INCH-POUND

MIL-PRF-32269 (MR)
18 October 2007

PERFORMANCE SPECIFICATION

PERFORATED HOMOGENEOUS STEEL ARMOR

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 perforated homogeneous steel appliqué armor in nominal thicknesses from 0. 250 - 2.000 inch, inclusive.

1.2 Classification. Perforated steel armor should be of the following classes as specified in the contract or purchase order (see 6.2). The specific design of the perforations will also be specified in the contract or purchase order (see 6.2).

1.2.1 Class 1. Class 1 is perforated wrought armor steel heat treated to develop a maximum resistance to penetration.

1.2.1.1 Class 1a. Class 1a is wrought armor steel plate tempered to attain a surface hardness between BHN 293 and BHN 402.

1.2.1.2 Class 1b. Class 1b is wrought armor steel plate tempered to attain a surface hardness between BHN 420 and BHN 534.

1.2.2 Class 2. Class 2 is perforated cast armor steel heat treated to develop a maximum resistance to penetration.

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

AMSC N/A FSC 9515

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-129	-	Military Marking for Shipment and Storage
MIL-STD-1916	-	DoD Preferred Methods for Acceptance of Product

(Copies of this document are available online at http://assist.daps.dla.mil/quicksearch/ 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 (see 6.2), the issues of these documents are those cited in the solicitation or contract.

U.S. ARMY TEST AND EVALUATION COMMAND (USATECOM)

TOP 2-2-710	-	Ballistic Tests of Armor Materials
ITOP 4-2-805	-	Projectile Velocity and Time of Flight Measurements

(Application for copies should be addressed to 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 specification to the extent specified herein. Unless otherwise indicated (see 6.2), the issue in effect on date of invitation for bids or request for proposal should apply.

ASTM INTERNATIONAL

ASTM A751	-	Steel Products, Practices, and Terminology for Chemical Analysis of (DoD Adopted)
ASTM E10	-	Materials, Metallic, Brinell Hardness of (DoD Adopted)

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

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

STEEL FOUNDERS' SOCIETY OF AMERICA

Steel castings handbook, Supplement 3 (Tolerances)

(Copies of this document are available from www.sfsa.org or Steel Founders' Society of America, 780 McArdle Dr. Unit G, Crystal Lake, IL 60014-8155.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order (see 6.2), a sample or samples of the specified classification along with the specific perforated armor design (see 1.2) shall be subjected to first article inspection in accordance with 4.4 and shall be made available to the contracting officer or an authorized representative for first article inspection and approval. 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 perforated armor in the applicable thickness range under this specification within a period of 37 months. The approval of the first article samples authorizes the commencement of shipment but does not relieve the supplier of the responsibility for compliance with all the applicable provisions of this specification, namely conformance or production acceptance. The first article samples and the production test plates shall be manufactured by the same process proposed for use in production.

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

3.1.2 Chemical composition. A declared chemistry (see 6.3) shall be submitted to the contracting agency or its authorized representative and to the ballistic test agency. The chemical composition of the declared chemistry shall conform to the requirements of Table I, column A, unless otherwise specified in the contract or purchase order (see 6.2). The chemical composition shall be determined by a product analysis 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 proposed for use in production.

3.1.3 Mechanical properties.

3.1.3.1 Hardness requirements. First article hardness test specimens shall be prepared in accordance with 4.6.1.2.1 and 4.8.2 and shall meet the requirements of Table II for the applicable Class and thickness.

3.1.4 Ballistic requirements. First article ballistic test specimens shall be prepared in accordance with 4.6.1.3 and 4.8.3 and shall have a minimum protection ballistic limit (BL(P)) in accordance with the requirements specified in Tables III though V. No through cracks greater than 2.5 inches in length on any plate surface are permitted after ballistic testing. The ballistic test agency shall record the results of the first article ballistic tests, showing the dates tested.

3.2 Production acceptance.

3.2.1 Chemical composition. The chemical composition shall be determined by a product analysis in accordance with 4.6.2.1 and 4.8.1. The results of this product analysis shall be within the applicable range (Column B of Table I) of the declared chemistry reported after first article testing (see 3.1.2).

3.2.2 Processing controls.

3.2.2.1 Thermal processing. The heat treating and quenching process schedule shall be identical for all plates (including samples) in each lot. When specified in the contract or purchase order (see 3.2.2.1.2, and 6.2) production and ballistic test plates may be heat treated separately but the heat treatment shall be the same. The test plates shall be heat treated in a production furnace.

3.2.2.1.1 Heat treatment. Product shall be heat treated within prescribed temperature, time, and atmospheric condition ranges established during first article testing or commonly approved production runs.

3.2.2.1.2 Separately heat treated ballistic test plates. When the contract or purchase order allows a ballistic test plate to be heat treated separately from the production plates it represents (see 6.2), it shall be so stated on the Perforated Armor Test Data Form (see Figure 1).

3.2.2.1.3 Condition. Unless otherwise specified in the contract or purchase order (see 6.2), plates shall be delivered in the as-heat treated condition.

3.2.2.1.3.1 Heating. Unless otherwise specified in the contract or purchase order (see 6.2), heating shall not be performed after the final hardening and tempering operation or after post weld stress relieving.

TABLE I. Chemical composition and precision (product analysis) [6/].

ELEMENT	MAXIMUM LIMIT for DECLARED CHEMISTRY (PERCENT OF TOTAL COMPOSITION) COLUMN A	ALLOWABLE RANGE [5/] for FUTURE PRODUCTION LOTS COLUMN B
Carbon	0.34	± 12 %
Manganese	NONE REQUIRED, HOWEVER IF: ≤ 1.00 > 1.00	 ± 30 % ± 15 %
Phosphorus	0.020 [1/]	[4/]
Sulfur	0.020 [1/]	[4/]
Silicon	NONE REQUIRED, HOWEVER IF: ≤ 0.60 > 0.60 to ≤ 1.00 > 1.00	 ± 25 % ± 20 % ± 15 %
Nickel	NO MAXIMUM [3/]	± 10 %
Chromium	NONE REQUIRED, HOWEVER IF: ≤ 1.25 [3/] > 1.25 [3/]	 ± 20 % ± 15 %
Molybdenum	NONE REQUIRED, HOWEVER IF: ≤ 0.20 [3/] > 0.20 [3/]	 ± 30 % ± 15 %
Vanadium	0.05 [3/]	± 80 %
Boron	--- [2/]	[4/]
Copper	0.25 [3/]	[4/]
Titanium	0.10 [3/]	[4/]
Zirconium	0.10 [3/]	[4/]
Aluminum	0.10 [3/]	[4/]
Lead	0.01	[4/]
Tin	0.02 [3/]	[4/]
Antimony	0.02 [3/]	[4/]
Arsenic	0.02 [3/]	[4/]

[1/] Phosphorus and sulfur should be controlled to the lowest attainable levels.
[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 percent.
[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/] The allowable range for any element is calculated by taking the declared value and multiplying it by the value listed in Column B. For example: If the declared value for carbon is 0.28 then the acceptable range for future acceptable lots would be 0.0336 (0.28 * 12%). Therefore, the acceptable value of carbon for future lots is 0.2464 to 0.3136.
[6/] Elements not listed in table, but intentionally added, shall be reported.

