Designation: A 131/A 131M – 01

Standard Specification for Structural Steel for Ships[1]

This standard is issued under the fixed designation A 131/A 131M; 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.

1. Scope

1.1 This specification covers structural steel plates, shapes, 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, CS, and E with a specified minimum yield point of 34 ksi [235 MPa], and

1.2.2 *Higher Strength*—Grades AH, DH, EH, and FH 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 Piling[2]

A 370 Test Methods and Definitions for Mechanical Testing of Steel Products[3]

E 112 Test Methods for Determining Average Grain Size[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *control rolling, n*—a steel treatment that consists of final rolling within the range used for normalizing heat treatments so that the austenite completely recrystallizes.

3.1.2 *thermo-mechanical controlled processing, n*—a steel treatment that consists of strict control of the steel temperature and the rolling reduction. A high proportion of the rolling reduction is to be carried out close to or below the Ar_3 transformation temperature and may involve rolling towards the lower end of the temperature range of the intercritical duplex phase region thus permitting little if any recrystallization of the austenite. The process may involve accelerated cooling on completion of rolling.

4. Ordering Information

4.1 Specification A 6/A 6M establishes the rules for the ordering information that should be complied with when purchasing material to this specification.

4.2 Additional ordering considerations specific to this specification are:

4.2.1 Cold flanging, if applicable, and

4.2.2 Condition (control rolled or thermo-mechanical control processed).

5. Materials and Manufacture

5.1 Except for Grade A steel up to and including ½ in. [12.5 mm] in thickness, rimmed steels shall not be applied.

5.2 Except for Grades A and B steel, semi-killed steels shall not be applied.

5.3 Except as permitted in 5.3.1, Grades D, CS, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, and FH40 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.

5.3.1 Grade D material 1.0 in. [25 mm] and under in thickness, at the option of the manufacturer, may be 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.

5.4 Plates in all thicknesses ordered to Grade CS shall be normalized. Plates in all thicknesses ordered to Grade E shall be normalized, or thermo-mechanical control processed. Plates over 1⅜ in. [35 mm] in thickness ordered to Grade D shall be normalized, control rolled, or thermo-mechanical control processed. See Table 1.

5.5 Plates in all thicknesses ordered to Grades EH32 and

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[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.

TABLE 1 Condition of Supply and Frequency of Impact Tests Ordinary Strength Hull Structural Steel

Grade	Deoxidation	Products[A]	Condition of Supply[B] (Impact Test Lot Size[C], in Tons [Mg]) Thickness, in inches [mm] exceeding:→ not exceeding:→	0.25 [6.4] 0.5 [12.5]	0.5 [12.5] 1.0 [25]	1.0 [25] 1.375 [35]	1.375 [35] 2.0 [50]	2.0 [50] 4.0 [100]
A	Rimmed	All		AR (–)				
	Semi-Killed	All		AR (–)				N (–)[D] TM (–) CR (50 [45]) AR (50 [45])
	Killed	P						
		S						
B	Semi-Killed	All		AR (–)		AR (50 [45])		N (50 [45]) TM (50 [45]) CR (25 [23]) AR (25 [23])
	Killed	P						
		S						
D	Killed	P		AR (50) N (50)				
		S						
D	Killed & Fine Grain	P		AR (50 [45]) N (50 [45])			N (50 [45]) TM (50 [45]) CR (50 [45])	N (50 [45]) TM (50 [45]) CR (25 [23])
		S						
E	Killed & Fine Grain	P		N (P) TM (P)				N (P) TM (P)
		S		N (25 [23]) TM (25 [23]) CR (15 [14])				
CS	Killed & Fine Grain	P		N (–)				N (P)
		S		N (–)				

[A]Products: P = plate S = shapes and bars
[B]Conditions of Supply: AR = as-rolled N = normalized CR = control rolled TM = thermo-mechanical controlled processing
[C]Frequency of Impact Test: (Impact Test Lot Size in Tons from Each Heat) (–) = no impact test required (P) = each plate as-rolled
[D]Impact tests for Grade A are not required when material is produced using a fine grain practice and normalized.

