



**Designation: A414/A414M – 13**

# Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy for Pressure Vessels<sup>1</sup>

This standard is issued under the fixed designation A414/A414M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification<sup>2</sup> covers hot-rolled carbon steel sheet for pressure vessels involving fusion welding or brazing. Welding and brazing technique is of fundamental importance and shall be in accordance with commercial practices.

1.2 The following grades are included in this specification:

Mechanical Requirements

Grade	Yield Strength, min		Tensile Strength, min	
	ksi	MPa	ksi	MPa
A	25	170	45	310
B	30	205	50	345
C	33	230	55	380
D	35	240	60	415
E	38	260	65	450
F	42	290	70	485
G	45	310	75	515
H	45	310	75	515

1.3 Hot-rolled carbon steel sheet is generally furnished in cut lengths and to decimal thickness only. Coils may be furnished, provided tension test specimens are taken to represent the middle of the slab as required by 6.1.3. The purchaser should recognize this may require cutting the coils to obtain test samples and results in half-size coils. The sheet is furnished to the following size limits:

Thickness, in. [mm]	Width, in. [mm]
0.270 to 0.230 [7.0 to 6.0]	Over 12 [Over 300]
Under 0.230 to 0.057 [6.0 to 1.5]	sheet (coils only) sheet

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 shall

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.19 on Steel Sheet and Strip.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-414 in Section 11 of that Code.

be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

1.5 Tolerances are found in General Requirements Specifications A568/A568M and A635/A635M. The appropriate General Requirements specification is applied based on the thickness and width of the product ordered.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A568/A568M Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for

A635/A635M Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

## 3. Terminology

3.1 *Definitions*—For definitions of other terms used in this specification refer to Terminology A941.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *lot, n*—all coils of one thickness and width combination from one heat and one rolling on the hot mill, up to 100 tons [90 tonnes] total mass.

## 4. Ordering Information

4.1 Orders for material under this specification shall include the following information, as required, to describe the material adequately:

4.1.1 Designation or specification number, date of issue, and grade,

<sup>3</sup> 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

4.1.1.1 Grade H may be substituted for Grade G upon agreement between the purchaser and producer,

4.1.2 Copper bearing steel, when required,

4.1.3 Special requirements, if required,

4.1.3.1 Charpy impact properties may be specified for Grade H at the time of order,

4.1.3.2 Strength levels at other than room temperature may be specified for Grade H at the time of order,

4.1.4 Condition—pickled (or blast cleaned), if required (material so ordered will be oiled unless ordered dry), and

4.1.5 Dimensions, including type of edges.

4.1.5.1 When the purchaser requires thickness tolerances for 3/8 in. [10 mm] minimum edge distance (see Supplementary Requirement in Specifications **A568/A568M** or **A635/A635M**, as applicable), this requirement shall be specified in the purchase order or contract.

NOTE 1—Not all producers are capable of meeting all of the limitations of the thickness tolerance tables in Specification **A568/A568M** or Specification **A635/A635M**. The purchaser should contact the producer regarding possible limitations prior to placing an order.

4.1.6 Cast or heat analysis, or test report request, or both, if required.

NOTE 2—A typical ordering description is as follows: “ASTM A414, Grade A, Hot-Rolled Sheet, 0.100 in. [2.54 mm] by 36 in. [914.4 mm] by 96 in. [2438 mm], cut edges.”

## 5. Chemical Requirements

5.1 *Cast or Heat Analysis*—The analysis of the steel shall conform to the requirements prescribed in **Table 1**.

5.1.1 Each of the elements listed in **Table 2** shall be included in the report of the heat analysis. When the amount of an element present is less than 0.02 %, the analysis may be reported as “<0.02 %.”

5.2 *Product, Check, or Verification Analysis*—Analyses may be made by the purchaser from finished material representing each heat.

