

METRIC

MIL-S-16216K(SH)

19 June 1987

SUPERSEDING

MIL-S-16216J(SH)

10 April 1981

(See 6.8)

MILITARY SPECIFICATION**STEEL PLATE, ALLOY, STRUCTURAL, HIGH YIELD STRENGTH
(HY-80 AND HY-100)**

This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers grade HY-80 and grade HY-100, sheared or gas cut, alloy steel plates, intended primarily for use in critical applications where a notch-tough high-strength material is required. The requirements apply to grade HY-80 plate up to 8 inches (203 millimeters (mm)) thick, and to grade HY-100 plate up to 6 inches (152 mm) thick.

1.2 Classification. Steel plate covered by this specification shall be of the following types and grades, as specified (see 6.2.1):

Type I - Plate where ultrasonic testing for soundness and thickness is not performed.

Type II - Plate over 1/2 inch (13 mm) thickness where ultrasonic testing for soundness and thickness is performed.

Grade HY-80 - 80,000 pounds per square inch (lb/in²) (552 million Pascals (MPa)) tensile yield strength, minimum.

Grade HY-100 - 100,000 lb/in² (690 MPa) tensile yield strength, minimum.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 9515

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2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specification and standards. The following specification 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.

SPECIFICATION

MILITARY

MIL-H-6875 - Heat Treatment of Steel, Process For.

STANDARDS

MILITARY

MIL-STD-163 - Steel Mill Products, Preparation for Shipment and Storage.
MIL-STD-248 - Welding and Brazing Procedure and Performance Qualification.
MIL-STD-271 - Nondestructive Testing Requirements for Metals.
MIL-STD-1684 - Control of Heat Treatment.
MIL-STD-1688 - Fabrication, Welding, and Inspection of HY 80/100 Submarine Applications.
MIL-STD-2149 - Standard Procedures for Explosion Testing Ferrous and Non-Ferrous Metallic Materials and Weldments.

2.1.2 Other Government publication. The following other Government publication forms a part of this specification to the extent specified herein. Unless otherwise specified, the issue shall be that in effect on the date of the solicitation.

PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

0900-LP-003-8000 - Metals, Surface Inspection Acceptance Standards.

(Copies of specifications, standards, and publications 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 documents 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.

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AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- A 20 - Standard Specification for General Requirements for Steel Plates for Pressure Vessels. (DoD adopted)
- A 370 - Standard Methods and Definitions for Mechanical Testing of Steel Products. (DoD adopted)
- E 604 - Standard Test Method for Dynamic Tear Testing of Metallic Materials. (DoD adopted)

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

(Nongovernment 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 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, a sample shall be subjected to first article inspection (see 4.3 and 6.4).

3.2 Material. Plates shall be made from ingots or slabs which have been made by the same process used for production of the first article plates. As a minimum, the steel shall be fully killed, vacuum degassed, and produced to fine grain practice. The steel may be cast by conventional methods or may be strand cast. The thickness ratio of reduction from strand cast slab to plate shall be a minimum of 3:1. When specified (see 6.2.1), virgin materials shall be used.

3.2.1 Recovered materials. Unless otherwise specified herein, all material incorporated in the steel plates covered by this specification shall be new and may be produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term recovered materials means suitable carbon and low alloy steel scrap which is used as a raw material, in lieu of virgin raw material.

3.3 Chemical composition. The chemical composition shall conform to table I. In cases where both heat and product analysis are determined, the product analysis shall be used to determine acceptance or rejection (see 4.6.1).

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TABLE I. Chemical composition, percent.^{1/}

Elements	Thickness, inches (millimeters)					
	To 1-1/4 (32) inclusive		Over 1-1/4 (32) to 3 (76)		Over 3 (76)	
	Grade HY-80	Grade HY-100	Grade HY-80	Grade HY-100	Grade HY-80	Grade HY-100
Carbon ^{2/}	0.12-0.18	0.12-0.18	0.13-0.18	0.14-0.20	0.13-0.18	0.14-0.20
Manganese	0.10-0.40	0.10-0.40	0.10-0.40	0.10-0.40	0.10-0.40	0.10-0.40
Phosphorous	0.015 max	0.015 max	0.015 max	0.015 max	0.015 max	0.015 max
Sulfur ^{3/}	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max	0.008 max
Silicon ^{4/}	0.15-0.38	0.15-0.38	0.15-0.38	0.15-0.38	0.15-0.38	0.15-0.38
Nickel	2.00-3.25	2.25-3.50	2.50-3.50	2.75-3.50	3.00-3.50	3.00-3.50
Chromium	1.00-1.80	1.00-1.80	1.40-1.80	1.40-1.80	1.50-1.90	1.50-1.90
Molybdenum	0.20-0.60	0.20-0.60	0.35-0.60	0.35-0.60	0.50-0.65	0.50-0.65
Residual elements ^{5/}						
Vanadium	0.03 max	0.03 max	0.03 max	0.03 max	0.03 max	0.03 max
Titanium	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max	0.02 max
Copper	0.25 max	0.25 max	0.25 max	0.25 max	0.25 max	0.25 max
Trace elements ^{5/}						
Antimony	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max
Arsenic	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max	0.025 max
Tin	0.030 max	0.030 max	0.030 max	0.030 max	0.030 max	0.030 max

1/ For definition of lot for analysis, see 4.4.1.1.

2/ For grade HY-80 plates 6 inches and over, add 0.02 percent to the upper limit.

3/ Unless otherwise specified (see 6.2.1), when sulfur is 0.002 percent or less, the plate shall be specifically identified.

4/ When vacuum carbon deoxidation is employed, the minimum silicon content may be reduced to 0.08 percent, in which case the steel shall be fully killed and shall not be active in the molds during teeming.

5/ Elements not added intentionally

3.3.1 Multiple ladle (heat) casting. When the multiple ladle (heat) casting process is utilized, each ladle (heat) shall meet the specified chemical composition including tolerances.

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3.4 Mechanical properties. Unless otherwise specified (see 6.2.1), the material shall meet the yield strength requirements specified in table II and the impact property requirements specified in table III after all heat treatments, including stress relief, have been performed.

3.4.1 Tensile ultimate strength. When specified (see 6.2.1), tensile ultimate strength shall be as specified in table II.

TABLE II. Tensile properties.

	Nominal thickness			
	Grade HY-80		Grade HY-100	
	3/4 inch (19 mm) and under	Over 3/4 inch (19 mm)	3/4 inch (19 mm) and under	Over 3/4 inch (19 mm)
Minimum ultimate tensile strength, lb/in ² (MPa) ^{1/}	When specified	When specified	When specified	When specified
Yield strength, 0.2 percent offset, lb/in ² (MPa)	80,000 to 100,000 (552-690)	80,000 to 99,500 (552-686)	100,000 to 120,000 (690-827)	100,000 to 120,000 (690-827)
Minimum elongation in 2 inches (50 mm), percent ^{2/}	19	20	17	18
Minimum reduction in area of a round specimen, percent		50		45

^{1/} Unless otherwise specified (see 6.2.1), this value is to be recorded for information only.

^{2/} For plates and sheets 1/4 inch (6 mm) and less thick, elongation shall be 14 percent for grade HY-80 and 12 percent for HY-100.

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TABLE III. Minimum impact test requirements.^{1/}

Nominal plate thickness		Temperature ^{5/} °F (°C)	Dynamic tear test requirement ^{2/} (average of two specimens)		Charpy test requirements ^{3/} (average of three specimens)		Fibrous fracture percent ^{4/}
Inches	(Milli-meters)		HY-80 Ft-lb (J)	HY-100 Ft-lb (J)	HY-80 Ft-lb (J)	HY-100 Ft-lb (J)	
Over 5/8 thru 8	(16 thru 203)	-40 (-40)	450 (610)				
Over 5/8 thru 6	(16 thru 152)	-40 (-40)		500 (680)			
1/2 thru 6	(13 thru 152)	-120 (-84) 0 (-18)			35 (47) 60 (81)		50 90
Over 6 thru 8	(Over 152 thru 203)	-120 (-84) 0 (-18)			30 (41) 60 (81)		40 90
1/2 to 4	(13 thru 102)	-120 (-84) 0 (-18)				40 (41) 60 (75)	50 90
Over 4 thru 6	(Over 102 thru 152)	-120 (-84) 0 (-18)				35 (34) 60 (75)	40 90

^{1/} Sampling and location of test specimens shall be as specified in 4.4.2.3 and 4.4.2.4.^{2/} No single test value shall be below the minimum average by more than 25 ft-lb (33.9 J).^{3/} No single test value shall be below the minimum average by more than 5 ft-lb (6.8 J).^{4/} Average of three specimens.^{5/} Tolerance for temperature tests shall be plus or minus 3°F or plus or minus 2°C.

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TABLE III. Minimum impact test requirements. - Continued

Application of impact tests			
Material thickness		Applicable test	Alternate test
Inches	Millimeters		
1/2 thru 5/8	13 thru 16	Charpy	None
Over 5/8 to 4 excl	Over 16 to 102 excl	Dynamic tear	None
4 thru 8	102 thru 203	Dynamic tear	Charpy (see 4.7.5.1 and 6.2.1)

3.5 Heat treatment. Plate shall meet the mechanical requirements of this specification with the following restrictions:

- (a) The plates shall be quenched and tempered. The final tempering temperature shall be not less than the temperature specified in table IV.
- (b) If the plates are stress relieved after final tempering, the stress relief temperature shall be not less than the temperature specified in table IV and shall not exceed the tempering temperature. The plates shall be rapidly cooled following stress relief.
- (c) When specified in the contract or order, a complete record of the heat treatment given shall be prepared for each plate including stress relief and a record of the final heat treatment shall be prepared in accordance with the data ordering document included in the contract or order (see 6.2.2). The final heat treatment record shall include the time and temperature for the final tempering cycle and for the stress relief cycle, if any, and the cooling method used.

TABLE IV. Minimum stress relief and tempering temperature.