EH36 shall be normalized, or thermo-mechanical control processed. Plates in all thicknesses ordered to Grade EH40, FH32, FH36, and FH40 shall be normalized, thermo-mechanical control processed, or quenched and tempered. Plates ordered to Grades AH32, AH36, AH40, DH32, DH36, and DH40 shall be normalized, control rolled, or thermo-mechanical control processed when so specified. See Table 2.

5.6 In the case of shapes, the thicknesses referred to are those of the flange. Heat treatment and rolling requirements for shapes and bars are shown in Tables 1 and 2.

6. Chemical Requirements

6.1 The heat analysis shall conform to the requirements for chemical composition prescribed in Tables 3 and 4.

6.1.1 When specified, the steel shall conform on product analysis to the requirements prescribed in Tables 3 and 4, subject to the product analysis tolerances in Specification A 6/A 6M.

6.2 For thermo-mechanical control process steel, the carbon equivalent shall be determined from the heat analysis and shall

TABLE 2 Condition of Supply and Frequency of Impact Tests Higher Strength Hull Structural Steel

Grade	Deoxidation	Grain Refining Element	Products[C]	Condition of Supply[A] (Impact Test Lot Size[B], in Tons [Mg]) Thickness, in inches (mm) exceeding:→ not exceeding:→	0.25 [6.4] 0.5 [12.5]	0.5 [12.5] 0.80 [20]	0.80 [20] 1.0 [25]	1.0 [25] 1.375 [35]	1.375 [35] 2.0 [50]	2.0 [50] 4.0 [100]
AH36 AH32	Killed & Fine Grain Practice	Nb V	P		AR (50 [45])	N (50 [45]) TM (50 [45]) CR (50 [45])				N (50 [45]) TM (50 [45]) CR (25 [23])
			S		AR (50 [45])	N (50 [45]) TM (50 [45]) CR (50 [45]) AR (25 [23])				
		Al	P		AR (50 [45])		AR (25 [23])	N (50 [45]) TM (50 [45]) CR (50 [45])		N (50 [45]) TM (50 [45]) CR (25 [23])
		Al + Ti	S		AR (50 [45])		N (50 [45]) TM (50 [45]) CR (50 [45]) AR (25 [23])			
DH32 DH36		Nb	P		AR (50 [45])	N (50 [45]) TM (50 [45]) CR (50 [45])				N (50 [45]) TM (50 [45]) CR (25 [23]
		V	S		AR (50 [45])	N (50 [45]) TM (50 [45]) CR (50 [45])				
		Al	P		AR (50 [45])		AR (25 [23])	N (50 [45]) TM (50 [45]) CR (50 [45])		N (50 [45]) TM (50 [45]) CR (25 [23]
		Al + Ti	S		AR (50 [45])		AR (25 [23])	N (50 [45]) TM (50 [45]) CR (50 [45])		
EH32 EH36		Any	P		N (P) TM (P)					N (P) TM (P)
			S		N (25 [23]) TM (25 [23]) CR (15 [14])					
FH32 FH36		Any	P		N (P) TM (P) QT (P)					
			S		N (25 [23]) TM (25 [23]) QT (25 [23])					
AH40		Any	All		AR (50 [45])	N (50 [45]) TM (50 [45]) CR (50 [45])				
DH40		Any	All		N (50 [45]) TM (50 [45]) CR (50 [45])					
EH40		Any	P		N (P) TM (P) QT (P)					
			S		N (25 [23]) TM (25 [23]) CR (25 [23])					
FH40		Any	P		N (P) TM (P) QT (P)					
			S		N (25 [23]) TM (25) CR (25 [23])					

[A]Conditions of Supply: AR = as-rolled TM = thermo-mechanical controlled processing CR = controlled QT = quenched and tempered N = normalized
[B]Frequency of Impact Test: (Impact Test Lot Size in Tons from Each Heat) (–) = no impact test required (P) = each plate as-rolled
[C]Products: P = plate S = shapes and bars