**TABLE 2 Limits on Unspecified Elements (See 5.1.1)**

Element	Analysis Method	Limit (%)
Copper, max % <sup>A</sup>	Heat analysis	0.40
	Product analysis	0.43
Nickel, max % <sup>A</sup>	Heat analysis	0.40
	Product analysis	0.43
Chromium, max % <sup>A,B</sup>	Heat analysis	0.30
	Product analysis	0.34
Molybdenum, max % <sup>A,B</sup>	Heat analysis	0.12
	Product analysis	0.13
Vanadium, max % <sup>C</sup>	Heat analysis	0.03
	Product analysis	0.04
Columbium, max % <sup>C</sup>	Heat analysis	0.02
	Product analysis	0.03

<sup>A</sup> The sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00 % on heat analysis. When one or more of these elements are specified, the sum does not apply, in which case, only the individual limits on the remaining unspecified elements will apply.

<sup>B</sup> The sum of chromium and molybdenum shall not exceed 0.32 % on heat analysis. When one or more of these elements are specified, the sum does not apply, in which case, only the individual limits on the remaining unspecified elements will apply.

<sup>C</sup> By agreement, the heat analysis limits for vanadium or columbium, or both, may be increased up to 0.10 % and 0.05 %, respectively.

5.3 *Deoxidation*—For all grades, killed steel is required. See **Table 1** and footnote B.

## 6. Mechanical Property Requirements

### 6.1 Tensile Strength:

6.1.1 *Requirements*—Material as represented by the test specimen shall conform to the tensile requirements specified in **Table 3**. One coil per lot shall have test specimens taken from locations representing the front end, middle, and back end of the coil. If all tensile results conform to the requirements, other coils of that lot may be tested only at the middle position.

### 6.1.2 Location and Orientation (see Fig. 1):

6.1.2.1 Tensile test samples shall be taken from the full thickness of the sheet as rolled.

6.1.2.2 Tensile test specimens shall be taken from a location approximately halfway between the center of the sheet and the edge of the material as-rolled.

**TABLE 1 Chemical Requirements**

Grade	% Heat Analysis, Element Maximum Unless Otherwise Shown														
	C	Mn <sup>A</sup>	P	S	Al <sup>B</sup>	Si <sup>B</sup>	Cu <sup>C</sup> <sub>D</sub>	Ni <sup>D</sup>	Cr <sup>D, E</sup>	Mo <sup>D, E</sup>	V <sup>F</sup>	Cb <sup>F</sup>	Ti <sup>G</sup>	N	B
A	0.15	0.90	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
B	0.22	0.90	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
C	0.25	0.90	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
D	0.25	1.20	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
E	0.27	1.20	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
F	0.31	1.20	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
G	0.31	1.35	0.035	0.035	0.02–0.08	0.30	0.40	0.40	0.30	0.12	0.03	0.02	0.025	...	...
H <sup>A, H</sup>	0.14	1.25	0.020	0.015	0.02–0.08	0.30	0.20	0.20	0.15	0.06	0.05 min	0.005/ 0.05	0.005 min	0.009	...

<sup>A</sup> For each reduction of 0.01 % below the specified carbon maximum, an increase of 0.06 % manganese above the specified maximum will be permitted up to a maximum of 1.50 %.

<sup>B</sup> The steel shall be considered aluminum-silicon killed when the silicon is between 0.15 % and 0.30 %, otherwise it shall be considered aluminum killed.

<sup>C</sup> When copper is specified, a minimum of 0.20 % is required. When copper is not specified, the copper limit is a maximum requirement.

<sup>D</sup> The sum of copper, nickel, chromium, and molybdenum shall not exceed 1.00 % on heat analysis. When one or more of these elements are specified, the sum does not apply, in which case, only the individual limits on the remaining unspecified elements will apply.

<sup>E</sup> The sum of chromium and molybdenum shall not exceed 0.32 % on heat analysis. When one or more of these elements are specified, the sum does not apply, in which case, only the individual limits on the remaining unspecified elements will apply.

<sup>F</sup> By agreement, the heat analysis limits for vanadium or columbium or both, may be increased up to 0.10 % and 0.05 % respectively.

<sup>G</sup> Titanium is permitted for Grades A through G, at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.

<sup>H</sup> Grade H contains the strengthening elements columbium (niobium), vanadium, titanium and molybdenum added singly or in combination. The minimum requirements only apply to the microalloy elements selected for strengthening of the steel.