TABLE II. Hardness Requirements.

Specified Nominal Thickness of Plate (Inches)		Armor Class	Brinell Hardness Range (3000 kg-load) (BHN)
From	To and Including		
0.250	0.499	1a	340 - 402
0.500	0.749	1a	331 - 375
0.750	1.249	1a	321 - 375
1.250	2.000	1a	293 - 331
0.250	2.000	1b	420 - 534
0.250	1.249	2	302 – 352
1.250	2.000	2	269 - 321

3. 2.2.1.3.2 Reheating. Unless otherwise approved by the procuring activity (see 6.2), after the final heat treatment, material shall not be reheated or processed above the final annealing, stress relieving, or aging temperatures or to a temperature that is within 50° F of the tempering temperature.

3.2.2.3 Repair welding. Repair welding on castings (Class 2 armor) produced under this specification is allowed to fix defects, including repair of core-drilled holes, and shall be performed in accordance with meeting the requirements in 4.7. Weld repair shall be conducted prior to final heat treatment.

3.2.3 Mechanical properties.

3.2.3.1 Hardness requirements. Production acceptance hardness test specimens shall be prepared in accordance with 4.6.2.2.1 and 4.8.2 and shall meet the requirements of Table II for the applicable Class and thickness.

3.2.4 Ballistic requirements. Production acceptance ballistic test specimens shall be prepared in accordance with 4.6.2.3 and 4.8.3 and shall have a minimum protection ballistic limit (BL(P)) in accordance with the requirements specified in Tables III though V. No through cracks greater than 2.5 inches in length on any plate surface are permitted after ballistic testing. The ballistic test agency shall record the results of the first article ballistic tests, showing the dates tested.

TABLE III. Minimum Required V_{50} Ballistic Limits (Protection Criteria) (BL(P)) for Solid Armor Design

Firing Obliquity: 0° Projectile: Caliber .30 AP M2

Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)
0.230	1418	0.355	1874	0.480	2242
0.235	1440	0.360	1890	0.485	2256
0.240	1461	0.365	1906	0.490	2269
0.245	1481	0.370	1922	0.495	2282
0.250[1]	1500	0.375	1938	0.500	2295
0.255	1521	0.380	1953	0.505	2309
0.260	1540	0.385	1969	0.510	2322
0.265	1559	0.390	1984	0.515	2335
0.270	1578	0.395	1999	0.520	2348
0.275	1597	0.400	2014	0.525	2361
0.280	1616	0.405	2029	0.530	2374
0.285	1635	0.410	2045	0.535	2387
0.290	1653	0.415	2060	0.540	2399
0.295	1671	0.420	2074	0.545	2412
0.300	1689	0.425	2089	0.550	2424
0.305	1706	0.430	2103	0.555	2437
0.310	1724	0.435	2117	0.560	2450
0.315	1742	0.440	2131	0.565[2]	2462
0.320	1759	0.445	2145	0.570	2474
0.325	1776	0.450	2159	0.575	2486
0.330	1793	0.455	2173	0.580	2499
0.335	1810	0.460	2187	0.585	2511
0.340	1825	0.465	2201	0.590	2523
0.345	1842	0.470	2215	0.595	2535
0.350	1858	0.475	2229	0.600	2547

1 Specification requirements begin with this ordered thickness.

2 Specification requirements end with this ordered thickness (See Table IV).

TABLE IV. Minimum Required V_{50} Ballistic Limits (Protection Criteria) (BL(P)) for Solid Armor Design

Firing Obliquity: 0° Projectile: Caliber .50 AP M2

Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)
0.550	1749	0.695	2007	0.845	2244
0.555	1758	0.700	2016	0.850	2251
0.560	1768	0.705	2024	0.855	2259
0.565	1777	0.710	2032	0.860	2267
0.566[1]	1779	0.715	2041	0.865	2274
0.570	1787	0.720	2049	0.870	2282
0.575	1796	0.725	2056	0.875	2289
0.580	1805	0.730	2064	0.880	2296
0.585	1814	0.735	2073	0.885	2304
0.590	1823	0.740	2081	0.890	2310
0.595	1833	0.745	2089	0.895	2317
0.600	1842	0.750	2097	0.900	2325
0.605	1851	0.755	2105	0.905	2332
0.610	1860	0.760	2113	0.910	2340
0.615	1869	0.765	2121	0.915	2347
0.620	1878	0.770	2129	0.920	2354
0.625	1887	0.775	2136	0.925	2361
0.630	1895	0.780	2145	0.930	2368
0.635	1904	0.785	2152	0.935	2375
0.640	1913	0.790	2160	0.940	2383
0.645	1922	0.795	2168	0.945	2389
0.650	1930	0.800	2176	0.950	2397
0.655	1939	0.805	2183	0.955	2403
0.660	1948	0.810	2191	0.960	2410
0.665	1956	0.815	2199	0.965	2418
0.670	1965	0.820	2206	0.970	2424
0.675	1973	0.825	2214	0.975	2432
0.680	1982	0.830	2222	0.980	2438
0.685	1990	0.835	2229	0.985	2445
0.690	1999	0.840	2237	0.990	2452

[1] Specification requirements begin with this ordered thickness.

TABLE IV. Minimum Required V_{50} Ballistic Limits (Protection Criteria) (BL(P)) for Solid Armor Design (cont.)

Firing Obliquity: 0° Projectile: Caliber .50 AP M2

Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)
0.995	2459	1.065	2553	1.135	2644
1.000	2466	1.070	2559	1.140	2651
1.005	2473	1.075	2567	1.145	2657
1.010	2479	1.080	2573	1.150	2663
1.015	2486	1.085	2580	1.155	2670
1.020	2493	1.090	2586	1.160	2676
1.025	2500	1.095	2593	1.165	2682
1.030	2506	1.100	2599	1.170	2688
1.035	2513	1.105	2605	1.175	2695
1.040	2520	1.110	2612	1.180	2701
1.045	2526	1.115	2618	1.185	2708
1.050	2534	1.120	2625	1.190	2713
1.055	2540	1.125[2]	2631	1.195	2720
1.060	2547	1.130	2638	1.200	2726

[2] Specification requirements end with this ordered thickness (See Table V).