Nominal plate thickness inches, nominal (millimeters)		Minimum tempering temperature		Minimum stress relief temperature	
		°F	(°C)	°F	(°C)
HY-80	2-1/2 (63) and less	1200	650	1100	600
HY-80	Over 2-1/2 (63) to 8 (203)	1175	635	1100	600
HY-100	2-1/2 (63) and less	1150	620	1050	565
HY-100	Over 2-1/2 (63) to 6 (152)	1100	600	1050	565

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3.5.1 Simulated stress relief. When a simulated stress relief is required (see 6.2.1), a sample from the same heat treated lot (see 4.4.1.2) shall be subjected to stress relief thermal cycles and then shall be sampled for mechanical and impact properties in accordance with 4.4 and shall meet the requirements of 3.4. The contracting activity will specify the stress relief thermal cycles (including cooling rates) to the contractor. Stress relief is to be specified only when necessary to meet machining tolerances. The stress relief time and temperature shall be equal to or greater than the stress relief cycle anticipated for the production plate.

3.5.2 Heat treatment equipment and controls. Continuous or automatic heat treating equipment may be employed provided such equipment produces heat-treated plate that meet the requirements specified herein. The furnaces and temperature recording equipment shall be shown to correlate with the actual temperature of the plate and shall be maintained and calibrated on a regular scheduled basis in accordance with MIL-H-6875 or MIL-STD-1684. The temperature of the plate shall be recorded during the heating and stress relieving cycles of the heat treatment. After the charge reaches the selected temperature control setting, furnaces for heat treatment of grade HY-80 and grade HY-100 plate shall maintain the temperature of the plate at any point in the working zone within plus or minus 25°F (plus or minus 16°C).

3.6 Surface quality. The depth of rolled-in scale, pits, or windrowed condition shall not exceed 0.015 inch (0.38 mm) and shall not result in an undergauge condition. Isolated, individual pits not over 0.030 inch (0.76 mm) deep are acceptable provided plate thickness is not reduced below the specified minimum. Surface imperfections may be removed by grinding, provided the thickness is not reduced below the minimum thickness permitted and the width of the ground area is three times its depth and radially tapered into the defect.

3.6.1 Weld repair of mill defects after heat treatment. When specified, weld repair after final heat treatment is prohibited (see 6.2.1). Mill imperfections may be repair welded or referred to the contracting activity for acceptance and so noted on the inspection reports. Areas of the plate found to have less than the minimum specified thickness may have the thickness restored by welding the depressed area. When weld repairs after final heat treatment are permitted, the following limitations shall apply:

- (a) The total area to be repaired shall not exceed 1 percent of the surface of one side of the plate.
- (b) The depth of any area to be repaired shall not exceed one half the minimum plate thickness specified or 1/2 inch (13 mm), whichever is less. The depth of the area to be repaired shall be a minimum of 1/16 inch (2 mm).
- (c) Areas within 2 inches (51 mm) of each other which require weld repair shall be combined to form a single repair.
- (d) All of the areas to be welded shall be ground sufficiently to assure that the welds are made on clean, sound metal.
- (e) After preparation for repair and prior to welding, all of the depressed areas shall be magnetic particle inspected in accordance with MIL-STD-271, and shown to be free of linear discontinuities.

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- (f) Weld repairs shall be made in accordance with MIL-STD-1688, or the applicable fabrication document (see 3.8). Procedures and personnel shall be qualified in accordance with MIL-STD-248.
- (g) The final repaired surface shall be ground smooth and shall be essentially flush with the adjacent surface and free of undercut in excess of 0.020 inch (0.5 mm). No point of the finished weld surface shall be below the adjacent plate surface.
- (h) Plates or segments of plates containing surface weld repairs shall be magnetic particle inspected after final grinding (or subsequent heat treatment, if applicable) in accordance with MIL-STD-271. All welds and adjacent heat affected zone surfaces shall be free of relevant linear indications longer than 1/8 inch (3 mm) in accordance with NAVSEA 0900-LP-003-8000.
- (i) Repaired areas shall be marked. The markings shall remain legible and shall not be removed prior to performing all inspections as required by this document.
- (j) Notations of such repaired areas shall be made on the plate inspection form as part of the records.
- (k) If a nonheat treatable electrode is used, reheat treatment of the plate, except for stress relief, is prohibited.

3.6.1.1 Weld repairs of mill defects prior to heat treatment. Weld repairs of mill imperfections may be accomplished prior to heat treatment within the limitations of 3.6.1 using an acceptable heat treatable electrode.

3.6.2 Edge defects. Visual laminar edge defects less than 1/4-inch (6 mm) long are acceptable. Laminar edge defects 1/4-inch long and over shall be explored by ultrasonics on the plate surface adjacent to the affected area. Edge defects that extend into the plate to the extent that they will result in rejectable defects according to the ultrasonic acceptance standards specified in table V shall be cause for rejection of the plate. Laminar edge defect weld repairs shall be made in accordance with 3.6.1.

TABLE V. Ultrasonic indications and acceptance standards.

Recordable indications	Acceptance standards
(a) Back reflection amplitude is reduced (but not transposed) over 50 percent.	Plate is rejectable whenever it is found, using procedures in accordance with appendix A, that the transposed back reflection is continuous in one plane over an area 4 square inches or larger.
(b) The transposed back reflection "T" has an amplitude over 50 percent (see 3.7.1(b)).	

3.7 Internal soundness and thickness. Type II plates over 1/2 inch (13 mm) thick shall be ultrasonically inspected for internal soundness and ultrasonically measured for decimal thickness. The plates shall meet the internal soundness requirements of table V. Ultrasonic inspection shall be in accordance with appendix A and 4.4.2.8 and the results shall be recorded using the format of figure 1 and appendix A, or its equivalent. Recorded thickness measurements and unless otherwise specified (see 6.2.1), internal soundness inspection results shall be prepared in accordance with the data ordering document included in the contract or order (see 6.2.2).

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3.7.1 Classification and recording of internal soundness. Internal conditions evaluated by ultrasonic inspection shall be classified and recorded as follows:

- (a) When the back reflection amplitude is reduced below 50 percent but not transposed, record its height as percentage of full back reflection.
- (b) When an indication to the left of the first back reflection exceeds 50 percent due to transposition, designate this condition by the letter "T". All demonstrated "T" areas shall be outlined in the inspection report.

3.8 Applicable fabrication document. The applicable fabrication document shall be specified (see 6.2.1) and shall cover the repair and the inspection of the base metal.

3.9 Tolerances. Tolerances shall be as specified in 3.9.1 through 3.9.4.

3.9.1 Thickness, weight, and gauge. For plate ordered to decimal thickness, the maximum allowable variations in thickness measurements shall be as specified in tables VI and VII. For plate ordered to a specific weight basis, the maximum allowable variations in weight and gauge shall be as specified in table VIII (see 6.2.1).

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TABLE VI. Thickness tolerances $\frac{1}{16}$ in inches and millimeters (average) over ordered thickness for a single plate 2 inches (51 mm) and under in thickness $\frac{7}{8}$.

Tolerance over ordered thickness for widths given, inch (mm)											
Specified thickness, inches (mm)	48 (1219) or under	48 (1219) to 60 (1524), exclusive	60 (1524) to 72 (1829), exclusive	72 (1829) to 84 (2134), exclusive	84 (2134) to 96 (2438), exclusive	96 (2438) to 108 (2743), exclusive	108 (2743) to 120 (3048), exclusive	120 (3048) to 132 (3353), exclusive	132 (3353) to 144 (3658), exclusive	144 (3658) to 168 (4267), exclusive	168 (4267) to 182 (4623), exclusive and over
1/4 (6.4)	0.015 (0.4)	0.015 (0.4)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)
5/16 (7.9)	0.015 (0.4)	0.015 (0.4)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)
3/8 (9.5)	0.015 (0.4)	0.015 (0.4)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)
7/16 (11.1)	0.015 (0.4)	0.015 (0.4)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)
1/2 (12.7)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)
9/16 (14.3)	0.021 (0.6)	0.021 (0.6)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)
5/8 (15.9)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)
11/16 (17.5)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)
3/4 (19.1)	0.027 (0.7)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)
13/16 (20.6)	0.027 (0.7)	0.035 (0.8)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)
7/8 (22.2)	0.035 (0.8)	0.035 (0.8)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)
1 (23.8)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)
1 1/8 (25.4)	0.035 (0.8)	0.035 (0.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)
1 1/4 (26.8)	0.042 (1.1)	0.042 (1.1)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)
1 3/8 (30.2)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)
1 1/2 (31.8)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)
1 5/8 (33.3)	0.042 (1.1)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)
1 3/4 (34.9)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)
1 7/8 (36.5)	0.042 (1.1)	0.052 (1.3)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)
2 (38.1)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 1/8 (39.7)	0.052 (1.3)	0.052 (1.3)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 1/4 (41.3)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 3/8 (42.9)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 1/2 (44.5)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 5/8 (46.0)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 3/4 (47.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.062 (1.6)	0.069 (1.8)	0.069 (1.8)	0.076 (1.9)	0.086 (2.1)	0.096 (2.4)	0.107 (2.8)	0.117 (2.9)
2 7/8 (49.2)	0.068 (1.7)	0.068 (1.7)	0.075 (1.9)	0.075 (1.9)	0.085 (2.0)	0.085 (2.0)	0.095 (2.3)	0.115 (2.8)	0.141 (3.6)	0.174 (4.4)	0.190 (4.8)
3 (50.8)	0.068 (1.7)	0.068 (1.7)	0.075 (1.9)	0.075 (1.9)	0.085 (2.0)	0.085 (2.0)	0.095 (2.3)	0.115 (2.8)	0.141 (3.6)	0.174 (4.4)	0.190 (4.8)

1/ Tolerance under specified thickness, 0.01 inch (0.3 mm).

