Designation: A 945/A 945M – 06$^{\epsilon 1}$

Standard Specification for High-Strength Low-Alloy Structural Steel Plate with Low Carbon and Restricted Sulfur for Improved Weldability, Formability, and Toughness[1]

This standard is issued under the fixed designation A 945/A 945M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

ϵ[1] NOTE—Corrected the thickness value for Nickel editorially in October 2006.

1. Scope*

1.1 This specification covers high-strength low-alloy structural steel plate intended for use in welded construction of naval ships where a savings in weight [mass] is important. Plates that conform to this specification offer improved weldability, formability, and toughness resulting from the specified alloying elements with limitations on carbon, sulfur, and residual element contents. Grades 50 and 65 may be provided as-rolled, control-rolled, thermo-mechanical control processed (including accelerated cooling), normalized, or quenched and tempered as required to meet the specified mechanical requirements.

1.2 The maximum thickness or weight [mass] of plates shall be as follows:

Grade	Plate thickness, max, in. [mm]	Plate weight [mass], max, lb/ft^2[kg/m^2]
50	2 [50]	81.7 [393]
65	2½ [65]	102 [502]

1.3 If the steel is to be welded, it is presupposed that a welding procedure suitable for the grade of steel and intended use or service will be utilized.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text the SI units are shown in brackets. The values stated in each system are not exact equivalents, therefore, each system is to be used independently of the other without combining values in any way.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

A 6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products

A 673/A 673M Specification for Sampling Procedure for Impact Testing of Structural Steel

A 700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment

E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels

3. General Requirements for Delivery

3.1 Plates furnished under this specification shall conform to the applicable requirements of the current edition of Specification A 6/A 6M.

3.2 If specified in the purchase order, plates ordered under this specification shall be prepared for shipment in accordance with the requirements of the current edition of Specification A 700.

4. Materials and Manufacture

4.1 The steel shall be made to fine grain practice.

4.2 Grade 65 plates less than 1 in. [25 mm] in thickness shall be provided from continuously cast product.

4.3 Except as specified in 5.1 and 5.2, the plates after finish-rolling shall be in one of the following conditions: as-rolled, control-rolled, or thermo-mechanical control processed (including accelerated cooling).

5. Heat Treatment

5.1 Grade 50 plates and Grade 65 plates are normally furnished without heat treatment. The manufacturer has the option to normalize or quench and temper such plates to meet the mechanical requirements of Section 7 provided that the heat treatment is reported on the test report.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel, and Related Alloys and is under the direct responsibility of Subcommittee A01.02 on Structural Steel for Bridges, Buildings, Rolling Stock, and Ships.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard.**

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5.2 Grade 65 plates greater than 1 ¼ in. [32 mm] in thickness shall be furnished in the quenched and tempered heat treatment.

6. Chemical Composition

6.1 The heat analysis shall conform to the requirements given in Table 1.

6.2 If a product analysis is made, it shall conform to the requirements given in Table 1, subject to the product analysis tolerances in Specification A 6/A 6M.

7. Mechanical Properties

7.1 *Tensile Properties*:

7.1.1 The plates as represented by the test specimens shall conform to the tensile properties given in Table 2 for the applicable grade.

7.1.2 For quenched and tempered plates, one tension test shall be taken from a corner of each plate as heat treated.

7.1.3 If measured on a 1½ in. [40-mm] wide specimen (see Fig. 3 of Test Methods and Definitions A 370), the elongation may be determined in a 2 in. [50-mm] gage length that includes the fracture and shows the greatest elongation.

7.2 *Charpy V-Notch Impact Properties*:

7.2.1 Except as allowed by section 7.2.2, Charpy V-Notch impact tests shall be conducted in accordance with Specification A 673/A 673M. All plates shall be tested in accordance with frequency (*P*) Piece Testing.

TABLE 1 Chemical Requirements

NOTE—Where "..." appears in this table, there is no requirement.

Element	Thickness	Composition, % Grade 50	Grade 65
Carbon (max)†	All	0.10	0.10
Manganese	All	1.10–1.65	1.10–1.65
Phosphorus (max)†	All	0.025	0.025
Sulfur (max)†	All	0.010	0.010
Silicon	All	0.10–0.40	0.10–0.40
Nickel	1¼ in. [32 mm] max.††	0.40 max	0.40 max
	Over 1 ¼ in. [32 mm]	0.40 max	0.50–1.00
Chromium (max)	All	0.20	0.20
Molybdenum (max)	All	0.08	0.08
Copper (max)	All	0.35	0.35
Vanadium (max)	All	0.10	0.10
Columbium (max)	All	0.05	0.05
Aluminum (max)	All	0.08	0.08
Titanium	All	...	0.007–0.020
Nitrogen (max)	All	...	0.012

††Value corrected editorially.