TABLE V. Minimum Required V_{50} Ballistic Limits (Protection Criteria) (BL(P)) for Solid Armor Design

Firing Obliquity: 0° Projectile: 20mm AP-T, M602

Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)
1.100	1682	1.390	1961	1.690	2212
1.110	1692	1.400	1971	1.700	2219
1.120	1703	1.410	1979	1.710	2227
1.126[1]	1709	1.420	1988	1.720	2234
1.130	1713	1.430	1997	1.730	2250
1.140	1723	1.440	2005	1.740	2258
1.150	1734	1.450	2014	1.750	2265
1.160	1743	1.460	2023	1.760	2273
1.170	1754	1.470	2031	1.770	2273
1.180	1763	1.480	2039	1.780	2280
1.190	1774	1.490	2048	1.790	2288
1.200	1784	1.500	2057	1.800	2296
1.210	1793	1.510	2065	1.810	2303
1.220	1804	1.520	2073	1.820	2311
1.230	1813	1.530	2082	1.830	2318
1.240	1823	1.540	2091	1.840	2326
1.250	1832	1.550	2098	1.850	2332
1.260	1842	1.560	2107	1.860	2340
1.270	1851	1.570	2115	1.870	2347
1.280	1861	1.580	2123	1.880	2355
1.290	1870	1.590	2132	1.890	2362
1.300	1879	1.600	2139	1.900	2369
1.310	1889	1.610	2147	1.910	2377
1.320	1897	1.620	2156	1.920	2384
1.330	1907	1.630	2164	1.930	2391
1.340	1917	1.640	2172	1.940	2399
1.350	1925	1.650	2179	1.950	2406
1.360	1934	1.660	2187	1.960	2413
1.370	1944	1.670	2196	1.970	2419
1.380	1952	1.680	2204	1.980	2426

[1] Specification requirements begin with this ordered thickness.

TABLE V. Minimum Required V_{50} Ballistic Limits (Protection Criteria) (BL(P)) for Solid Armor Design (cont.)

Firing Obliquity: 0° Projectile: 20mm AP-T, M602

Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)	Thickness (in)	Required BL(P) (fps)
1.990	2434	2.020	2455	2.050	3346
2.000[2]	2441	2.030	2462	2.060	2483
2.010	2448	2.040	3339	2.070	2490

[2] Specification requirements end with this ordered thickness.

3.2.5 Dimensions.

3.2.5.1 Length, width, and thickness. Length, width and thickness shall be as specified in the contract or purchase order (see 6.2) and be taken in accordance with 4.6.2.4.

3.2.5.2 Weight. The weight of the perforated plate shall be 50% ± 5% of the weight of the same size solid plate or casting of the exact dimensions.

3.2.5.3 Tolerances.

3.2.5.3.1 Length, width, and thickness. Unless otherwise specified in the contract or purchase order (see 6.2), the tolerances for the length and width dimensions shall be plus1/8 inches and minus zero for Class 1 and plus or minus 1/8 inches for Class 2. The plus and minus tolerances on plate thickness for Class 1 shall be as specified in Table VI.

TABLE VI. Plate Thickness Tolerances for Class 1.

Thickness Range (inch)	Tolerance (inch)
0.250 to 0.374	0.019
0.375 to 0.749	0.019
0.750 to 0.999	0.023
1.000 to 2.000	0.043

3.2.5.3.1.1 Class 2 Permissible Variations. Unless otherwise specified in the contract or purchase order (see 6.2), the thickness tolerance and the weight tolerance shall loosely reflect

those outlined in Steel Castings Handbook. Guidelines and recommendations are provided in the proceeding sections if requirements are not specified by the procuring activity. Generally tolerance limits shall be indicated in one direction only. The absence of a tolerance in the other direction does not mean a limitation of zero tolerance. The plus tolerance for thickness shall be controlled by the weight limitations, and the minus tolerance for weight shall be automatically controlled by the limitations on thickness. However, if the official weights have not been established and specified for the casting design, the weights of any casting should not vary by more than 5% from the average weight computed from at least the first 10 castings made for production.

3.2.5.4 Straightness. Plates shall be of such straightness that the maximum edgewise curvature (depth of arc) shall not exceed 1/8 inch for any 2 ft section along its length.

3.2.5.5 Flatness. Unless otherwise specified in the contract or purchase order (see 6.2), the flatness tolerance of each Class 1 plate shall be within the requirements specified in Table VII for the applicable thickness after final heat treatment. Unless otherwise specified in the contract or purchase order (see 6.2), the flatness tolerance of each Class 2 plate shall be within 2 times the requirements specified in Table VII for the applicable thickness after final heat treatment. Tighter tolerance requirements may be specified on the drawing, contract or order and shall be as agreed upon between the vendor and the procuring activity (see 6.2).

3.2.5.6 Waviness. Unless otherwise specified in the contract or purchase order (see 6.2), the waviness tolerance of each Class 1 plate shall be within the requirements of Table VIII for the applicable thickness after final heat treatment. There is no waviness requirement for Class 2 plates unless otherwise specified in the contract or purchase order (see 6.2).

3.2.6 Perforations. To reduce the weight and the overall areal density of the plate or casting, perforation shall be made according to the requirements specified in the contract or purchase order (see 6.2).

3.2.6.1 Geometry. The geometry of perforations shall be as specified in the contract or purchase order (see 6.2).

3.2.6.1.1 Draft angle. For Class 2 armor material that is manufactured with a draft angle, the layout of the holes shall be such that the minimum web thickness is maintained. The minimum web thickness shall be specified in the contract or purchase order (see 6.2).

3.3 Marking for identification. Unless otherwise specified in the contract or purchase order (see 6.2) that MIL-STD-129 or any other markings shall be used, each plate shall be marked on one face or edge with the manufacturer's name or trademark, the basic number and revision letter of this specification, the nominal plate thickness, and the lot number. The characters shall be not less than 3/8 inch in height and shall be applied using a suitable marking fluid whose residue shall contain not more than traces of halogen-bearing compounds and shall be capable of being removed in hot alkaline cleaning solution without rubbing. The markings shall have no deleterious effect on the plate material or its performance and shall be sufficiently stable to withstand normal handling. When practicable, the marking shall be raised characters formed on each ballistic test plate.

3.3.1 Marking of ballistic test plates. Each ballistic test plate shall be marked with a plate identification code (see 3.3) and the letters 'PRE' if a first article test plate and 'ACC' if an acceptance test plate. When practicable, the marking shall be raised characters formed on each ballistic test plate.

