



Standard Specification for Structural Steel for Ships¹

This standard is issued under the fixed designation A 131/A131M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers structural steel shapes, plates, bars, and rivets intended primarily for use in ship construction.

1.2 Material under this specification is available in the following categories:

1.2.1 *Ordinary Strength*—Grades A, B, D, DS, CS, and E with a specified minimum yield point of 34 ksi [235 MPa], and

1.2.2 *Higher Strength*—Grades AH, DH, and EH with specified minimum yield points of either 46 ksi [315 MPa], 51 ksi [350 MPa], or 57 ksi [390 MPa].

1.3 Shapes and bars are normally available as Grades A, AH32, or AH36. Other grades may be furnished by agreement between the purchaser and the manufacturer.

1.4 When 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. See Appendix X3 of Specification A 6/A 6M for information on weldability.

1.5 The values stated in either inch-pound units or SI units are to be regarded separately as the standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

A 6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling²

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products³

E 112 Test Methods for Determining the Average Grain Size⁴

3. Ordering Information

3.1 Inquiries, orders, contracts, etc., for material to this specification should include the following information to

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

Current edition approved June 15, 1994. Published August 1994. Originally published as A 131 – 31 T. Last previous edition A 131/A 131M – 93b.

² *Annual Book of ASTM Standards*, Vol 01.04.

³ *Annual Book of ASTM Standards*, Vol 01.03.

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

describe adequately the desired material:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Name of material (ordinary strength or higher strength, carbon steel shapes, plates, bars, or rivets),

3.1.3 ASTM specification designation, grade, and year of issue,

3.1.4 Cold flanging when applicable,

3.1.5 Dimensions,

3.1.6 Condition (hot rolled or hot rolled and normalized), and

3.1.7 Supplementary requirements, if any.

4. Manufacture

4.1 *Melting Process:*

4.1.1 The steel may be made by any of the following processes: open-hearth, basic-oxygen, electric-furnace, vacuum arc remelt (VAR), or electroslag remelt (ESR).

4.1.2 Except for Grade A steel up to and including ½ in. [12.5 mm] in thickness, rimming-type steels shall not be applied.

4.1.3 Grades AH32 and AH36 shapes through 426 lb/ft, and plates up to 0.5 in. [12.5 mm] in thickness may be semi-killed, in which case the 0.10 % minimum silicon does not apply.

4.1.4 Except as permitted in 4.1.4.1, Grades D, DS, CS, E, AH40, DH32, DH36, DH40, EH32, EH36, and EH40 shall be made using a fine grain practice. For ordinary strength grades, aluminum shall be used to obtain grain refinement. For high strength grades, aluminum, vanadium, or columbium (niobium) may be used for grain refinement.

4.1.4.1 Grade D material 1⅜ in. [35 mm] and under in thickness, at the option of the manufacturer, may be semi-killed and exempt from the fine austenitic grain size requirement of 7.1, but such material shall be subject to the toughness requirement of 8.2.1.

5. Heat Treatment

5.1 Plates in all thicknesses ordered to Grades CS and E shall be normalized. Plates over 1⅜ in. [35 mm] in thickness ordered to Grade D shall be normalized. When Grade D steel is furnished semi-killed, it shall be normalized over 1 in. [25 mm] in thickness. Upon agreement between the purchaser and the manufacturer, control rolling of Grade D steel may be substituted for normalizing, in which case impact tests are required for each 25 tons [25 Mg] of material in the heat.

5.2 Plates in all thicknesses ordered to Grades EH32 and

EH36 shall be normalized. Plates in all thicknesses ordered to Grade EH40 shall be normalized or quenched and tempered. Grades AH32, AH36, AH40, DH32, DH36, and DH40 shall be normalized when so specified in Table 1. Upon agreement between the purchaser and the manufacturer, control rolling of Grade DH may be substituted for normalizing, in which case impact tests are required on each plate.

5.3 In the case of shapes, the thicknesses referred to are those of the flange.

6. Chemical Requirements

6.1 The heat analysis shall conform to the requirements for chemical composition prescribed in Table 2.

6.1.1 The steel shall conform on product analysis to the requirements prescribed in Table 2, subject to the product analysis tolerances in Specification A 6/A 6M, except as specified in 6.1.2.

6.1.2 Product analysis is not required for bar-size shapes or flat bars 1/2 in. [12.5 mm] and under in thickness.

6.1.3 When tension tests are waived in accordance with 8.1.1.2, chemistry consistent with the mechanical properties desired must be applied.

7. Metallurgical Structure

7.1 Fine grain practice for ordinary strength grades shall be met using aluminum. For higher strength grades, aluminum, vanadium, or columbium may be used as grain refining elements.