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

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TABLE VII. Thickness tolerances^{1/} in inches (mm) (average) over ordered thickness for a single plate over 2 inches (51 mm) thick when ordered to thickness in inches (mm).^{2/}

Specified thickness, inches (mm)	Tolerances over specified thickness for widths given					
	To 36 (914), exclusive	36 (914) to 60 (1524), exclusive	60 (1524) to 84 (2133), exclusive	84 (2133) to 120 (3048), exclusive	120 (3048) to 132 (3353), exclusive	132 (3353) and over
Over 2 (50.8) to 3 (76.2), exclusive	0.063 (1.6)	0.094 (2.4)	0.109 (2.8)	0.125 (3.2)	0.125 (3.2)	0.141 (3.6)
3 (76.2) to 4 (101.6), exclusive	.078 (2.0)	.094 (2.4)	.109 (2.8)	.125 (3.2)	.125 (3.2)	.141 (3.6)
4 (101.6) to 6 (152.4), exclusive	.094 (2.4)	.125 (3.2)	.141 (3.6)	.156 (4.0)	.156 (4.0)	.172 (4.4)
6 (152.4) to 8 (203.2), exclusive	.109 (2.8)	.125 (3.2)	.156 (4.0)	.172 (4.4)	.172 (4.4)	—

^{1/} Tolerance under specific thickness, 0.01 inch (0.3 mm).

^{2/} For intermediate thickness, the tolerance of the closer gauge shall apply. In case of mid-point, the tolerance for lower gauge or interpolated value shall apply.

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TABLE VIII. Allowable variation in weight and gauge for plates specified on a weight basis (applicable to single plates).

Specified weight lb/ft ² (kg/m ²) (thickness, inch (mm))	Allowable under gauge at edge for widths given, inches (mm)										
	Up to 66 (1676) inclusive Percent	Over 66 (1676) to 80 (2032) inclusive Percent	Over 80 (2032) to 90 (2286) inclusive Percent	Over 90 (2286) to 100 (2540) inclusive Percent	Over 100 (2540) to 115 (2921) inclusive Percent	Over 115 (2921) to 135 (3429) inclusive Percent	Over 135 (3429) to 150 (3810) inclusive Percent	Over 150 (3810) to 168 (4267) inclusive Percent	Over 168 (4267) Percent		
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	
To 20.4 (101) ex- clusive (1/2 (13))	6	6	8	8	---	---	---	---	---	---	
20.4 to 25.5 (101 to 124) exclusive (1/2-5/8 (13-16))	3.5	4	4.5	5	5.5	6.5	---	---	---	---	
25.5 to 30.6 (124 to 151) exclusive (5/8-3/4 (16-19))	3.5	4	4.5	5	5.5	6	---	---	---	---	
30.6 to 40.8 (151 to 202) exclusive (3/4-1 (19-25))	3	3	3.5	4	4	4.5	5	5.5	6	6	
40.8 (202) and over (1 (25))	3	3	3	3	3	3.5	4	4.5	5	5	
Specified weight lb/ft ² (kg/m ²) (thickness, inch (mm))	Allowable weight tolerance for widths given, inches (mm)										
	Up to 150 (3810) inclusive		Over 150 (3810) to 168 (4267) inclusive						Over 168 (4267)		
	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Under
To 20.4 (101) ex- clusive (1/2 (13))	8	10	---	---	---	---	---	---	---	---	---
20.4 to 25.5 (101 to 124) exclusive (1/2-5/8 (13-16))	2	4	---	---	---	---	---	---	---	---	---
25.5 to 30.6 (124 to 151) exclusive (5/8-3/4 (16-19))	2	4	---	---	---	---	---	---	---	---	---
30.6 to 40.8 (151 to 202) exclusive (3/4-1 (19-25))	2	3.5	3	4	3	4	4	3	4	4	4
40.8 (202) and over (1 (25))	2	3	2	3	2	3	3	3	3	4	4

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3.9.2 Flatness. Plates shall be flat within the tolerance limits specified in table IX. The flatness, as specified in table IX, shall be an overall flatness factor. This factor shall not apply to "kinks" or "waviness". The waviness or kinking permitted shall be judged by laying a 3-foot (1-meter) straightedge across the affected edges. The maximum permissible deviation from the straightedge shall be 1/4-inch (6 mm). When specified (see 6.2.1), tighter requirements may be required.

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TABLE IX. Flatness tolerances for plates ordered on a lb/ft² (kg/m²) or inch (mm) basis. 1/2/3/

Specified thickness, inches (mm)	Specified weight, lb/ft ² (kg/m ²)	Flatness tolerances for specified widths, inches (mm)									
		Up to 36 (914), exclusive	36 (914) to 48 (1219), exclusive	48 (1219) to 60 (1524), exclusive	60 (1524) to 72 (1829), exclusive	72 (1829) to 84 (2134), exclusive	84 (2134) to 96 (2438), exclusive	96 (2438) to 108 (2743), exclusive	108 (2743) to 120 (3048), exclusive	120 (3048) to 144 (3657), exclusive	144 (3657) to 168 (4267), exclusive and over
To 1/4 (6), exclusive	To 10.2 (49.8), exclusive	13/16 (21)	1-1/8 (29)	1-3/8 (35)	1-7/8 (48)	2 (51)	2-1/4 (57)	2-3/8 (60)	2-5/8 (67)	2-3/4 (70)	---
1/4 (6) to 3/8 (10), exclusive	10.2 (49.8) to 15.3 (74.7), exclusive	3/4 (19)	15/16 (24)	1-1/8 (29)	1-3/8 (35)	1-3/4 (45)	1-7/8 (48)	2 (51)	2-1/4 (57)	2-3/8 (60)	---
3/8 (10) to 1/2 (13), exclusive	15.3 (74.7) to 20.4 (99.8), exclusive	3/4 (19)	7/8 (22)	15/16 (24)	15/16 (24)	1-1/8 (29)	1-5/16 (36)	1-1/2 (38)	1-5/8 (41)	1-7/8 (48)	3-1/8 (79)
1/2 (13) to 3/4 (19), exclusive	20.4 (99.8) to 30.6 (149.5), exclusive	5/8 (16)	3/4 (19)	13/16 (21)	7/8 (22)	1 (25)	1-1/8 (29)	1-1/4 (32)	1-3/8 (35)	1-5/8 (41)	3 (76)
3/4 (19) to 1 (25), exclusive	30.6 (149.5) to 40.8 (199.5), exclusive	5/8 (16)	3/4 (19)	7/8 (22)	7/8 (22)	15/16 (24)	1 (25)	1-1/8 (29)	1-5/16 (36)	1-1/2 (38)	2-5/8 (67)
1 (25) to 2 (51), exclusive	40.8 (199.5) to 81.6 (399.5), exclusive	9/16 (14)	5/8 (16)	3/4 (19)	13/16 (21)	7/8 (22)	15/16 (24)	1 (25)	1 (25)	1-5/8 (41)	2-1/4 (57)

See footnotes at end of table.

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TABLE IX. Flatness tolerances for plates ordered on a lb/ft² (kg/m²) or inch (mm) basis. 1/2/3/ - Continued

Specified thickness, inches (mm)	Specified weight, lb/ft ² (kg/m ²)	Flatness tolerances for specified widths, inches (mm)									
		Up to 36 (914), exclu- sive	36 (914) to 48 (1219), exclu- sive	48 (1219) to 60 (1524), exclu- sive	60 (1524) to 72 (1829), exclu- sive	72 (1829) to 84 (2134), exclu- sive	84 (2134) to 96 (2438), exclu- sive	96 (2438) to 108 (2743), exclu- sive	108 (2743) to 120 (3048), exclu- sive	120 (3048) to 144 (3657), exclu- sive	144 (3657) to 168 (4267), exclu- sive and over
2 (51) to 4 (102), exclusive	81.6 (399.5) to 163.2 (799), exclusive	1/2 (13)	9/16 (14)	11/16 (27)	3/4 (19)	3/4 (19)	3/4 (19)	3/4 (19)	7/8 (22)	1 (25)	1-1/4 (32) 1-5/8 (41)
4 (102) to 6 (152)	163.2 (799) to 244.8 (1195), exclusive	9/16 (14)	11/16 (27)	3/4 (19)	3/4 (19)	7/8 (22)	7/8 (22)	15/16 (24)	1-1/8 (29)	1-1/4 (32)	1-1/2 (38)
6 (152) to 8 (203)	244.8 (1195) to 326.4 (1645), exclusive	5/8 (16)	3/4 (19)	3/4 (19)	15/16 (24)	1 (25)	1-1/8 (29)	1-1/4 (32)	1-5/16 (33)	1-1/2 (38)	1-1/2 (38)
8 (203) to 10 (254)	326.4 (1645) to 418.0 (2050), exclusive	3/4 (19)	13/16 (21)	15/16 (24)	1 (25)	1-1/8 (29)	1-1/4 (32)	1-5/16 (36)	1-3/8 (35)	1-1/2 (38)	1-1/2 (38)
10 (254) to 12 (305)	418.0 (2050) to 489.6 (2390), exclusive	3/4 (19)	15/16 (24)	1-1/8 (29)	1-1/4 (32)	1-5/16 (33)	1-3/8 (35)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)
12 (305) to 15 (381)	489.6 (2390) to 612 (2990), exclusive	7/8 (22)	1 (25)	1-3/16 (30)	1-5/16 (33)	1-3/8 (35)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)	1-1/2 (38)

See footnotes at top of next page.

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- 1/ Flatness tolerances for length and width. The longer dimension specified is considered the length. Variation from a flat surface along the length shall not exceed the tabular amount for the specified width in any 12 feet (4 meters) of length.
- 2/ When the longer dimension is under 36 inches (1 meter), the variation in flatness shall not exceed 1/4-inch (6 mm).
- 3/ The above table and notes also cover the flatness tolerances of circular and sketch plates, based on the maximum dimensions of those plates.

3.9.3 Camber. Camber of the plates shall not exceed the tolerance limits specified in table X.

TABLE X. Camber tolerances for plates ordered on a lb/ft² (kg/m²) or inch (mm) basis.