TABLE VII. Permissible Variations for Flatness for Class 1

Specified Nominal Thickness of Plate (inches)	Variations from a flat surface for specified widths (inches)						
	Under 36	36 to 48 excl.	48 to 60 excl.	60 to 72 excl.	72 to 84 excl.	84 to 96 excl.	96 to 108 excl.
1/4 to 3/8 excl.	3/8	15/32	9/16	11/16	7/8	15/16	1
3/8 to 1/2 excl.	3/8	7/16	15/32	15/32	9/16	21/32	3/4
1/2 to 3/4 excl.	5/16	3/8	13/32	7/16	1/2	9/16	5/8
3/4 to 1-1/4 excl.	5/16	3/8	7/16	7/16	15/32	1/2	9/16
1-1/4 to 2	9/32	5/16	3/8	13/32	7/16	15/32	1/2

NOTE: The above variations apply to plates up to 12 feet in length, or in any 12 foot section for longer plates.

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

3.5 Workmanship. All plates shall have two (2) inspection zones as outlined in Figure 2 and each plate shall be visually inspected and the surface of the finished plate shall not exceed the specified linear discontinuities listed in 3.5.1 for the applicable Class of material. The degree of acceptable surface roughness and surface discontinuities shall be as specified in the contract or purchase order (see 6.2) in accordance with 4.7.1.

3.5.1 Surface defects. The top and bottom surface of each Class 1 plate and the final top and bottom surface (after machining) for each Class 2 plate shall be free of surface defects (see 6.5.1 for a partial list of defects) in zone A (see Figure 2) that are greater than 0.25 inches in diameter or width or length. Also in zone A, the total number of defects that have the largest dimension (length, width, or diameter) that is greater or equal to 0.10 inches shall be added together and shall not exceed a total of 1.5 inches. Surface defects that are greater than 0.75 inches in diameter or width or length shall be cause for rejection if they are located in zone B (see Figure 2). Also in zone B, the total number of defects that have the largest dimension (length, width, or diameter) that is greater or equal to 0.10 inches shall be added together and shall not exceed a total of 3.0 inches.

3.5.1.1 Depth of imperfections. The depth of rolled-in scale, scale pitting, mechanical gouges, or snakes for both Class 1 & 2 shall not exceed 0.03 inches and shall not reduce the steel thickness below the allowable minimum as specified in the contract or purchase order (see 6.2).

TABLE VIII. Waviness Tolerances for Plates. for Class 1

Flatness Tolerance from Table VII. (inches)	When Number of Waves in 12 feet is:						
	1	2	3	4	5	6	7
9/32	9/32	7/32	5/32	3/32	3/32	1/32	1/32
5/16	5/16	1/4	3/16	1/8	1/8	1/16	1/16
11/32	11/32	9/32	5/32	3/32	1/8	1/16	1/16
3/8	3/8	5/16	3/16	3/16	1/8	1/16	1/16
13/32	13/32	5/16	7/32	5/32	1/8	3/32	1/16
7/16	7/16	5/16	1/4	3/16	1/8	1/8	1/16
15/32	15/32	11/32	9/32	3/16	5/32	1/8	1/16
1/2	1/2	3/8	5/16	3/16	3/16	1/8	1/16
17/32	17/32	13/32	5/16	7/32	3/16	1/8	3/32
9/16	9/16	7/16	5/16	1/4	3/16	1/8	1/8
19/32	19/32	15/32	11/32	1/4	3/16	1/8	1/8
5/8	5/8	1/2	3/8	1/4	3/16	1/8	1/8
21/32	21/32	1/2	3/8	9/32	3/16	5/32	1/8
11/16	11/16	1/2	3/8	5/16	3/16	3/16	1/8
23/32	23/32	17/32	13/32	5/16	7/32	3/16	1/8
3/4	3/4	9/16	7/16	5/16	1/4	3/16	1/8
25/32	25/32	19/32	7/16	5/16	1/4	3/16	1/8
13/16	13/16	5/8	7/16	5/16	1/4	3/16	1/8
27/32	27/32	21/32	15/32	11/32	1/4	3/16	1/8
7/8	7/8	11/16	1/2	3/8	1/4	3/16	1/8
29/32	29/32	11/16	1/2	3/8	9/32	7/32	5/32
15/16	15/16	11/16	1/2	3/8	5/16	1/4	3/16
31/32	31/32	23/32	17/32	13/32	5/16	1/4	3/16
1	1	3/4	9/16	7/16	5/16	1/4	3/16

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

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

REQUEST FOR BALLISTIC TEST OF PERFORATED ARMOR									
FIRING RECORD:							**DATE:**		
Plate MANUFACTURER / PRODUCER:							**PRIME CONTRACTOR:**		
Name:							Name:		
Address:							Address:		
POC:							POC:		
Phone No:							Phone No:		
Fax No:							Fax No:		
SPECIFICATION: MIL-PRF-32269							**REVISION:**		**AMENDMENT:**
CONTRACT NO:							TECOM PROJECT NO:		
DCAS REGION:							BALLISTIC TEST CONTRACT NO:		
TEST ITEM IDENTIFICATION:							**TEMPERING TEMPERATURE:_____ ^{O} F**		
Lot No.	Plate No.	Perforation Design					Ordered Thickness		Alloy and Temper
PURPOSE: ___ Acceptance ___ First Article ___ Development _____Solid _____Perforated									
SAMPLE: ___ Primary ___ Retest (Firing Record No. of Failed Sample_____)									
CHEMISTRY ANALYSIS	C	Mn	P	S	Si	Ni	Cr	Mo	V
FIRST ARTICLE RESULTS:									
PRODUCTION RESULTS:									
DIFFERENCE (Pass / Fail)									
B:	Cu:	Ti:	Zr:	Al:	Pb:	Sn:	Sb:	As:	
MECHANICAL PROPERTIES: HARDNESS:_____									
BALLISTIC TEST RESULTS: **SEPARATELY HEAT TREATED TEST PLATE : YES_____NO_____**									
Test	Projectile	Obl. (deg)	Actual Thickness (in)	Required V_{50} (fps)	Actual V_{50} (fps)		Pass/ Fail	Notes	
LOTS REPRESENTED BY:			Reduced Testing			Audit Testing			
Lot [met] [failed to meet] the ballistic requirements of specification MIL-PRF-32269.									
Government Representative			Date	Supplier Representative			Date		