TABLE 3 Chemical Requirements Ordinary Strength Hull Structural Steel

Grade	A	B	D	E	CS
Deoxidation	Killed or Semi-Killed[A] t ≤ 2.0 in.. [50 mm] Killed t > 2.0 in. [50 mm]	Killed or Semi-Killed t ≤ 2.0 in.. [50 mm] Killed t > 2.0 in. [50 mm]	Killed t ≤ 1.0 in.. [25 mm] Killed and Fine Grain t > 1.0 in. [25 mm][B]	Killed and Fine Grain[B]	Killed and Fine Grain[B]
	Chemical composition (ladle analysis), % max, unless specified otherwise[C]				
C	0.21[D]	0.21	0.21	0.18	0.16
Mn_{min}	2.5 × C	0.80[E]	0.60	0.70	1.00
Si	0.50	0.35	0.10–0.35[F]	0.10–0.35[F]	0.10–0.35[F]
P	0.035	0.035	0.035	0.035	0.035
S	0.035	0.035	0.035	0.035	0.035
Ni	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]
Cr	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]
Mo	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]
Cu	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]	See Footnote[G]
C + Mn/6	0.40	0.40	0.40	0.40	0.40

[A] For Grade A, rimmed steel shapes and bars may be accepted up to and including 0.5 in. [12.5 mm].
[B] Grade D steel over 1.0 in. [25 mm], Grade E steel and Grade CS steel are to contain at least one of the grain refining elements in sufficient amount to meet the fine grain practice requirements (see Section 7).
[C] Intentionally added elements are to be determined and reported.
[D] A maximum carbon content of 0.23 % is acceptable for Grade A shapes and bars.
[E] For Grade B steel of cold flanging quality or where fully killed, the lower limit of manganese may be reduced to 0.60 %.
[F] Where the content of soluble aluminum is not less than 0.015 %, the minimum required silicon content does not apply.
[G] The contents of nickel, chromium, molybdenum and copper are to be determined and reported. When the amount does not exceed 0.02 %, these elements may be reported as ≤0.02 %.

TABLE 4 Chemical Requirements Higher-Strength Hull Structural Steel

Grades	AH/DH/EH 32, AH/DH/EH 36 and AH/DH/EH 40	FH 32/36/40
Deoxidation	Killed, Fine Grain Practice[A]	Killed, Fine Grain Practice[A]
	Chemical composition[B] (ladle analysis), % max, unless specified in range	
C	0.18	0.16
Mn	0.90–1.60[C]	0.90–1.60
Si	0.10–0.50[D]	0.10–0.50[D]
P	0.035	0.025
S	0.035	0.025
Al (acid soluble), min[E,F]	0.015	0.015
Nb[F,G]	0.02–0.05	0.02–0.05
V[F,G]	0.05–0.10	0.05–0.10
Ti	0.02	0.02
Cu[H]	0.35	0.35
Cr[H]	0.20	0.20
Ni[H]	0.40	0.40
Mo[H]	0.08	0.08
N	...	0.009 0.012 (if Al present)

[A] *The steel is to contain at least one of the grain refining elements in sufficient amount to meet the fine grain practice requirement (see Section 7).*
[B] The contents of any other element intentionally added is to be determined and reported.
[C] Grade AH 0.5 in. [12.5 mm] and under in thickness may have a minimum manganese content of 0.70 %.
[D] Where the content of soluble aluminum is not less than 0.015 %, the minimum required silicon content does not apply.
[E] The total aluminum content may be used instead of acid soluble content, in accordance with 7.1.
[F] The indicated amount of aluminum, niobium, and vanadium applies when any such element is used singly. When used in combination, the minimum content in 7.2.2 and 7.2.3, as appropriate, will apply.
[G] These elements need not be reported on the mill sheet unless intentionally added.
[H] These elements may be reported as ≤0.02 % where the amount present does not exceed 0.02 %.

conform to the requirements in Table 5.

7. Metallurgical Structure

7.1 The steel grades indicated in Section 5 shall be made to fine grain practice, and the requirements for fine austenitic grain size in Specification A 6/A 6M shall be met.