Specified weight, lb/ft ² (kg/m ²)	Thickness, inches (mm)	Width, inches (mm)	Camber tolerance for thick- ness and width given
To 81.6 (399), inclusive	To 2 (51), inclusive	All	1/8 inch X $\frac{\text{length (feet)}}{5}$ 3 mm X $\frac{\text{length (meters)}}{16.4}$
---	Over 2 (51) to 8 (203), exclusive	To 30 (762), inclusive	3/16 inch X $\frac{\text{length (feet)}}{5}$ 5 mm X $\frac{\text{length (meters)}}{16.4}$
---	Over 2 (51) to 8 (203), exclusive	Over 30 (762) to 60 (1524) inclusive	1/4 inch X $\frac{\text{length (feet)}}{5}$ 6 mm X $\frac{\text{length (meters)}}{16.4}$

3.9.4 Size tolerances. The width and length of the plates shall not vary in excess of the tolerances specified in tables XI and XII.

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TABLE XI. Width and length tolerances for sheared plates 1 inch (25 mm) thick or less.^{1/}

Specified dimensions, inches (mm)	Maximum permissible variations over specific width and length for weight or thickness given					
	To 3/8 inch (10 mm), exclusive		3/8 to 5/8 inch (10 to 16 mm), exclusive		5/8 to 1 inch (16 to 25 mm), exclusive	
Width	Length		Length		Length	
	Width inch (mm)	Length inch (mm)	Width inch (mm)	Length inch (mm)	Width inch (mm)	Length inch (mm)
To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over	To 120 (3048), exclusive 120 (3048) to 240 (6096), exclusive	3/8 (10)	1/2 (13)	7/16 (11)	5/8 (16)	3/4 (19)
		7/16 (11)	5/8 (16)	1/2 (13)	11/16 (17)	7/8 (22)
		1/2 (13)	3/4 (19)	5/8 (16)	7/8 (22)	1 (25)
		5/8 (16)	7/8 (22)	3/4 (19)	7/8 (22)	1-1/8 (29)
To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over	240 (6096) to 360 (9144), exclusive	3/8 (10)	3/4 (19)	1/2 (13)	5/8 (16)	1 (25)
		7/16 (11)	3/4 (19)	5/8 (16)	7/8 (22)	1 (25)
		1/2 (13)	3/4 (19)	5/8 (16)	7/8 (22)	1 (25)
		5/8 (16)	7/8 (22)	3/4 (19)	7/8 (22)	1-1/8 (29)
To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over	360 (9144) to 480 (12192), exclusive	3/8 (10)	1-1/16 (27)	11/16 (17)	1-3/16 (30)	1-7/16 (37)
		7/16 (11)	1-3/16 (30)	7/8 (22)	1-5/16 (33)	1 (25)
		1/2 (13)	1-5/16 (33)	5/8 (16)	1-7/16 (37)	5/8 (16)
		5/8 (16)	1-7/16 (37)	3/4 (19)	1-9/16 (40)	3/4 (19)
To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over		3/4 (19)	1-7/16 (37)	7/8 (22)	1 (25)	1-11/16 (43)

See footnotes at end of table.

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TABLE XI. Width and length tolerances for sheared plates 1 inch (25 mm) thick or less.^{1/} - Continued

Specified dimensions, inches (mm)		Maximum permissible variations over specific width and length for weight or thickness given					
Width	Length	To 3/8 inch (10 mm), exclusive		3/8 to 5/8 inch (10 to 16 mm), exclusive		5/8 to 1 inch (16 to 25 mm), exclusive	
		Width inch (mm)	Length inch (mm)	Width inch (mm)	Length inch (mm)	Width inch (mm)	Length inch (mm)
To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over To 60 (1524), exclusive 60 (1524) to 84 (2134), exclusive 84 (2134) to 108 (2743), exclusive 108 (2743) and over	480 (12192) to 600 (15240), exclusive	7/16 (11)	1-3/8 (35)	1/2 (13)	1-5/8 (41)	5/8 (16)	1-3/4 (45)
		1/2 (13)	1-1/2 (38)	5/8 (16)	1-5/8 (41)	3/4 (19)	1-3/4 (45)
		5/8 (16)	1-1/2 (38)	3/4 (19)	1-5/8 (41)	7/8 (22)	1-3/4 (45)
	600 (15240) to 720 (17780), exclusive	3/4 (19)	1-5/8 (41)	7/8 (22)	1-3/4 (45)	1 (25)	1-7/8 (48)
		1/2 (13)	1-7/8 (48)	5/8 (16)	2 (51)	3/4 (19)	2 (51)
		5/8 (16)	1-7/8 (48)	3/4 (19)	2 (51)	7/8 (22)	2 (51)
	720 (17780) and over	5/8 (16)	1-7/8 (48)	3/4 (19)	2 (51)	7/8 (22)	2 (51)
		7/8 (22)	1-7/8 (48)	1 (25)	2-1/8 (54)	1-1/8 (29)	2-3/8 (60)
		9/16 (14)	2-1/8 (54)	3/4 (19)	2-1/4 (57)	7/8 (22)	2-3/8 (60)
		3/4 (19)	2-1/8 (54)	7/8 (22)	2-1/4 (57)	1 (25)	2-3/8 (60)
	84 (2134) to 108 (2743), exclusive	3/4 (19)	2-1/8 (54)	7/8 (22)	2-1/4 (57)	1 (25)	2-3/8 (60)
		1 (25)	2-1/8 (54)	1-1/8 (63)	2-1/2 (63)	1-1/4 (32)	2-5/8 (67)

^{1/} Maximum permissible variation under specified width and length, 1/4-inch (6 mm).

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TABLE XII. Width and length tolerances for gas cut rectangular plates.

Specified thicknesses, inches (mm)	Tolerances over for all specified widths or lengths, inches (mm)
To 2 exclusive (51)	3/4 (19)
2 to 4 exclusive (51 to 102)	1 (25)
4 to 6 exclusive (102 to 152)	1-1/8 (29)
6 to 8 exclusive (152 to 203)	1-5/16 (33)

3.10 Cleaning and preservation of plate surfaces. Unless otherwise specified (see 6.2.1), the surfaces of the plates shall be descaled and coated as specified in appendix B.

3.11 Marking. Each plate shall be indentation stamped with heat number, plate number, type number, and the designation grade HY-80 or HY-100. The marking may be painted or stenciled in lieu of die stamped on plates 1/4-inch (6 mm) thick and less. Where the plate number provides positive identification of the heat number, the heat number may be omitted from the markings. Indentation stamping shall be done with round nose dies.

3.12 Explosion bulge. When required for first article testing, two crack starter and four explosion bulge specimens shall be subjected to explosion bulge testing (see 4.6.5). Performance is considered satisfactory provided the following conditions are met:

(a) Crack starter.

(1) First shot:

- a. Crack starter bead must crack.
- b. Percent reduction in thickness obtained for information only.
- c. No piece shall be thrown out of material being tested.
- d. No through thickness cracks shall be present.
- e. No cracks shall extend into hold-down area.^{1/}

(2) Second shot:

- a. Percent reduction in thickness obtained for information only.
- b. No piece shall be thrown out of material being tested.
- c. Through thickness cracks are acceptable.
- d. No cracks shall extend into hold-down area.^{1/}

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(b) Bulge.

(1) First shot:

- a. Percent reduction in thickness obtained for information only.
- b. No piece shall be thrown out of material being tested.
- c. No through thickness cracks shall be present.
- d. No cracks shall extend into hold-down area.^{1/}

(2) Second shot:

- a. Percent reduction in thickness obtained for information, 3 percent reduction per shot is expected.
- b. No piece shall be thrown out of material being tested.
- c. No through thickness cracks shall be present.
- d. No cracks shall extend into hold-down area.^{1/}

(3) Additional shots:

- a. Shots shall continue until a reduction in thickness of 16 percent for HY-80 or 14 percent for HY-100 is obtained on one or both sides of the test assembly.
- b. The performance is considered satisfactory provided the following conditions are met:
 - 1. No piece shall be thrown out of material being tested.
 - 2. Through thickness cracks are acceptable.
 - 3. No cracks shall extend into the hold-down area.^{1/}
- c. Shots shall be discontinued when cracks go into the hold-down area, a through thickness crack occurs, or if the reduction in thickness requirements are met. The material is rejected if the reduction in thickness criteria is not met when shots are discontinued.

^{1/} The bulge area is defined as that plate over the diehold (9 inch (229 mm) radius) plus the rounded outside corners (3 inch (26 mm) radius) plus 1/2 inch (13 mm) for a total circle diameter of 25 inches (635 mm). The hold-down area is defined as the area outside of this circle.

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4. QUALITY ASSURANCE PROVISIONS

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.

4.1.2 Certification of quality conformance. When specified in the contract or order, a certificate of quality conformance shall be prepared for each lot of material offered for acceptance (see 6.2.2). The certificate shall include actual data of specified chemical and mechanical tests and a record of the final heat-treatment. Qualitative results of nondestructive tests and other inspections or tests shall be recorded on the certificate. The certificate shall state that each lot has been sampled, tested, and inspected in accordance with the specification requirements and that the manufacturer has maintained manufacturing procedures and practices to produce plates to meet the minimum property requirements throughout the plate. The certificate shall identify the heat number, plate number (see 3.11) which are marked on the plates to provide traceability. The certificate shall state each lot meets all specification requirements and shall be signed by a responsible representative of the contractor. Where test certificates issued by the manufacturer contain the above data requirements, a separate certificate of conformance will not be required.

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

- (a) First article inspection (see 4.3).
- (b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall consist of testing the samples specified in 4.3.2 in accordance with the procedures of 4.6 and shall include the following:

- (a) Standard specification data from standard production stock (chemistry, mechanical properties, visual, dimensional, and ultrasonic inspection results).
- (b) The transverse to longitudinal roll ratio for each plate along with a complete heat treatment record.

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- (c) The quality control procedures which will be used to ensure uniform properties throughout the plate.
- (d) Production line operations such as melt practice, processing history, and heat treatment details.
- (e) Weld procedure qualification test data in accordance with 3.6.1. The plate used for weld inserts shall have been characterized by DT and CVN impact, tensile and chemical composition tests. The explosion bulge tests will be conducted under Government direction to evaluate plate and weldment performance. Explosion bulge tests for weldments and plates will be required in accordance with MIL-STD-2149.
- (f) Plates shall be ultrasonically tested using the 100 percent scanning technique specified in appendix A and the requirements of 3.7.
- (g) The ingot or strand casting process (see 6.4.3).