FIGURE 1. Perforated Armor Test Data Form

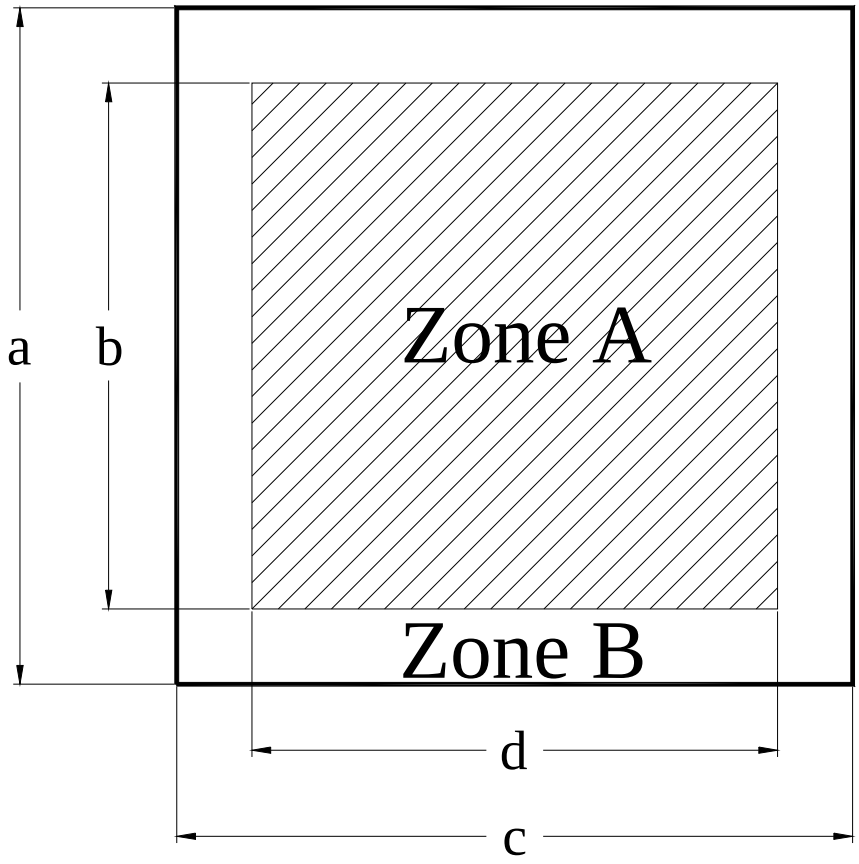

FIGURE 2. Defined Zones of inspection for defects.

NOTE: Zone A of dimensions b and d is equal to the innermost 60% of the total area of the plate, either a x c or a^2.

4. VERIFICATION

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

a. First article inspection (see 4.4).
b. Conformance 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: CSTE-DTC-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059 for ballistic testing for first article or production acceptance.

4.3 Lot. A lot shall consist of all plates of the same declared chemistry, the same nominal thickness from the same heat, processed together as a unit. All plates in a lot shall receive the same final heat treatment within standard parameters, but not necessarily at the same time.

4.4 First article inspection. First article inspection, except as otherwise indicated in this specification, shall utilize the same requirements and test methods as the production acceptance inspection shown in 4.5.

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

4.6 Sampling.

4.6.1 For first article inspection.

4.6.1.1 Chemical analysis. A sample for chemical analysis shall be taken in accordance with 4.8.1 from one of the test plates submitted for ballistic testing.

4.6.1.2 Mechanical properties.

4.6.1.2.1 Hardness samples. The Brinell hardness of each plate submitted for ballistic testing shall be measured in two places on either the top or bottom surface of each plate at diagonally opposed corners.

4.6.1.3 Ballistic test samples. One plate, of the thickness specified on the contract, shall be submitted to a Government approved facility for ballistic tests. This sample shall be taken from a solid plate or casting. The required ballistic test plate dimensions are listed in Table IX. When more than one thickness is involved, first article approval may be obtained for each of the size ranges listed in Table IX by submission of plates for one specified thickness within each range. All ballistic tests shall be conducted at the specified degree of obliquity with the specified test projectile for each ordered thickness as listed in Table IX.

4.6.2 For production acceptance inspection.

4.6.2.1 For chemical analysis. A sample sufficient to perform the analysis required to determine compliance with 3.2 shall be selected from each lot (see 4.8.1).

4.6.2.2 For mechanical properties (See 3.2.3).

4.6.2.2.1 Hardness samples. The Brinell hardness of each plate submitted for ballistic testing shall be measured in two places on either the top or bottom surface of each plate at diagonally opposed corners.

TABLE IX. Ballistic Test Plate Sizes and Corresponding Test Projectiles for First Article and Acceptance Testing

Thickness Ranges (inches)	Class of Armor	Design	Minimum Size (inches)	Ballistic Test Projectile	Degree of Obliquity	Table for Ballistic Acceptance
0.250 to 0.565, incl	1 & 2	Solid	12 x 12	Cal .30 AP M2	0^o	Table III
0.566 to 1.125, incl	1 & 2	Solid	18 x 12	Cal .50 AP M2	0^o	Table IV
1.126 to 2.000, incl	1 & 2	Solid	18 x 12	20-mm AP-T M602	0^o	Table V

4.6.2.3 For ballistic testing. According to the thickness of the plate represented (ordered plate thickness) one plate of a solid design shall be selected for every lot of material of the same thickness. In the event of reduced testing (see 4.8.4), multiple lots represented by a single acceptance ballistic test shall have been manufactured using the same heat treatment and other processing within standard mill parameters of a fixed process.

4.6.2.3.1 Cast plates. When the plates specified in 4.6.2.3 are from castings then the frequency of ballistic testing shall be as specified in the contract or purchase order (see 6.2).

4.6.2.4 Plate thickness measurements. Unless otherwise specified in the contract or purchase order (see 6.2),at least one (1) thickness measurement shall be taken along each side of the plate for a total of four (4) measurements minimum. The acceptance of each plate shall be based on these measurements meeting the thickness tolerance requirements set forth in Table VI, as applicable.

4.7 Examination.

4.7.1 Visual. Each piece in each lot shall be visually examined for compliance with the requirements for workmanship (see 3.5) unless otherwise specified by the contract or purchase order (see 6.2) and marking for identification (see 3.3).

4.7.1.1 Weld repair. All weld repairs for Class 2 armor shall be visually inspected. The weld deposit shall be ground to blend into the surrounding area to provide a smooth, uniform surface to support the visual inspection process. The inspection area shall include the weld deposit and one (1) inch from the weld deposit to assure freedom from cracks in the heat affected zone. The inspected area shall be free of cracks and lack of fusion open to the surface. Unless otherwise specified by the contract or purchase order (see 6.2) indications less than or equal to 0.10 inches in length, width, or diameter shall be considered non-relevant.

4.7.2 Dimensions. All plates shall be subject to inspection for compliance with the dimensional and tolerance requirements (see 3.2.5).

4.8 Tests (first article and production conformance).

4.8.1 Chemical composition. Chemical analysis shall be conducted in accordance with the applicable method specified in ASTM A751 (see 6.6)

4.8.2 Hardness properties. Brinell hardness tests shall be conducted in accordance with either ASTM E10 or ASTM E110 using a 10mm carbide ball and a 3000 kilogram load. Surface scale and decarburization shall be removed from the areas where the tests are to be made.