7.2 Where the use of fine grain practice using columbium, vanadium, or combinations is permitted under Section 5, the following limits shall be applied:

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

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

TABLE 5 Carbon Equivalent for Higher-Strength Hull Structural Steel Produced by TMCP

Grade	Carbon Equivalent[A], max, %	
	$t \le 2.0$ in. [50 mm]	$t > 2.0$ in. [50 mm] $t \le 4.0$ in. [100 mm]
AH32, DH32, EH32	0.36	0.38
FH32	0.36	
AH36, DH36, EH36	0.38	0.40
FH36	0.38	
AH40, DH40, EH40, FH40	0.40	

[A] The following carbon equivalent formula shall be used to calculate the carbon equivalent, C_{eq}:

$$C_{eq} = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15} (\%)$$

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

7.2.3 When columbium (niobium) and aluminum are used in combination, minimum columbium (niobium) content of 0.010 % and minimum acid-soluble aluminum content of 0.010 %, or minimum total aluminum content of 0.015 %.

8. Mechanical Requirements

8.1 *Tension Test*:

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 6.

8.1.1.1 Shapes less than 1 in.^{2} [645 mm^2] in cross section, and bars, other than flats, less than ½ in. [12.5 mm] in thickness or diameter need not be subjected to tension tests by the manufacturer, but chemistry consistent with the required tensile properties must be applied.

8.1.1.2 The elongation requirement of Table 6 does not apply to material ordered as floor plates with a raised pattern. However, for floor plates over ½in. [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 ⅜ 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 quenched and tempered steel, including Grades EH40, FH32, FH36, and FH40, one tension test shall be made on each plate as quenched and tempered.

8.2 *Toughness Tests*:

8.2.1 Charpy V-notch tests shall be made on Grade A material over 2 in. [50 mm] in thickness, on Grade B material over 1 in. [25 mm] in thickness and on material over ¼in. [6.4 mm] in thickness of Grades D, E, AH32, AH36, AH40, DH32, DH36, DH40, EH32, EH36, EH40, FH32, FH36, and FH40, as required by Tables 1 and 2. The frequency of Charpy V-notch impact tests shall be as required in Tables 1 and 2. The test results shall conform to the requirements of Table 7.

8.2.2 For Grades EH32, EH36, EH40, FH32, FH36, and FH40 plate material, one set of three impact specimens shall be made from each plate-as-rolled.

8.2.3 For Grade A, B, D, AH32, AH36, AH40, DH32, DH36, and DH40 plate material, and for all shape material, and all bar material, one set of three impact specimens shall be made from the thickest material in each test lot size of each heat, as required by Tables 1 and 2. When heat testing is called for, a set of three specimens shall be tested for each test lot size indicated in Tables 1 and 2, 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 heat-treated pieces of the heaviest gage produced. An as-rolled piece refers to the product rolled from a slab, billet, bloom, or directly from an ingot. Where the maximum thickness or diameter of various sections differs by ⅜in. [10 mm] or more, one set of impacts shall be made from both the thickest and the thinnest material rolled regardless of the weight represented.

8.2.4 The specimens for plates shall be taken from a corner of the material and the specimens from shapes shall be taken from the end of a shape at a point one third the distance from the outer edge of the flange or leg to the web or heel of the shape. Specimens for bars shall be in accordance with Specification A 6/A 6M.

8.2.5 The largest size specimens possible for the material thickness are to be machined. For plates, flats, and bars, the specimens are to be located with its edge within 0.08 in. [2 mm] from the surface except that where the thickness exceeds 1.57 in. [40 mm], the longitudinal axis of the specimen is to be located at a point midway between the surface and the center of the thickness. The length of the notch is to be perpendicular to the original rolled surface.

8.2.6 Unless a specific orientation is called for on the purchase order, the longitudinal axis of the specimens may be parallel or transverse to the final direction of rolling of the material at the option of the steel manufacturer.

8.2.7 The impact test shall be made in accordance with the Charpy Impact Testing section in Test Methods and Definitions A 370.

8.2.8 Each impact test shall constitute the average value of

TABLE 6 Tensile Requirements Ordinary Strength and Higher-Strength Hull Structural Steel

Grade	Tensile Strength, ksi [MPa]	Yield Point, min, ksi [MPa]	Elongation, min, %,[A,B] in 8 in. [200 mm]	Elongation, min, %,[B,C] in 2 in. [50 mm]
Ordinary strength:				
A, B, D, E, CS	58 to 75 [400 to 520][D]	34 [235]	21	24
Rivet steel and steel for cold flanging	55 to 65 [380 to 450]	30 [205]	23	26
Higher strength:				
AH32, DH32, EH32, FH32	64 to 85 [440 to 590]	46 [315]	19	22
AH36, DH36, EH36, FH36	71 to 90 [490 to 620]	51 [355]	19	22
AH40, DH40, EH40, FH40	74 to 94 [510 to 650]	57 [390]	19	22

[A] For nominal thickness or diameter under 5/16 in. [8 mm], a deduction from the specified percentage of elongation in 8 in. [200 mm] shall be made. See elongation requirement adjustments under the Tension Tests section of Specification A 6/A 6M for deduction values.