4.3.1 First article inspection report. When specified in the contract or order, a first article inspection report shall be prepared in accordance with the data ordering document included in the contract or order (see 6.2.2).

4.3.2 First article samples. First article samples shall be taken from plates rolled from ingots or slabs strand cast that represent the largest size to be used at the rolling facility and from one lot (see 4.4.1). As a minimum, plate thicknesses of 1 and 2 inches and the thickest gauge to be produced at the mill shall be tested. Unless otherwise specified (see 6.2.1), HY-80 and HY-100 shall be tested separately.

4.3.2.1 Sampling for chemical composition. For chemical composition, broken transverse middle tensile specimens from the top, middle, and bottom center set from each of the plates shall be analyzed.

4.3.2.2 Charpy V-notch (CVN). Sets of three transverse CVN test specimens shall be taken from the mid-thickness at the left, middle, and right positions of both ends and the center of each gauge plate for a total of nine sets and 27 specimens at each temperature. These CVN specimens shall be tested at both 0 and minus 120°F (minus 18 and minus 84°C) and both the energy and the percent fibrous fracture shall be recorded.

4.3.2.3 Dynamic tear (DT). Sets of two transverse DT test specimens shall be taken at the same locations as specified in 4.3.2.2 at each temperature. These DT specimens shall be tested at 0 and minus 40°F (minus 18 and minus 40°C) (see 6.6).

4.3.2.4 Transition curves. Transverse CVN transition curves and transverse DT transition curves shall be developed from tests at minus 120, minus 90, minus 40, 0 and plus 30°F (minus 84, minus 68, minus 40, minus 18, and minus 1°C). Sets shall be taken from mid-thickness at the center of each gauge plate.

4.3.2.5 Tensile test. A set of two transverse tensile test specimens shall be taken at the same set locations as specified in 4.3.2.2.

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4.4 Quality conformance inspection.4.4.1 Lot. Lot shall be specified in 4.4.1.1 through 4.4.1.3.

4.4.1.1 Lot for chemical composition. Lots for chemical composition shall be defined as follows: ingot cast, each heat; strand cast, each ladle; vacuum arc remelt (VAR) or electroslag remelt (ESR), each remelted ingot; argon-oxygen decarburization (AOD), each vessel charge. Unless otherwise qualified by first article testing, continuous casting shall cease after one ladle of steel is completely cast.

4.4.1.2 Lot for mechanical properties. Each plate as-heat treated shall constitute a lot.

4.4.1.3 Lot for examinations and inspections. For the purpose of visual and dimensional examination and for ultrasonic inspection, each plate as submitted for final inspection shall constitute a lot.

4.4.2 Sampling. Sampling shall be as specified in 4.4.2.1 through 4.4.2.8.1.

4.4.2.1 Sampling for chemical analysis. Samples for chemical analysis shall be taken from the transverse tensile test specimen from the top plate of each of two ingots or two slabs in the case of continuous casting in each lot (heat). Suitable solid samples may be taken for spectrographic analysis from the locations as above.

4.4.2.2 Sampling for tensile test. After final heat treatment of the plates, including any stress relief treatment, one top transverse tensile specimen and one bottom transverse tensile specimen shall be taken from each plate. The tensile test specimen shall be in accordance with ASTM A 370.

4.4.2.3 Location of test specimens in plate. The specimens shall be located as shown on figures 2 and 3. Figure 2 shall be used when the final direction of rolling is parallel to the longitudinal axis of the ingot. Figure 3 shall be used when the final rolling is parallel to the transverse axis of the ingot. The specimens shall be separated by not less than three times the plate thickness or 4 inches (102 mm), whichever is less, from the "as-heat treated" edge of the plate. When possible, test specimens shall be taken adjacent to opposite surfaces of the plate.

4.4.2.4 Sampling for impact test. Samples for the impact test shall be taken after final heat treatment of the plates, including any stress relief treatment. Dynamic tear tests shall be performed on plates over 5/8 inch (16 mm), CVN tests on plates over 1/2 through 5/8 inch (13 through 16 mm), and no tests shall be required for plates 1/2 inch (13 mm) and under thick.

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4.4.2.4.1 CVN test specimens. From the plates selected, three transverse CVN test specimens shall be taken from each location for each test temperature. The specimens shall be in accordance with ASTM A 370. The specimens shall be so located in the thickness of the plate, that for 20.4 lb/ft² (1/2 inch thick) to 35.7 lb/ft² (7/8 inch thick) (0.96 to 1.50 kg/m²) the plate surface (after light machining) shall be one face, and for plates 35.7 lb/ft² (7/8 inch thick) (1.50 kg/m²) and heavier, the center line of the plate shall be in one face. The notch shall be perpendicular to the plate surface.

4.4.2.4.2 Dynamic tear testing. In the case of dynamic tear testing from the plates selected, two transverse dynamic tear test specimens shall be taken from each location for each test temperature. The test specimens shall be in accordance with ASTM E 604. The dynamic tear specimens shall be located in the thickness of the plate, such that the center line of the plate shall be the center line of the specimen. The notch shall be perpendicular to the plate surfaces.

4.4.2.4.3 Marking of test specimens. The test specimens shall be marked to ensure positive identification of the lot being tested.

4.4.2.5 Sampling for mechanical properties following simulated stress relief. When specified (see 6.2.1), sample material (see 4.4.2.2 and 4.4.2.4) shall be subjected to simulated stress relief operations after quenching and tempering, but prior to testing for conformance to the mechanical property requirements in 3.4. The sample material shall not be removed from the plate prior to quenching and tempering. The total time at temperature and cooling rate for the simulated stress relief operations shall be as specified (see 6.2.1). The cooling rate and the maximum and minimum time at temperature used on the sample material shall be incorporated in the test certification (see 4.1.2), along with the destructive and nondestructive test results.

4.4.2.6 Thermal buffer plate requirements. In the cases where the crop would be insufficient to obtain test specimens the proper distance from the heat treated edge of the plate, thermal buffer plates in accordance with ASTM A 20 shall be used.

4.4.2.7 Sampling for thickness inspection. Each plate shall be inspected by a calibrated micrometer at three evenly distributed points along each longitudinal edge and at two evenly distributed points along each transverse edge. Each type II plate shall be gauged using the ultrasonic technique contained in appendix A.

4.4.2.8 Sampling for plate soundness. Each type II plate over 1/2 inch (13 mm) up to and including 2-1/2 inch (63 mm) thickness shall be ultrasonically checked on the intersections of a 24 inch (610 mm) grid pattern. If continuous mechanized scanning is employed, the plates shall be scanned on parallel lines not more than 24 inches (610 mm) apart. Each plate over 2-1/2 inches (63 mm) shall be ultrasonically inspected by continuous scanning on a 24 inch (610 mm) grid, and one diagonal in each grid or at the intersections of an 8 inch (207 mm) grid pattern. If mechanized scanning is employed, the plates shall be scanned on parallel lines not more than 8 inches (203 mm) apart.

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4.4.2.8.1 Expanded search. If any recordable indication noted in table V is observed in the above inspection, an area enclosed by a 1 foot (305 mm) radius circle about that point shall be 100 percent scanned.

4.5 Visual and dimensional examination. Each plate shall be examined visually and dimensionally for conformance to the requirements of this specification. The number of plates subjected to paint film thickness measurements shall be held to the minimum necessary to ensure continued satisfactory performance.

4.6 Tests and procedures. Tests and procedures shall be as specified in 4.6.1 through 4.6.5.

4.6.1 Chemical analysis. Samples selected in accordance with 4.4.2.1 shall be analyzed in accordance with a standard ASTM method or a method that will ensure equally accurate results for conformance to 3.3, as applicable. If the sample from the topmost plates fails to meet the requirements; all plates from the heat in question shall be rejected. Samples from rejected plates may be analyzed separately, provided the samples are taken in the specified locations, and those plates which conform in chemical composition to 3.3 will be accepted. The methods shall be correlated with National Bureau of Standards standard reference materials, when available, to ensure the validity of the method that is used as a control in chemical analysis or for calibration in instrumental methods of analysis.

4.6.1.1 Continuous cast slabs. The sample selected in accordance with 4.4.2.1 shall be analyzed to determine conformance with the requirements of 3.3. If either sample fails to meet the requirements, all plates from the heat shall be rejected. Plates may be analyzed separately provided the samples are taken in the specified locations, and those plates which conform in chemical composition to 3.3 will be accepted.

4.6.2 Tensile test. Tensile test specimens selected in accordance with 4.4.2.2 shall be tested in accordance with ASTM A 370.

4.6.3 CVN impact test. The test specimens selected in accordance with 4.4.2.4.1 shall be tested with a coolant temperature of minus $120 \pm 3^\circ\text{F}$ (minus $84 \pm 2^\circ\text{C}$) and at $0 \pm 3^\circ\text{F}$ (minus $18 \pm 2^\circ\text{C}$) in accordance with ASTM A 370. Precaution shall be taken to ensure that the specimen has reached the temperature of the coolant and the tongs used in handling the specimen shall be cooled with the specimen.

4.6.3.1 Dynamic tear impact test. The test specimens selected in accordance with 4.4.2.4.2 shall be tested with a coolant temperature of minus $40 \pm 3^\circ\text{F}$ (minus $40 \pm 2^\circ\text{C}$) in accordance with ASTM E 604.

4.6.3.2 Percent fibrous fracture. Percent fibrous fracture shall be determined in accordance with ASTM A 370.

4.6.4 Ultrasonic testing and gauging. Ultrasonic procedures shall be as specified in appendix A.

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4.6.5 Explosion bulge tests. The explosion bulge tests shall be conducted and specimens fabricated in accordance with MIL-STD-2149. Specimens shall be tested with weld reinforcement in place.

4.7 Retests. When a test specimen representing a lot of material fails to meet specification requirements, the lot is rejected. The lot may be reworked or retested as provided. The rejected lots shall be identified and separated from acceptable lots until the rejected lots are withdrawn or have been demonstrated to meet specification requirements.