4.8.3 Ballistic tests. Plate thickness as determined by the ballistic test agency shall be used to determine the required protection ballistic limit for that plate and shall be taken as the average of 4 thickness measurements read to the nearest 0.001 inch and the average thickness reported to the nearest 0.005 inch. At least one measurement shall be taken near each edge of the plate at a distance of at least 1 inch from the edge. The V_{50} ballistic tests shall be performed in accordance with USATECOM Ballistic Tests of Armors, TOP 2-2-710 and Projectile Velocity and Time of Flight Measurements, ITOP 4-2-805. When a complete penetration can not be obtained for any class of armor material, the following rule shall be in effect until a new ballistic acceptance round is developed and utilized. When the ballistic velocities of four (4) partial penetrations are above the minimum ballistic requirement for the specific thickness, the material shall be certified as acceptable with a V_{50} (which obviously can not be explicitly determined) above the minimum requirement.

4.8.3.1 Cracking. No through cracks greater than 2.5 inch in length on any plate surface are acceptable after ballistic testing.

4.8.4 Reduced testing for acceptance. Upon the approval of the procuring activity (see 6.2), reduction in the amount of testing per MIL-STD-1916 may be authorized provided the results on consecutive lots indicate that a uniform product meeting the requirements is being produced. Reduction in testing shall only be considered if steady production exists as determined by the procuring activity. Testing for a given plate thickness shall return to standard (non-reduced testing) conditions of one plate per lot, whenever a ballistic test plate fails to meet ballistic requirements.

4.8.4.1 First level reduced testing. Testing frequency may be reduced, upon approval by a responsible authority (see 6.2), to one ballistic test plate for every three lots of material of the same thickness providing the preceding five ballistic test plates for that thickness have met ballistic requirements.

4.8.4.2 Second level reduced testing. Testing frequency may be further reduced, upon approval by a responsible authority (see 6.2), to one ballistic test plate for every five lots of material of the same thickness providing the preceding ten ballistic test plates of that thickness have met ballistic requirements.

4.9 Rejection.

4.9.1 First article. Failure of the first article samples to meet any of the testing and inspection requirements of this specification indicates failure of the process to produce acceptable product.

4.9.2 Retests. Resubmission of first article samples shall not be made until the contractor has demonstrated that he has made necessary corrections in processing the material to the satisfaction of the procuring activity.

4.9.3 Production acceptance.

4.9.3.1 Examination. A lot shall be subject to rejection for failure to meet the visual and dimensional requirements of 4.7.

4.9.3.2 Tests. A lot shall be subject to rejection for failure to meet any of the test requirements of 4.8.

4.9.3.3 Retests. At the discretion of the producer, a rejected lot may be retested as specified below.

4.9.3.3.1 Non-ballistic retests. All failed sample units from the original sample shall be excluded from the retest lot. Two new sample units shall be taken and tested in accordance with 4.8.2, as applicable. Failure of any retest specimen to meet the applicable property requirements shall be cause for rejection of the entire lot and no further retesting shall be permitted.

4.9.3.3.2 Ballistic retests. In the event of failure of any one or all of the ballistic test plates, the failed lot(s) may be reprocessed and one plate shall be submitted for retest from each reprocessed lot. If a failure then occurs, the lot shall be permanently rejected.

5. PACKAGING

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

6. NOTES

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

6.1 Intended use. The armor specified herein is intended for use on combat vehicles as appliqué armor.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Product form size (thickness, width, and length) (see 3.2.5.1 and 3.5.1.1) and quantity.
c. Specify classification and specific design (geometry) of the perforations (see 1.2, 3.2.6, and 3.2.6.1).
d. If issues of documents are different (see 2.2.1, 2.2.2, and 2.3).
e. When first article sample is required (see 3.1).
f. If the chemical requirements in Column A of table I are different (see 3.1.2).
g. If production and ballistic test plates can be heat treated separately (see 3.2.2.1 and 3.2.2.1.2).
h. If plates can be delivered in other than the as-heat treated condition (see 3.2.2.1.3).
i. If heating can be performed after the final hardening and tempering operation or after post weld stress relieving (see 3.2.2.1.3.1).
j. If reheating is allowed (see 3.2.2.1.3.2).
k. If the tolerances are different than those specified (see 3.2.5.3.1).
l. If the thickness tolerance and the weight tolerance are different than those outlined in Steel Castings Handbook (see 3.2.5.3.1.1) .
m. If the flatness tolerances are different than those specified in Table VII for Class 1 and/or are different than 2 times the values specified in Table VII for Class 2. (see 3.2.5.5).
n. If the waviness tolerances are different than those specified in Table VIII for Class 1 and if there is a waviness requirement for Class 2 (see 3.2.5.6).
o. Specify the minimum web thickness (see 3.2.6.1.1)
p. If markings for identification are specified (see 3.3).
q. Specify the degree of acceptable surface roughness and surface discontinuities (see 3.5 and 4.7.1).
r. If someone else beside the contractor is responsible for the performance of the requirements (see 4.2).
s. If testing facilities are to be specified (see 4.2).
t. If another Government ballistic testing facility is selected by the procuring activity (see 4.2.1).
u. If the plates are castings then the frequency of ballistic testing should be specified (see 4.6.2.3.1)
v. If the number and location of thickness measurements are different than those specified (see 4.6.2.4).
w. If the visual acceptance criteria are different than that specified (see 4.7.1).

x. If indications less than or equal to 1/8 inch are to be considered relevant (see 4.7.1.1).
y. If reduced testing is allowed (see 4.8.4).
z. If reduced testing (First level) is approved (see 4.8.4.1).
aa. If reduced testing (Second level) is approved (see 4.8.4.2).
ab. Packaging requirements (see 5.1).

6.3 Acceptable alloys. The Armor Mechanics Branch, U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD has determined that 4130 steel alloy and 4330 steel alloy are acceptable alloys for cast perforated plate (Class 2 armor). ARL has also determined that MIL-A-12560 rolled homogenous steel (Class 1a armor) and MIL-A-46100 high hard rolled homogenous steel armor (Class 1b armor) is acceptable for imparting a hole pattern into to make perforated plate. These are examples of perforated material types ARL has qualified to date and are by no means comprehensive. If other candidate alloys for making cast perforated plates (or alternatives, e.g. expanded metal) exist, it is recommended sample perforated plates made of the chosen alloy be sent to the agency responsible for the original armor design to determine the material candidacy. Likewise, if any contracted supplier using processes other than cast makes or wants to make a material change, it is recommended sample perforated plates be sent to the agency responsible for the original armor design to determine the material candidacy. Vendors supplying a new cast perforated plate alloy and/or supplying a new processed perforated plate material who have had their plate(s) selected as candidate material to be used in the armor system are then required to perform first article testing.