[B] Elongation is not required for floor plate.

[C] For nominal thickness or diameter over 3.5 in. [90 mm], a deduction from the specified percentage of elongation in 2 in. [50 mm] shall be made. See elongation requirement adjustments under the Tension Tests section of Specification A 6/A 6M for deduction values.

[D] For Grade A shapes and bars, the upper limit of tensile strength may be 80 ksi [550 MPa].

TABLE 7 Charpy V-Notch Impact Requirements Ordinary Strength and Higher-Strength Hull Structural Steel

Material Thickness		Average Absorbed Energy[A], min, ft-lbf [J]					
		≤2.0 in. [50 mm]		>2.0 in. [50 mm] ≤2.8 in. [70 mm]		>2.8 in. [70 mm] ≤4.0 in. [100 mm]	
Grade[B,C]	Test Temperature,° F (°C)	Charpy V-notch Impact Specimen Orientation					
		Longitudinal[D]	Transverse[D]	Longitudinal[D]	Transverse[D]	Longitudinal[D]	Transverse[D]
A	68 [20]	...	...	25 [34]	17 [24]	30 [41]	20 [27]
B	32 [0]	20 [27]	14 [20]	25 [34]	17 [24]	30 [41]	20 [27]
AH32		25 [34]	17 [24]	28 [38]	19 [26]	34 [46]	23 [31]
AH36		25 [34]	17 [24]	30 [41]	20 [27]	37 [50]	25 [34]
AH40		30 [41]	20 [27]	NA	NA	NA	NA
D	−4 [−20]	20 [27]	14 [20]	25 [34]	17 [24]	30 [41]	20 [27]
DH32		25 [34]	17 [24]	28 [38]	19 [26]	34 [46]	23 [31]
DH36		25 [34]	17 [24]	30 [41]	20 [27]	37 [50]	25 [34]
DH40		30 [41]	20 [27]	...	...	...	...
E	−40 [−40]	20 [27]	14 [20]	25 [34]	17 [24]	30 [41]	20 [27]
CS		...	...	25 [34]	17 [24]	30 [41]	20 [27]
EH32		25 [34]	17 [24]	28 [38]	19 [26]	34 [46]	23 [31]
EH36		25 [34]	17 [24]	30 [41]	20 [27]	37 [50]	25 [34]
EH40		30 [41]	20 [27]	...	...	...	...
FH32	−76 [−60]	25 [34]	17 [24]				
FH36		25 [34]	17 [24]	...	...	...	...
FH40		30 [41]	20 [27]				

[A]The energy shown is minimum for full-sized (0.394 by 0.394-in. [10 × 10-mm]) specimen. For sub-sized specimens, the energy shall be reduced as follows:

Specimen Size, in in. [mm]	0.394× 0.295 [10× 7.5]	0.394× 0.197 [10× 5.0]	0.394× 0.098 [10× 2.5]
Required Energy	5E/6	2E/3	E/2

E—energy required for full-sized specimen

[B] Either direction is acceptable.

[C]Charpy V-notch impact test requirements for ordinary strength hull structural steel grades apply where such test is required by Table 5.

[D]Charpy V-notch impact test requirements for higher-strength hull structural steel grades apply where such test is required by Table 6.

three specimens taken from a single test location. The average value shall meet the specified minimum average with not more than one value below the specified minimum average but in no case below 70% of the specified minimum average.

8.2.8.1 When the results fail to meet the preceding requirements but 8.2.8.1 (*2*) and (*3*) are complied with, three additional specimens may be taken from the location as close to the initial specimens as possible and their test results added to those previously obtained to form a new average. The material represented may be accepted if for the six specimens 8.2.8.1 (*1*), (*2*), and (*3*) are met.