4.7.1 Reheat treatment. Plates which fail to meet tensile or impact requirements of this specification may be reheat treated. All required tests originally performed on the failed plates (except chemical analysis) shall be repeated when the material is reinspected.

4.7.2 Tensile retest. If the results on an original tensile specimen are within 1,000 lb/in² (6.9 MPa) of the required yield strength, or within 2 percent of the required elongation or within 2 percent of the required reduction in area, a retest on a duplicate specimen (selected from the same approximate location) will be permitted.

4.7.2.1 Gauge length retest. If the percentage of elongation or reduction in area of any tensile specimen is less than that specified in table II and any part of the fracture is outside the gauge length, or within the gauge length and less than 25 percent of the gauge length from either datum point, another specimen from the same location may be selected in its place.

4.7.3 CVN impact retest. In the event a CVN specimen does not meet individual value requirements, a retest of three specimens will be permitted on the same plate. If the retest specimens do not meet requirements, the lot represented by the specimens shall be rejected. As an option, each plate in the rejected lot may be impact tested and each plate that fails to meet the requirements of table III shall be rejected.

4.7.4 Explosion bulge retests. The explosion bulge specimen shall be fabricated and tests conducted in accordance with MIL-STD-2149. Specimens shall be tested with weld reinforcement in place.

4.7.5 Dynamic tear retest. If dynamic tear specimens do not meet the requirements of table III, a retest of two additional specimens from that plate may be performed. If either retest specimen does not meet table III requirements, the lot represented by the specimens shall be rejected. As an option of the manufacturer, each plate in the rejected lot may be impact tested in accordance with 4.6.3.1, and each plate that fails to meet the requirements of table III shall be rejected.

4.7.5.1 Dynamic tear retest substitution. Unless otherwise specified (see 6.2.1), material 4 inches (102 mm) thick or thicker with unacceptable dynamic tear values may be retested for acceptance using the CVN test.

4.7.6 Defective specimen. If any test specimen shows defective machining or obvious lack of continuity of metal, it may be discarded and another selected.

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4.8 Inspection of packaging. Sample packages and packs, and the inspection of the preservation-packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisitions.)

5.1 Preservation and packing. Unless otherwise specified (see 6.2.1), plates shall be cleaned and preserved as specified in 3.10 herein. Packing shall be level A, C, or commercial, as specified (see 6.2.1) in accordance with MIL-STD-163.

5.2 Marking. In addition to any special marking required (see 6.2.1, 3.6.1(i) and 3.11), marking shall be in accordance with MIL-STD-163.

6. NOTES

6.1 Intended use. Grade HY-80 and grade HY-100, sheared or gas cut, alloy steel plate, are intended for use in critical structural applications where a notch tough high strength material is required. The use of these steels in fabricated structure or equipment entails much more than a material specification, and caution is advised in the areas of welding, fabrication, and non-destructive testing.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Sizes and number of plates required.
- (c) Type and grade required (see 1.2).
- (d) First article sample, when required (see 3.1).
- (e) If plates are required to be composed of all virgin raw material (see 3.2).
- (f) If plate is to be specifically identified (see table I).
- (g) If minimum ultimate tensile strength is required, the minimum value must be specified (see 3.4).
- (h) When a simulated stress relief sample is required. If required, the number of thermal cycles, the heating and cooling rates, and time at temperature shall be specified (see 3.5.1 and 4.4.2.5).
- (i) When weld repair after final heat treatment is prohibited (see 3.6.1).
- (j) When a copy of the internal soundness inspection report is not required for the contracting activity (see 3.7).
- (k) The applicable fabrication document (see 3.8).
- (l) When ordered to thickness, weight, or gauge (see 3.9.1).

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- (m) When tighter tolerances are desired (see 3.9.2).
- (n) When descaling and coating are not required (see 3.10).
- (o) Type of coating required (see 3.10 and appendix B).
- (p) If first article tests for one grade may be applied to the other grade (see 4.3.2).
- (q) When CVN impact tests cannot be used for accepting material over 4 inches in thickness with a dynamic tear test failure (see 4.7.5.1 and table III).
- (r) Plate preservation, other than specified (see 5.1).
- (s) Levels of packing or commercial packing required (see 5.1).
- (t) Special marking required (see 5.2).
- (u) Whether first article approval from previous revision or amendments is valid (see 6.4).

6.2.2 Data requirements. When this specification is used in an acquisition and data are required to be delivered, 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 Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.410-6 (DD Form 1423) 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 requirement title</u>	<u>Applicable DID no.</u>	<u>Option</u>
3.5, 3.7	Reports, test	DI-T-2072	10.1.b
4.1.2, 50.1.1, 50.2.1, 40.1.3.1, 50.3.1	Certification data/ report	UDI-A-23264 and UDI-T-23191	----
4.3.1	First article inspection report	DI-T-4902	----

(Data item descriptions related to this specification and identified in section 6 will be approved and listed as such in DoD 5010.12-L., 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.)

6.2.2.1 The data requirements of 6.2.2 and any task in sections 3, 4, or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 Thin plates. Plates under 7.65 lb/ft² (36.6 kg/m²) should be ordered under this specification only when they are for structural purposes where strength and gauge are important.

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6.4 First article. When a first article inspection is required, the item should be a first article sample. The first article should consist of one unit. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4.1 New vendors. Prior to delivery, steel mills which have not previously produced plates under this specification of the strength level specified should demonstrate to the Commander, Naval Sea Systems Command, Materials Engineering Division (NAVSEA) that their facilities produce plate conforming to the requirements of this specification. When grade HY-100 plate material has qualified to first article test requirements, the grade HY-80 may be reviewed for first article approval by submitting the required first article inspection data exclusive of explosion bulge tests unless specifically required by the contract or acquisition document.

6.4.2 Forwarding data. When a contract does not exist, first article data may be submitted directly to NAVSEA. The first article inspection data should be verified by the Defense Contract Administration Services Management Area (DCASMA) or by the American Bureau of Shipping (ABS) representative. The report should be forwarded to the Commander, NAVSEA. Upon review of the report, authorization will be forwarded for preparation of test specimens for the explosion bulge tests as required by MIL-STD-2149 and instructions will be furnished for shipment to designated Government testing locations. Specimen preparation and shipment will be under the cognizance of DCASMA or ABS representative, as applicable

6.4.3 Ingot or strand casting process. The rolling of the plate or slabs, the laying out of test specimens, and the testing should be witnessed by ABS or DCASMA representative.

6.5 Receipt inspection. The plates should be subject to receipt inspection (including chemical composition and mechanical property tests), by consignee to verify conformance to all requirements of the specification. Plates not conforming to the requirements of the specification at any location in the plate may be rejected by the consignee. The plate manufacturer may verify the results of the consignee's receipt inspection. It is the responsibility of the consignee to determine acceptability of the plates for the intended application.

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6.6 Dynamic tear. Dynamic tear test results (see 4.3.2.3) at 0°F should be regarded for informational purposes only.

6.7 Subject term (key word) listing.

Charpy V-notch
Dynamic tear
Explosion bulge
High yield strength
HY-80 steel
HY-100 steel
Steel plate
Ultrasonic inspection

6.8 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 9515-N042)

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		TOP													
		6"	18"	30"	42"	54"	66"	78"	90"	102"	114"	126"			
162	6"														
467	18"														
762	30"														
1067	42"														
1372	54"														
1676	66"														
1981	78"														
2286	90"														
2590	102"														
2896	114"														
3201	126"														
3506	138"														
4013	150"														
4318	162"														
4623	174"														
4928	186"														
5232	198"														
5730	210"														
6045	222"														
6350	234"														
6656	246"														
6960	258"														
7264	270"														
7569	282"														
7874	294"														
7772	306"														
8077	318"														
8362	330"														
8667	342"														
8962	354"														
9296	366"														
9601	378"														
9906	390"														
10211	402"														
10516	414"														
10820	426"														
11125	438"														
11430	450"														
11735	462"														

Micrometer →

Micrometer ←

← Micrometer

→ Micrometer

JOB

MILL MARK NO.

HEAT/MELT NO.

SLAB/PLATE NO.

MATERIAL LENGTH WIDTH GAGE

THICKNESS	MINIMUM	MAXIMUM
ALLOWABLE	"	
MEASURED	"	
DEVIATION	"	

SPECIFICATION/PROCEDURE NO.

INSTRUMENT MODEL NO.