TABLE 2 Tensile Requirements

Grade	Yield Point or Yield Strength[A] min, ksi [MPa]	Tensile Strength ksi [MPa]	Minimum Elongation, %[B] In 8 in. [200 mm]	In 2 in. [50 mm]
50	50 [345]	70 [485]–90 [620]	21	24
65	65 [450]	78 [540]–100 [690]	18	22

[A] Measured at 0.2 % offset or 0.5 % extension under load as described in Section 13 on yield strength of Test Methods and Definitions A 370.

[B] For plates wider than 24 in. [600 mm], the elongation requirement is reduced two percentage points. See elongation requirement adjustment in the Tension Tests section of Specification A 6/A 6M.

7.2.2 The plates as represented by the test specimens shall conform to the impact properties given in Table 3 for the applicable grade. For Grade 50, the longitudinal axis of the specimens may be parallel or transverse to the final direction of rolling of the plate at the option of the manufacturer, unless the test orientation is specified in the purchase order.

7.2.3 For material thicknesses below 7⁄16 in. [10 mm], the absorbed energy in Table 3 shall be reduced proportionally in accordance with Table 1 in Specification A 673 for sub-sized Charpy test specimens.

8. Report

8.1 The manufacturer or processor shall report the results of all tests required by this specification as identified in Section 18 of Specification A 6/A 6M.

8.2 The manufacturer shall furnish a certification that the material has been manufactured and tested in accordance with the requirements of the material specification.

9. Keywords

9.1 as-rolled; high-strength; low-alloy; low-carbon; normalized; plate; quenched; restricted sulfur; ship applications; steel; structural applications; tempered; thermo-mechanical control processed (TMCP); weight; welded construction

TABLE 3 Charpy V-Notch Impact Test Requirements

Grade	Temperature °F [°C]	Longitudinal Specimens, min avg ft·lbf	[J]	Transverse Specimens, min avg ft·lbf	[J]
50	–40 [–40]	30	[41]	20	[27]
65	–40 [–40]	...	...	70	[95]

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SUPPLEMENTARY REQUIREMENTS

Supplementary requirements shall not apply unless specified in the purchase order or contract. Standardized supplementary requirements for use at the option of the purchaser are listed in Specification A 6/A 6M.

ADDITIONAL SUPPLEMENTARY REQUIREMENTS

In addition, the following special supplementary requirements are also suitable for use with this specification:

S78. First Article Inspection

S78.1 The manufacturer shall demonstrate the uniformity of properties throughout the plate prior to the initial shipment of the order.

S78.1.1 Testing shall be conducted on a single plate of the maximum thickness to be supplied to the order.

S78.1.1.1 Tensile tests shall be conducted on material taken from each end of the plate and along both edges near the mid-length of the plate (four test locations). One tensile test from each area shall be oriented parallel to the direction of rolling and one tensile test from each area shall be oriented transverse to the principal direction of rolling.

S78.1.1.2 Charpy V-notch impact tests shall be conducted on material from each end of the plate and along both edges near the mid-length of the plate (four test locations). Impact tests shall be performed at −40°F (−40°C) on one set of specimens taken parallel and one set of specimens taken transverse to the principal direction of rolling at each location.

S78.1.1.3 The Nil-ductility transition temperature shall be determined for the plate in accordance with Test Method E 208.

S78.2 A first article inspection report shall be prepared and submitted to the purchaser prior to shipment of the order.

S79. Weldability

S79.1 Weldability tests shall be conducted. The type of test and the acceptance criteria shall be as agreed upon between the manufacturer and the purchaser.

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A 945/A 945M – 05) that may impact the use of this standard. (Approved Sept. 15, 2006.)

(1) Changed minimum Nickel content from 0.4 % to 0.5 % for plates over 1 ¼ in. thickness in.

(2) Added section 7.2.3, adding reference to Table 1 of Specification A 673 for sub-size Charpy specimens.

Committee A01 has identified the location of selected changes to this standard since the last issue (A 945/A 945M – 00) that may impact the use of this standard. (Approved Sept. 1, 2005.)

(1) Changed maximum plate thickness for Grade 65 in section 1.2.

(2) Added section 4.2, to include requirement for Grade 65.

(3) Added section 5.2 to include heat treat requirement for Grade 65 over 1 ¼ in.

(4) Removed test orientation option for Grade 65 from section 7.2.2.

(5) Revised Table 1 for Grade 65.

(6) Changed impact values for Grade 65 in Table 3.

(7) Deleted reference to Supplemental Requirement S5.

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