(*1*) The average is not less than the required minimum average.

(*2*) No more than two individual values are below the required minimum average.

(*3*) No more than one individual value is below 70% of the required minimum average.

8.2.8.2 If the required energy values are not obtained upon retest, the material may be heat treated at the option of the producer in the case of as-rolled material or reheat treated in the case of heat-treated material.

8.2.8.3 After heat treatment or reheat treatment, a set of three specimens shall be tested and evaluated in the same manner as for the original material.

8.2.8.4 If the impact test result fails to meet the requirement for the thickest product tested when heat testing, that material shall be rejected and the next thickest material may be tested to qualify the balance of the heat in accordance with 8.2.8. At the option of the producer, retests may be made on each piece of the rejected material, in which case each piece shall stand on the results of its own test. It shall also be the option of the producer to heat treat the product prior to retesting if desired.

8.3 *Rivet Steel and Rivets*:

8.3.1 For rivet steel a sulfur print requirement shall be met when other than killed or semi-killed steel is applied, in order to confirm that its core is free of concentrations of sulfur segregates and other nonmetallic substances.

8.3.2 Test specimens for rivet bars that have been cold drawn shall be normalized before testing.

8.3.3 Finished rivets are to be selected as sample specimens from each diameter and tested hot and cold by bending and crushing as follows: The shank must stand being doubled together cold, and the head being flattened hot to a diameter 2½ times the diameter of the shank, both without fracture. Bend test requirements for rivets are given in Table 8.

9. General Requirements for Delivery

9.1 Material furnished under this specification shall conform to the requirements of the current edition of Specification A 6/A 6M, for the ordered material, unless a conflict exists in which case this specification shall prevail.

10. Plate Conditioning

10.1 After removal of any imperfection preparatory to welding the thickness of the plate at any location must not be reduced by more than 20 % of the nominal thickness of the plate.

TABLE 8 Bend Test Requirements for Rivet Steel

Thickness of Material, in. [mm]	Ratio of Bend Diameter to Thickness of Specimen
¾ [20] and under	flat on itself
Over ¾ [20] to 1¼ [30], incl	1
Over 1¼ [30]	2

11. Test Reports

11.1 When test reports are required by the purchase order, the report shall show the results of each test required by Sections 7 and 8, except that the results of only one set of tests need be reported when the amount of material from a heat in a shipment is less than 10 tons [9 Mg] and when the thickness variations described in Section 8 are not exceeded.

11.2 The thickness of the product tested may not necessarily be the same as an individual ordered thickness since it is the heat that is tested rather than each ordered item.

12. Marking

12.1 In addition to the marking specified in Specification A 6/A 6M, material ordered to cold flanging quality shall be additionally marked with the letter **F**.

12.2 Plates produced to a normalized heat treatment condition shall be marked with the suffix **N** to indicate that the material has been normalized.

12.3 Plates produced to a control rolled condition shall be marked with the suffix **CR** to indicate that the material has been control rolled.

12.4 Plates produced to a thermo-mechanical control processed condition shall be marked with the suffix **TM** to indicate that the material has been thermo-mechanical control processed.

12.5 Plates produced to a quenched and tempered heat treatment condition shall be marked with the suffix **QT** to indicate that the material has been quenched and tempered.

13. Keywords

13.1 bars; higher strength; ordinary strength; plates; rivets; shapes; ship construction; steel; structural steel

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified in the order:

S85. Product Chemical Analysis

S85.1 The chemical composition shall be determined for plates, shapes, or bars in accordance with 6.1.1. The number of pieces to be tested shall be stated on the order.

S86. Orientation of Impact Specimens

S86.1 The orientation of the impact test specimens shall be as specifically stated on the order. (The purchaser shall state whether the tests are to be longitudinal or transverse.)

S87. Heat-Treatment of Grade DH

S87.1 Grade DH aluminum-treated steel over ¾in. [19 mm] in thickness shall be normalized.

S88. Additional Tension Tests

S88.1 At least one tension test shall be made from each 50 tons [45 Mg] or fraction thereof from each heat. If the material differs by 0.375 in. [10 mm] or more in nominal thickness or diameter, one tension test shall be made from both the thickest and thinnest material in each 50 tons.