TRANSDUCER SIZE FREQ. MHZ

AUXILIARY EQUIPMENT

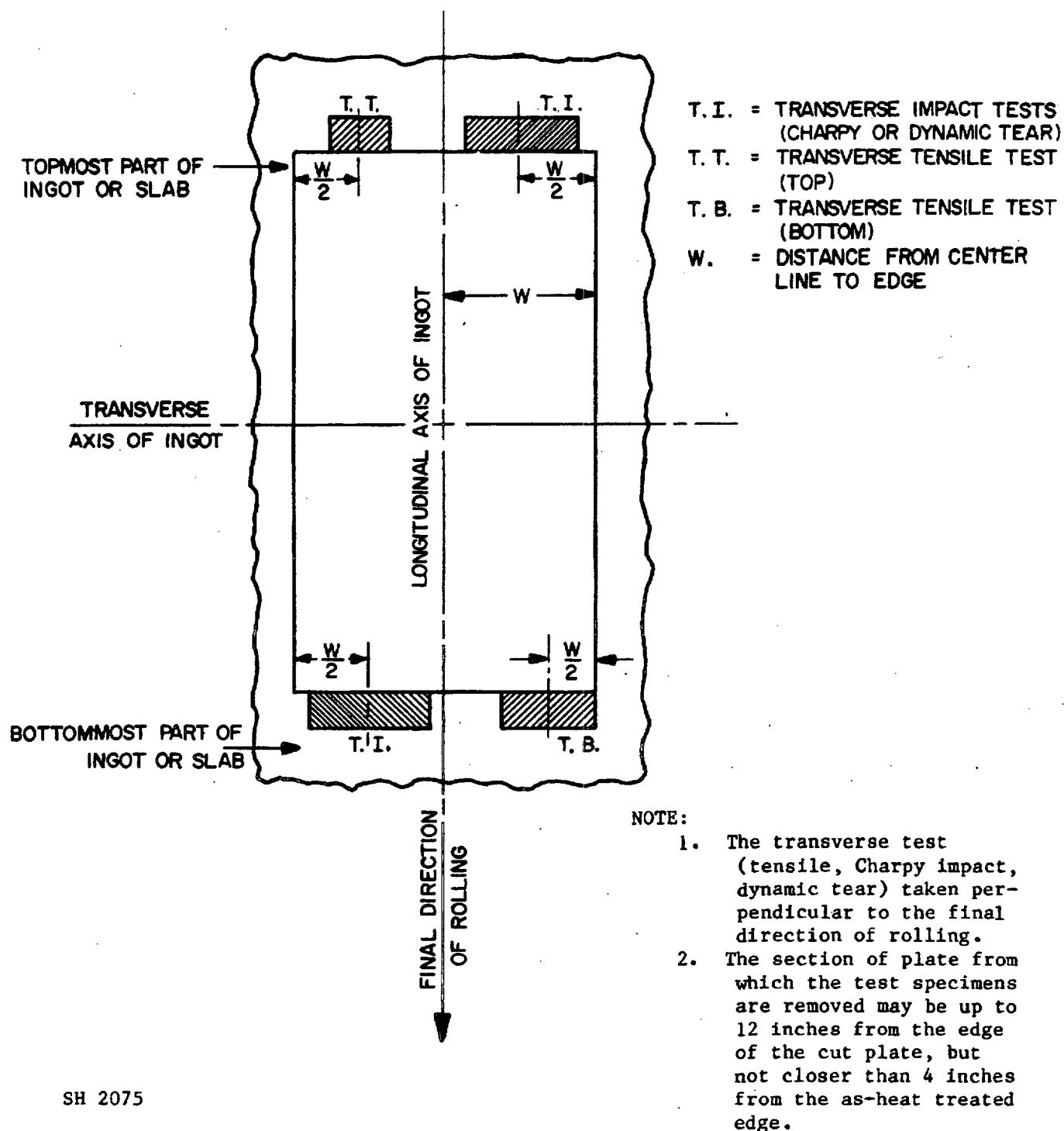
INSPECTOR (S) DATE

REVIEWED BY: DATE

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FIGURE 1. Suggested plate gauging report format (micrometer and ultrasonic).

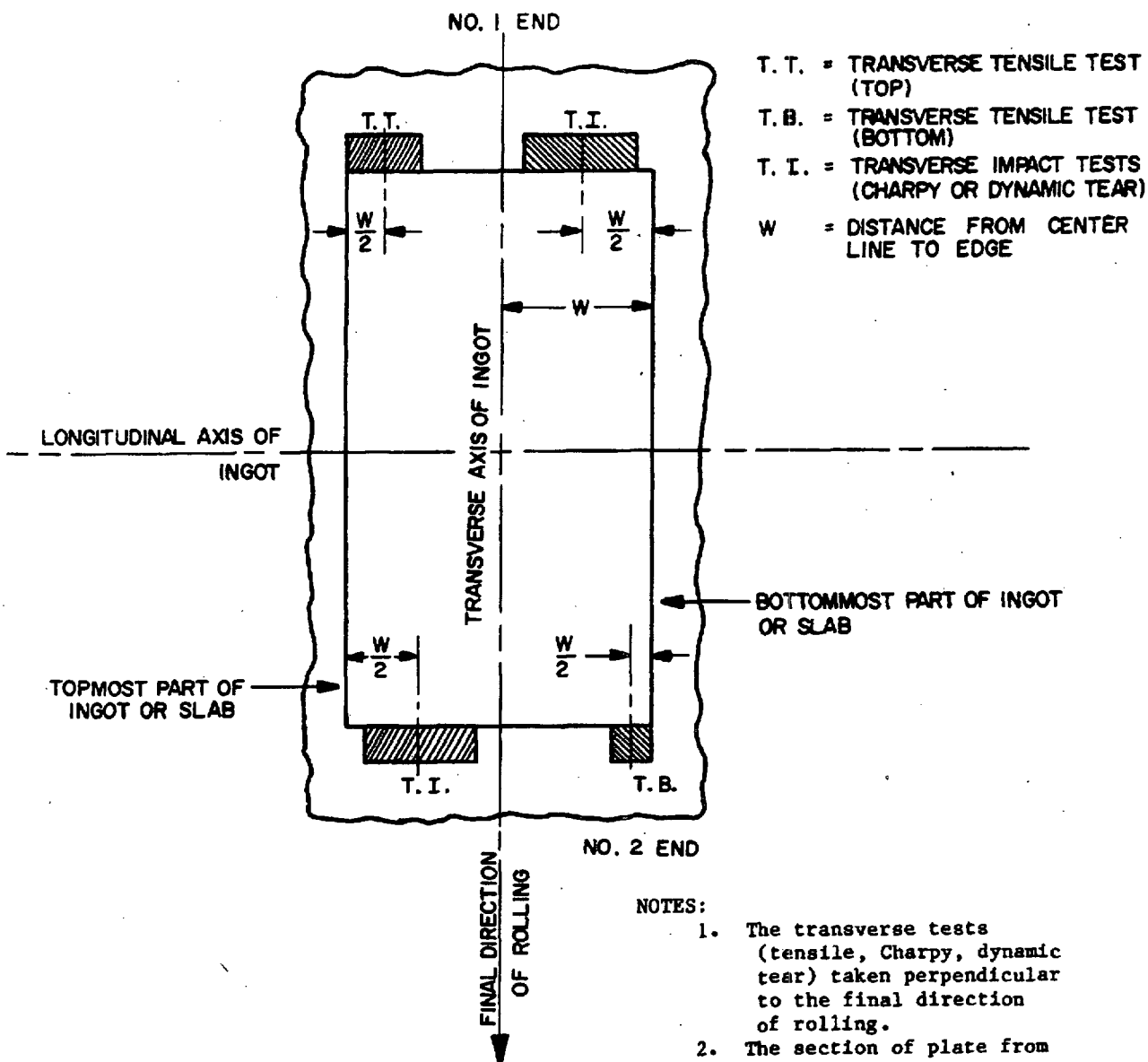
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FIGURE 2. Method of locating test specimens for plates as rolled directly from ingots or slabs with the final direction of rolling parallel to the longitudinal axis of the ingot.

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SH 2076

FIGURE 3. Method of locating test specimens for plates as rolled directly from ingots or slabs with the final direction of rolling parallel to the transverse axis of the ingot.

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APPENDIX A

ULTRASONIC PROCEDURES AND EVALUATIONS

10. SCOPE.

10.1 Scope. This appendix describes basic methods of ultrasonic testing for soundness and thickness of plate for service acceptability. It shall in no way restrict the supplemental use of other tests, where the application requires them, to define or otherwise determine the acceptability or need for repair of these plates. This appendix forms a mandatory part of this specification.

10.2 The appendix describes the basic methods of gauging and soundness inspection of plates and contains the minimum requirements for equipment, personnel, and extent of evaluation in the inspections to acceptance or rejection standards contained herein.

10.3 These methods, as described in this appendix, shall be used when gauging or soundness testing is required for acceptance of plate by contract or order.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. REQUIREMENTS

30.1 Personnel requirements.

30.1.1 Personnel performing ultrasonic inspection shall comply with the qualification requirements of MIL-STD-271. In addition, they shall be familiar with inspection requirements and acceptance standards as specified herein.

30.2 Equipment requirements.

30.2.1 Equipment used for thickness gauging shall have periodic performance checks to determine the limits of accuracy.

30.2.2 Mechanical micrometer.

30.2.2.1 Calibration of micrometers shall be performed monthly or in accordance with approved calibration programs using certified Johansson blocks, or equal.

30.2.3 Ultrasonic gauging instruments.

30.2.3.1 Ultrasonic thickness gauging instruments shall be qualified in accordance with MIL-STD-271.

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30.2.4 Ultrasonic soundness inspection equipment.

30.2.4.1 The soundness inspection equipment shall consist of the detection instrument, search unit, reference calibration standard, and accessories. The equipment package shall produce, receive and display high-frequency electrical pulses at the required frequencies and energy levels.

30.2.4.2 The instrument shall be the pulse-echo type, having an "A" scan presentation. Instruments having attenuation-correction circuitry may be employed.

30.2.4.3 The type of search unit used is optional, but shall be compatible with the test instrument. The transducer shall be a straight beam unit that transmits a longitudinal mode of sound vibration into the plate, and receives the returning sound energy. For evaluation of soundness defects, the maximum size of transducer shall be 1-1/8 inches (28.6 mm) square and the minimum nominal frequency shall be 2.25 megahertz (MHz).

30.2.4.4 Ultrasonic soundness inspection equipment shall be qualified in accordance with MIL-STD-271.

30.3 Extent of test.

30.3.1 Mechanical and ultrasonic thickness gauging. Type II plates require mechanical and ultrasonic thickness gauging as specified in 3.7 and described in section 30 and shall be compared to the tolerance limits described in 3.9.

30.3.2 Soundness inspection. Soundness inspection of type II plates shall be accomplished by ultrasonically scanning as described in section 30 and shall be evaluated to the acceptance standards of 3.7.

30.4 Surface preparation. The scanning surface of the plate shall be grit blasted or sandblasted and may have one coat each of pretreatment and primer. The surface shall be free of all loose dirt, rust, or any foreign substance which may interfere with the test. If necessary, conditioning of the test areas may be accomplished by any suitable mechanical means, such as disc grinding and sanding.

30.5 Couplant. The couplant chosen shall give the best results for the equipment in use and the surface conditions prevailing. In addition, the couplant material shall be readily removable from the surface when the test is completed. A water-detergent solution for glycerine gives good test results and is easily removed.

30.6 Reference base designation. The upper left corner of the plate scan surface shall be indicated to designate this as a common reference base location for layout and recording purposes.