6.4 Potential suppliers. Potential suppliers who have not previously supplied perforated armor plate to this specification and wish to have their material ballistically tested, may do so at their expense. It is recommended that inquiries for such testing be directed to Commander, USA ATC, ATTN: CSTE-DTC-AT-SL-V, Building 358, 400 Colleran Road, APG, MD 21005-5059.

6.5 Definitions.

6.5.1 Defects.

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

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

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

6.5.1.4 Seams. An un-welded fold or lap that appears as a crack, usually resulting from a discontinuity on a metal surface.

6.5.1.5 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.

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

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

6.5.1.8 Burning. 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.

6.5.1.9 Lamination. A type of discontinuity with separation or weakness generally aligned parallel to the 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.

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

6.5.1.11 Linear indication. For nondestructive examination purposes, a linear indication is evidence of a discontinuity that requires interpretation to determine its significance. For the purpose of this specification, a linear indication has a length three (3) times its width.

6.5.1.11.1 Linear discontinuities Elongated discontinuities are considered linear if their length equals or exceeds three times the width.

6.5.1.12 Veins. Raised, narrow, linear ridges that form upon cracking of the sand mold or core due to expansion of sand and the resulting mold or core stresses during filling of the mold with liquid steel.

6.5.1.13 Rat tails. Long, narrow, linear depressions or small steps occurring on a casting surface. Rat tails form as a result of sand expansion and minor buckling of the mold surface during filling of the mold with liquid metal.

6.5.1.14 Scab. A raised, rough area on a casting that usually consists of a crust of metal covering a layer of sand. Sometimes, a scab consists of a raised, rough area of essentially solid metal on the surface of a casting.

6.5.1.15 External chills. Usually metal blocks, or graphite and carbon blocks, that are incorporated into the mold to locally increase the rate of heat removal during solidification. Brackets have the same purpose but represent an integral part of the casting. Brackets are produced by providing suitable cavities in the mold or core. External chills may produce flat spots and edges (raised areas or depressions) on the casting surface. Brackets merely change the casting appearance due to their presence. Brackets may be removed or allowed to remain on the casting.

6.5.1.16 Parting line and core print fins. Thin projections of excess metal at the parting plane between mold halves or core and mold. Causes are improper closing of the mold, insufficient weighting or clamping of the mold for pouring, or uneven pattern surfaces at the matching locations. Core print fins are usually caused by improper dimensions of core prints of the pattern or core box, by rough placement of cores in a soft mold, or by inadequately secured cores.

6.5.1.17 Wrinkles. Elongated, smooth depressions of the casting surface, frequently appearing in closely spaced groups. Wrinkles result from irregularities of the liquid metal flow in the mold cavity, frequently associated with low temperature, and are distinguished from the more severe phenomenon of laps, folds, or cold shuts where the casting surface is actually folded over.

6.5.1.18 Misrun. An incompletely formed casting, due to only partial filling of the mold cavity when the liquid metal solidifies prematurely. The resulting casting appearance is characterized by rounded edges, for a mild degree of misrun. Irregular, malformed edges of more severe misruns, and not fully formed castings, are characteristic. Frequently, misruns are associated with such discontinuities as wrinkles or laps and folds, or both.

6.5.1.19 Gas porosity. A concave discontinuity in castings due to the evolution of gas, either from the solidifying metal or the surrounding mold.

6.5.1.20 Chaplets. Metallic (steel) devices used to maintain the spacing between the core and the mold. Low liquid metal temperature and unfavorable flow conditions in the mold may produce insufficient fusion and cause irregular contact areas on the casting surface.

6.5.1.21 Internal chills. Metallic (steel) devices used to locally increase the rate of heat removal during solidification. Incomplete fusion due to low liquid steel temperatures and prevailing flow conditions may produce irregularities of the surface similar to those that may be associated with chaplets.

6.5.1.22 Cracks. Cold and hot, less jagged, sometimes straight ruptures that occur after solidification of the casting, due to excessive strain. Sometimes cracks are referred to as cold, hot, or heat treat-cracks to indicate the condition of the castings, or the operation during which the cracks occur.

6.5.1.23 Hot tears. Jagged ruptures in castings that occur during the final stages of solidification, while there is still some liquid in the interdendritic spaces, or shortly after solidification is complete.

6.5.1.24 Metal removal marks. Flame cutting and air carbon arc cutting produce parallel grooves in the cut-off area. Finer marks are produced with the abrasive cut-off wheel and grinding.

6.5.1.25 Nonmetallic inclusions. Casting surface inclusions such as ceroxides, slag, and sand are partially or completely removed during the cleaning process of pressure blasting. Surface

discontinuities left by these inclusions are referred to by the inclusion type that caused their formation:

6.5.1.25.1 Ceroxides. Ceroxides cause depressions on the surface of the casting by displacement of molten metal. Ceroxides consist of a mixture of low-melting oxides and partially fused sand. The crater-like appearance of the casting surface depression is typical.

6.5.1.25.2 Slag. Depressions on the casting surface caused by slag are similar to those caused by ceroxides. They differ by a more rounded appearance of the depression and do not exhibit the crater-like appearance of ceroxides.

6.5.1.25.3 Sand. Depressions caused by sand are similar to those of ceroxides and slag. Their appearance may, at times, more closely reflect the granular nature of the sand.

6.5.1.26 Shrinkage under risers and gates, and revealed by machining. A shrinkage void is a discontinuity in castings due to the lack of available liquid feed metal during solidification contraction. Riser removal and machining may reveal shrinkage that extends from the interior of the casting to the near surface area.

6.5.1.27 Surface texture. Cast surfaces have a multidirectional lay, without the uniform sequence of ridges and valleys of machined surfaces.

6.5.1.28 Welding.

6.5.1.28.1 Weld undercuts. Narrow elongated depressions that border the weld contour and result from improper welding conditions or inadequate control of welding operations.

6.5.1.28.2 Weld spatter. Weld metal droplets that solidified against and adhere to the component being welded.

6.5.2 Homogeneous armor. Homogeneous armor is armor that has a uniform composition and heat treatment throughout.

6.5.3 Interested parties.

6.5.3.1 Contractor. The contractor is the company which has a direct contract from the Government to furnish an end item – usually a vehicle. Also, known as the prime contractor.

6.5.3.2 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 authority.

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

6.5.3.4 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.

6.5.4 Fair impact. A fair impact is an impact resulting from the striking of the test plate by a projectile in normal flight (no yawing or tumbling) and separated from another impact or the edge of the plate, hole, crack, or spalled area by an undisturbed area of at least one caliber.

