a new lot for acceptance.

If he 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 of the retest plates fail, the manufacturer may re-heat treat the lot and submit a test plate from the retreated lot. If this plate fails the lot is rejected. If he chooses option (3) and the test plate fails, he may again resort to any one of the three options.

40.1.4 Disposition of ballistic test plates.

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

40.1.4.2 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 will be returned, upon request, as in 40.1.4.1.

MIL-A-46099C

TABLE I. Minimum required V_{50} ballistic limits (protection criteria) - caliber .30 AP, M2 projectile at 30° obliquity.

Thickness, inch	Required BL(P) fps	Thickness, inch	Required BL(P) fps
0.170	2133		
0.175	2167	0.270	2742
*.180	2201	.275	2769
.185	2234	.280	2796
.190	2267	.285	2823
.195	2299	.290	2849
.200	2331	.295	2875
.205	2363	.300	2902
.210	2394	.305	2927
.215	2425	.310	2952
.220	2455	** .3125	2965
.225	2486	.315	2978
.230	2515	.320	3003
.235	2545	.325	3028
.240	2574	.330	3052
.245	2603		
.250	2631		
.255	2659		
.260	2687		
.265	2715		

*Specification requirements begin for this ordered thickness.

**Specification requirements end for this ordered thickness.

MIL-A-46099C

APPENDIX

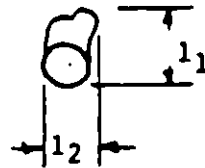
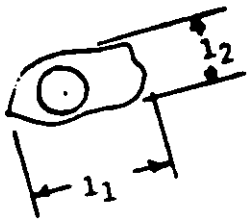
TABLE II. Minimum required V₅₀ ballistic limits (protection criteria) - caliber .50 AP, M2 projectile at 30° obliquity.

Thickness, inch	Required BL(P) fps	Thickness, inch	Required BL(P) fps	Thickness, inch	Required BL(P), fps
		0.405	2402	0.535	2963
		.410	2426	.540	2983
0.290	1774	.415	2450	.545	3002
.295	1805	.420	2473	.550	3022
.300	1836	.425	2496	.555	3041
.305	1867	.430	2519	.560	3060
.310	1897	.435	2542	** .565	3079
*.3126	1912	.440	2565	.570	3098
.315	1927	.445	2587	.575	3125
.320	1956	.450	2610	.580	3135
.325	1985	.455	2632	.585	3154
.330	20131	.460	2653		
.335	2041	.465	2675		
.340	2069	.470	2697		
.345	2097	.475	2718		
.350	2124	.480	2739		
.355	2150	.485	2760		
.360	2177	.490	2781		
.365	2203	.495	2802		
.370	2229	.500	2823		
.375	2254	.505	2843		
.380	2280	.510	2864		
.385	2305	.515	2884		
.390	2330	.520	2904		
.395	2354	.525	2924		

*Specification requirements begin for this ordered thickness.

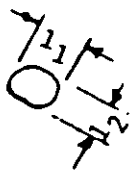
**Specification requirements end for this ordered thickness.

MIL-A-46099C



$$\text{Exit Diameter} = \frac{l_1 + l_2}{2}$$

Figure A-1. Typical exit holes with and without back spall areas



$$\bar{D}_0 = \frac{1}{3} \left[\frac{l_1 + l_2}{2} + \frac{l_3 + l_4}{2} + \frac{l_5 + l_6}{2} \right] = \frac{\sum_{i=1}^6 l_i}{6}$$

Figure A-2. Illustration of computation for overall average exit diameter, \bar{D}_0

MIL-A-46099C



Determine each area using a planimeter around the outside perimeter of the exit hole including backspall area if any. Calculate \bar{D}_0 as follows:

$$\frac{\bar{A}_0}{3} = \frac{A_1}{3} + A_2 + A_3 = \frac{\bar{A}_0}{4}$$

$$\bar{D}_0 = 2 \sqrt{\frac{\bar{A}_0}{3\pi}}$$

Compare with allowable \bar{D}_0 for the thickness (Para 30.2.1 and 30.2.2).

Figure A-3. Computations of overall average exit diameter from planimeter area measurements.

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (**DO NOT STAPLE**), and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any remarks not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE ARMY

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE \$300



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

U.S. ARMY Materials Technology Laboratory
Attn: SLCMT-MSR-ES
Watertown, MA 02172-0001

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL*(See Instructions - Reverse Side)***1. DOCUMENT NUMBER**

Mil-A-46099C

2. DOCUMENT TITLE

ARMOR PLATE, STEEL, ROLL-BONDED, DUAL HARDNESS (0.187 inches to 0.400 inches inclusive)

3a. NAME OF SUBMITTING ORGANIZATION**4. TYPE OF ORGANIZATION (Mark one)**☐

VENDOR

☐

USER

☐

MANUFACTURER

☐

OTHER (Specify): _____

b. ADDRESS (Street, City, State, ZIP Code)**5. PROBLEM AREAS****a. Paragraph Number and Wording:****b. Recommended Wording:****c. Reason/Rationale for Recommendation:****6. REMARKS****7a. NAME OF SUBMITTER (Last, First, MI) - Optional****b. WORK TELEPHONE NUMBER (Include Area Code) - Optional****c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional****8. DATE OF SUBMISSION (YYMMDD)**