7.2 Except as modified by 7.2.1, grain size shall be determined on each heat by the McQuaid-Ehn test of Methods E 112. The grain size so determined shall be No. 5 or finer in 70 % of the area examined.

7.2.1 As an alternative to the McQuaid-Ehn test, a fine grain practice requirement may be met by a minimum acid-soluble aluminum content of 0.015 % or minimum total aluminum content of 0.020 % for each heat.

7.2.2 For Grades AH40, DH32, DH36, DH40, EH32, EH36, and EH40 the fine grain practice requirement may also be met as follows:

7.2.2.1 Minimum columbium (niobium) content of 0.020 % or minimum vanadium content of 0.050 % for each heat, or

7.2.2.2 When vanadium and aluminum are used in combination, minimum vanadium content of 0.030 % and minimum

acid-soluble aluminum content of 0.010 %, or minimum total aluminum content of 0.015%.

8. Mechanical Requirements

8.1 *Tension Tests:*

8.1.1 Except as specified in the following paragraphs the material as represented by the test specimens shall conform to the tensile requirements prescribed in Table 3.

8.1.1.1 Unless a specific orientation is called for on the purchase order, tension test specimens may be taken parallel or transverse to the final direction of rolling at the option of the steel manufacturer.

8.1.1.2 Shapes less than 1 in.² [645 mm²] in cross section, and bars, other than flats, less than 1/2 in. [12.5 mm] in thickness or diameter need not be subjected to tension tests by the manufacturer.

8.1.1.3 The elongation requirement of Table 3 does not apply to material ordered as floor plates with a raised pattern. However, for floor plates over 1/2 in. [12.5 mm] in thickness, test specimens shall be bent cold with the raised pattern on the inside of the specimen through an angle of 180° without cracking when subjected to a bend test in which the inside diameter is three times plate thickness. Sampling for bend testing shall be as specified for the tension tests in 8.1.2.

8.1.2 One tension test shall be made from each of two different plates, shapes, or bars from each heat of structural steel and steel for cold flanging unless the finished material from a heat is less than 50 tons [45 Mg], when one tension test will be sufficient. If, however, material from one heat differs 3/8 in. [10 mm] or more in thickness or diameter, one tension test shall be made from both the thickest and the thinnest material rolled, regardless of the weight represented.

8.1.3 Two tension tests shall be made from each heat of rivet steel.

8.1.4 For Grade EH40, one tension test shall be made on each plate as quenched and tempered.

8.2 *Toughness Tests* (material 2 in. [50 mm] and less in thickness):

8.2.1 Except as permitted in 8.2.1.1, Charpy V-notch tests shall be made on Grade B material over 1 in. [25 mm] in thickness and on material of Grades D, E, AH32, AH36, DH32, DH36, DH40, EH32, EH36, and EH40. The test results shall conform to the requirements of Table 4.

8.2.1.1 Toughness tests are not required: (a) on Grade D normalized material made fully killed and having a fine austenitic grain size, (b) on Grades AH32 and AH36 when normalized, or when 0.5 in. [12.5 mm] or less in thickness when treated with vanadium or columbium (niobium) or 1 3/8 in. [35 mm] or less in thickness when treated with aluminum, and (c) on Grades DH32 and DH36 material when normalized.

8.2.2 For plate material, when required, one set of three impact specimens shall be made from the thickest material in each 50 tons [45 Mg] of each heat of Grades B, D, AH32, AH36, AH40, DH32, DH36, and DH40 steels and from each rolled product of Grades E, EH32, EH36, and EH40 steels. When heat testing is called for, a set of three specimens shall be tested for each 50 tons [45 Mg] of the same type of product produced on the same mill from each heat of steel. The set of impact specimens shall be taken from different as-rolled or

TABLE 1 Heat Treatment Requirements for Higher Strength Grades (32, 36, and 40)^A

Aluminum-treated steels:

AH32 or AH36 Normalizing not required up to and including 2 in. [50 mm] in thickness

AH40 Normalizing required over 0.50 in. [12.5 mm]

DH32 or DH36 Normalizing required over 1.0 in. [25 mm]

DH40, EH32, or EH36 Normalized

EH40 Normalized or Quenched and Tempered

Columbium (niobium) or vanadium-treated steels:

AH32 or AH36 Normalizing not required up to and including 2 in. [50 mm] in thickness

AH40, DH32, or DH36 Normalizing required over 0.50 in. [12.5 mm]

DH40, EH32, or EH36 Normalized

EH40 Normalized or Quenched and Tempered

^A When columbium (niobium) or vanadium is used in combination with aluminum, heat treatment requirements for columbium or vanadium apply.