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

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

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

6.5.8 V_{50} protection ballistic limit, BL(P). A BL(P) consists of an equal number of complete and partial penetrations attained by the up- and down-firing method. All BL(P)s should be computed using the highest partial penetration velocities and the lowest complete penetration velocities. Table X delineates the order of priority.

TABLE X. Ballistic Limits (Protection Criteria)

No. of Rounds in BL(P)	Maximum Allowable Velocity Spread (fps)	Maximum No. of Rounds To Be Used
4	60	12[1]
6	90	12
10	125[2]	as required

[1] Firing should continue until either a 4-round or 6-round BL(P) has been attained, whichever comes first in the firing order. If these occur simultaneously the 6-round BL(P) should be reported. If, after 12 rounds have been fired and neither a 4 or 6 round BL(P) has been determined, then firing should continue until a 10-round BL(P), having a maximum velocity spread of 125 fps, has been determined.

[2] In the event that a high partial penetration velocity occurs which is more than 125 fps above the low complete penetration velocity, then the ballistic limit should consist of the 5 highest partial penetration velocities and the 5 lowest complete penetration velocities. The maximum velocity spread should be kept as small as possible without deviating from the normal up-and-down method of firing.

6.5.8.1 Recomputed BL(P). In the event that after following the above procedures the BL(P) is less than 25 fps above the minimum required BL(P), and a gap (high partial penetration velocity less than the low complete penetration velocity) of 25 fps or more exists in the velocities used to compute the BL(P), then one or more rounds should be fired to reduce the gap to less than 25 fps. The BL(P) should then be recomputed as before using the highest partial velocities and the lowest complete penetration velocities. The recomputed BL(P) should be the one reported on the firing record.

6.5.9 Schematic of perforated plate design. An example of a perforated plate design is shown in Figure 3.

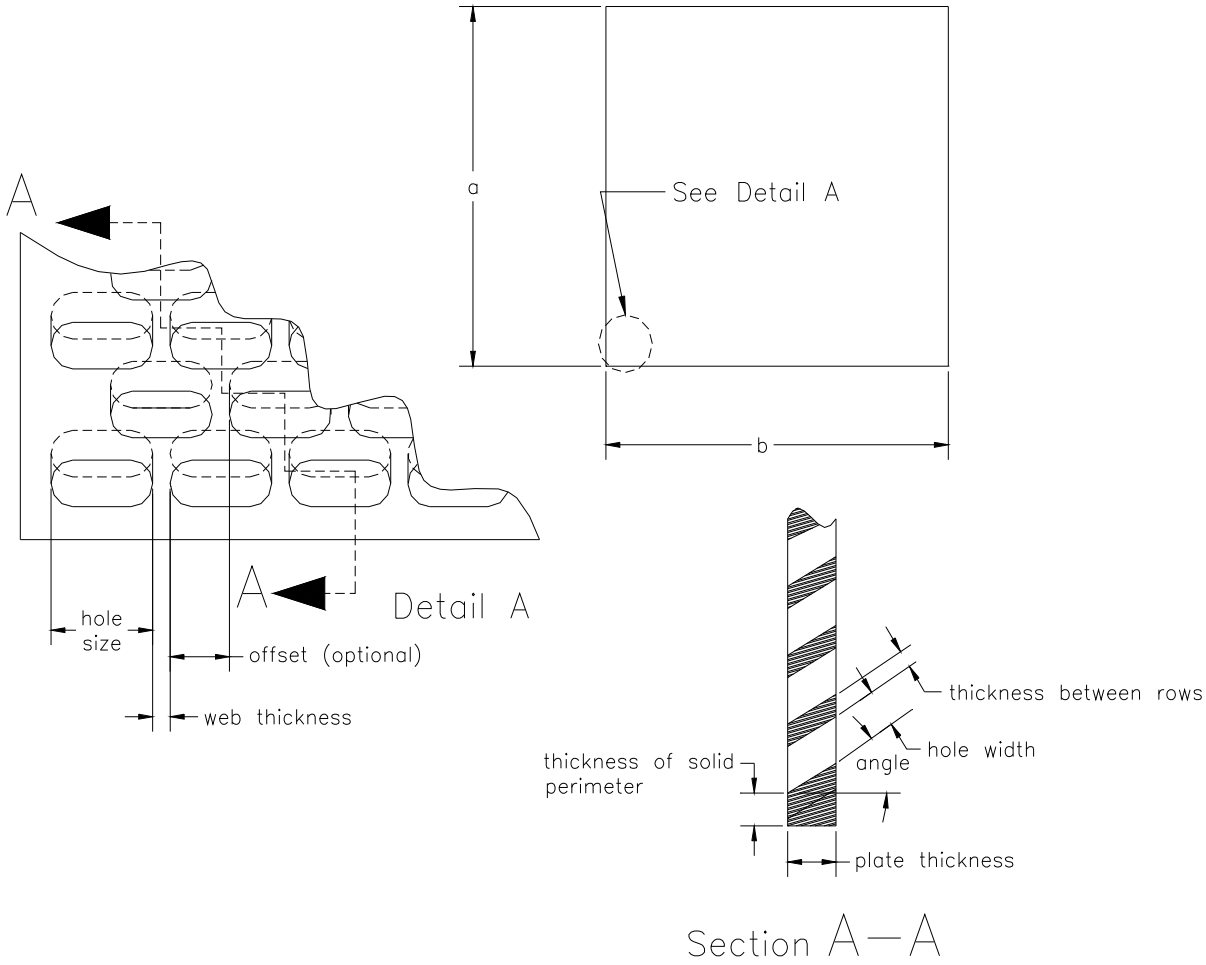

FIGURE 3. Schematic of perforated plate design.

6.5.10 Draft angle. A draft angle describes the amount of taper for molded or cast parts perpendicular to the parting line, required to facilitate removal of the cast part from the die cavity.

6.6 Chemical analysis. Suggested ASTM instrumental methods that can be used are chemical analysis E415, E282, E484, and E322. ASTM A751 should be consulted for a complete list of methods.

6.7 Ownership of ballistic test plates. First article and test plates that comply with the requirements of this specification are considered as part of the lot of perforated armor they represent, and ownership of them passes to the Government upon 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 does the rejectable lot they represent.

6.8 Marking. Suggested wording to be included in the contract or purchase order "Marking for shipment and storage should be in accordance with MIL-STD-129".

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

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

6.10 Subject term (key word) listing.

Armor	Perforated	Foundry	20-mm API-T M602
Armor plate	Casting	Welding	
Ballistic limit	Steel	Repair	
caliber .30 AP M2	caliber .50 AP M2	Vehicles	

CONCLUDING MATERIAL

Custodians:
Army – MR

Preparing activity:
ARMY – MR
(Project 9515-2007-006)

Review activities:
Army – AR, AT, AV, MI

DLA – IS

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