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40. PROCEDURES

40.1 Plate gauging. Plate gauging shall be as specified in 40.1.1 through 40.1.3.1.

40.1.1 Equipment. Equipment shall be as specified in 40.1.1.1 through 40.1.1.3.

40.1.1.1 The plate gauging equipment shall consist of mechanical micro-meters and either pulse-echo or resonance-frequency ultrasonic gauging instrumentation and shall meet the requirements of section 30.

40.1.1.2 The resonance-frequency systems, the operating frequency range shall be as specified by the instrument manufacturer.

40.1.1.3 For pulse-echo systems, a transducer frequency of 2.25 to 5.0 MHz provides satisfactory results for most gauging.

40.1.2 Technique. Technique shall be as specified in 40.1.2.1 through 40.1.2.5.

40.1.2.1 Mechanical gauging shall be in accordance with 4.4.2.7.

40.1.2.2 These mechanically-gauged locations shall be used as check points to verify the calibration of the ultrasonic instrument during the ultrasonic gauging of each plate. Deviations in excess of 1 percent shall require recalibration of the instrument and regauging of all measurements made subsequent to the last valid verification check. Verification check shall be performed after each interruption in power supply.

40.1.2.3 Using ultrasonic gauging equipment, the plate thickness shall be measured at each intersection of a grid pattern layout on one major surface of the plate. The layout shall consist of a 6-inch (152 mm) margin inward from each edge of the plate, enclosing a grid pattern of lines at 24-inch (610 mm) intervals. Spacing dimensions shall be referenced from the upper left corner of the margin.

40.1.2.4 If mechanized soundness scanning is employed for gauging, the average of the readings obtained on the 24-inch (610 mm) scan lines may be used as plate gauge. All points on the scan lines shall meet the requirements specified in 3.7.

40.1.2.5 Gauging readouts that vary from the specified allowable tolerances shall be submitted to expanded search to determine the extent of plate area not within tolerance limits.

40.1.3 Reporting.

40.1.3.1 The mechanical and ultrasonic gauging shall be recorded in the respective locations on the suggested report format of figure 1 (see 6.2.2).

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40.2 Plate soundness inspection. Plate soundness inspection shall be as specified below:

40.2.1 Equipment.

40.2.1.1 The plate soundness inspection equipment shall meet the requirements of section 30.

40.2.2 Technique. Technique shall be as specified in 40.2.2.1 through 40.2.2.3.

40.2.2.1 Test calibration. Test calibration shall be accomplished by placing a compressional wave search unit on an experimentally determined defect free area. The instrument shall then be adjusted to display a scale 10 (just saturated), first back reflection on the cathode ray tube.

40.2.2.2 Recalibration. Recalibration shall be accomplished prior to each use or after any interruption in power supply.

40.2.2.3 Plate soundness. Plate soundness shall be tested with a straight beam (longitudinal wave) search in accordance with 4.4.2.8. When continuous scanning is used for expanded search in accordance with 4.4.2.8.1, each pass shall be overlapped a minimum of 15 percent of the transducer width until the entire surface (of area) has been inspected.

50. RECORDS

50.1 General.

50.1.1 Gauging and soundness inspection shall be recorded (see 6.2.2).

50.2 Gauging.

50.2.1 Plate thickness gauging. Plate thickness gaugings, as described in 30.3 and 40.1.2 shall be recorded in the respective locations on the suggested report format of figure 1 (see 6.2.2), and as a minimum, the following information shall be included:

- (a) Plate identification.
- (b) Gauging equipment used.
- (c) Inspector's identity.
- (d) Inspection date.
- (e) Notation of reference corner, minimum reading, and maximum reading.
- (f) Location and limits of areas deviating from tolerances.

50.3 Soundness inspection.

50.3.1 The extent of plate conditions as described in 30.3 and 40.2.2.3, shall be recorded in the respective locations on the suggested report format of figure 4 (see 6.2.2), and, as a minimum, shall include the following information:

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- (a) Plate identification.
- (b) Inspection equipment used.
- (c) Inspector's identity.
- (d) Inspection date.
- (e) Notation of reference corner.
- (f) Flaw location dimensions as referenced from the top end and left side of the plate.
- (g) Notation of "T" area dimension or percentage reduction of back reflection.
- (h) Notation of rejectable areas that have been authorized for repair by the reviewing activity.

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	152	762	1372	1981	2591	3201	4013	4623	
	6	30	54	78	102	126	150	174	
152	6	+	+	+	+	+	+	+	MILL MARK NO.
									HEAT/MELT NO.
762	30	+	+	+	+	+	+	+	SLAB/PLATE NO.
									MATERIAL
									LENGTH
									WIDTH
									GAGE
1372	54	+	+	+	+	+	+	+	"
									"
									"
									"
1981	78	+	+	+	+	+	+	+	SOUNDNESS DEFECTS - CLASS & LOCATION
									FLAW CLASS
									DIMENSION TO:
									TOP END
									LEFT SIDE
2591	102	+	+	+	+	+	+	+	FLAW CLASS
									DIMENSION TO:
									TOP END
									LEFT SIDE
3201	126	+	+	+	+	+	+	+	
4013	150	+	+	+	+	+	+	+	
4623	174	+	+	+	+	+	+	+	
5232	198	+	+	+	+	+	+	+	
6045	222	+	+	+	+	+	+	+	
6655	246	+	+	+	+	+	+	+	
6264	270	+	+	+	+	+	+	+	
7874	294	+	+	+	+	+	+	+	
8077	318	+	+	+	+	+	+	+	
8687	342	+	+	+	+	+	+	+	
9296	366	+	+	+	+	+	+	+	
9906	390	+	+	+	+	+	+	+	
10616	414	+	+	+	+	+	+	+	
1126	438	+	+	+	+	+	+	+	

* LBR= LOST BACK REFLECTION (REJECT)
 XCL= EXCEEDS CALIBRATION LEVEL (REJECT)
 KEY: RBR= REDUCED BACK REFLECTION (RECORD)
 LCL= LESS THAN CALIBRATION LEVEL (RECORD)

☐ SOUNDNESS SATISFACTORY ☐ REFER EVALUATION

REMARKS

SPECIFICATION/PROCEDURE

INSTRUMENT: MODEL NO.

SEARCH UNIT: SIZE FREQUENCY MHZ

INSPECTOR(S): DATE

REVIEWED BY: DATE

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FIGURE 4. Suggested plate ultrasonic report format.

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APPENDIX B

COATINGS

10. SCOPE

10.1 Scope. This appendix outlines the cleaning and preserving procedures and requirements for ships plates intended for Naval service. This appendix forms a mandatory part of this specification.

10.2 This appendix allows the maximum latitude in cleaning and preserving methods and materials for the intended plate storage time and conditions.

10.3 Coatings. The coatings specified herein shall be selected in terms of the particular use. Cleaning, followed by one coat of alkyd primer TT-P-645, formula 84, or one coat of primer coating TT-P-664 or one coat of primer coating conforming to TT-P-1757 should provide protection for approximately 9 months.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standard. The following specifications and standard 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.

SPECIFICATIONS

FEDERAL

- TT-P-645 - Primer, Paint, Zinc Chromate, Alkyd Type.
- TT-P-664 - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.
- TT-P-1757 - Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity.

STANDARD

FEDERAL

- FED-STD-595 - Colors.

(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.)

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30. DESCALING AND CLEANING

30.1 Methods. Plates shall be descaled and cleaned by abrasive blast cleaning or acid pickling.

30.2 Abrasive blast cleaning. Abrasive blast cleaning shall result in a clean metal surface, suitable for painting, with mill scale, rust, and other surface contaminants removed.

30.3 Acid pickling. The acid pickling process shall be as follows:

- (a) Plates shall be handled on edge throughout the various steps of the procedure. They shall not be laid flat in the solutions.
- (b) Rust preventives, oils, greases, oil paints, and other foreign matter shall be removed from the plates prior to immersion in the acid pickling bath. Where alkaline solutions are used for this purpose, the plates shall be thoroughly rinsed with water prior to pickling.
- (c) The pickling bath shall consist of a sulphuric acid solution to which has been added to pickling inhibitor and 1-1/2 percent of sodium chloride. In making the initial solution, 5 gallons of concentrated sulphuric acid shall be used for each 100 gallons of solution. The acid concentration shall not be allowed to drop below 3.5 percent by volume. The inhibitor shall be used at the concentration recommended by the manufacturer. The bath temperature shall be maintained at 170 to 180°F. When the concentration of iron in the solution reaches 5 percent by weight, the entire bath shall be discarded.
- (d) The water rinse shall consist of fresh circulating water maintained at a temperature of 170 to 180°F. The flow of fresh water shall be maintained so that a complete change of water occurs at least every 24 hours. The combined concentrations of sulphuric and iron sulphates in the bath, calculated from the acid concentration and the ferrous iron concentration, shall not exceed 2 grams per gallon. This determination shall be made at least once each week.

40. PRESERVATIVE COATINGS

40.1 Coating. The plates, as prepared for coating, shall be in the descaled condition and free of visible rust. The paint film shall cover surface roughness peaks. Two random dry film thickness measurements per 100 square feet of painted surface, made with a calibrated suitable thickness gauge, shall be sufficient for determining conformity of any one plate to the specified coating thicknesses. Other methods of measurement or quality control may be used for paint film thickness, subject to the approval of the command or agency concerned. The plates shall be coated as follows:

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- (a) For grade HY-80, one coat of primer conforming to formula 84 (brown) of TT-P-645 approximating color number 30117 of FED-STD-595 and for HY-100, one coat of alkyd primer conforming to TT-P-645 modified to a dull orange approximating color number 22190 of FED-STD-595 to an average dry film thickness of approximately 1 mil.
- (b) The drying time of the coatings at 73°F (23°C) shall be a maximum of 6 hours. Higher plate temperatures of ambient temperature would shorten drying time.
- (c) When modified to meet the color requirements of 40.1(a), primers conforming to either TT-P-1757 or TT-P-664 are acceptable. These primers have a maximum drying time of 30 minutes, and therefore allow the effective use of automated cleaning and painting. They are subject to the limitations specified in 10.3.