



Designation: A1011/A1011M – 23

# Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength<sup>1</sup>

This standard is issued under the fixed designation A1011/A1011M; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope\*

1.1 This specification covers hot-rolled, carbon, structural, high-strength low-alloy, high-strength low-alloy with improved formability, and ultra-high strength steel sheet and strip, in coils and cut lengths.

1.2 Hot rolled steel sheet and strip is available in the designations as listed in 4.1.

1.3 This specification is not applicable to the steel covered by Specification A635/A635M.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</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

A749/A749M Specification for Steel, Strip, Carbon and High-Strength, Low-Alloy, Hot-Rolled, General Requirements for

A751 Test Methods and Practices for Chemical Analysis of Steel Products

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

E18 Test Methods for Rockwell Hardness of Metallic Materials

## 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 *aging, n*—loss of ductility with an increase in hardness, yield strength, and tensile strength that occurs when steel, which has been slightly cold worked (such as by temper rolling) is stored for some time.

3.2.1.1 *Discussion*—Aging also increases the tendency toward stretcher strains and fluting.

3.2.2 *inclusion control, n*—the process of reducing the volume fraction of inclusions or modifying the shape of inclusions to improve formability, weldability, and machinability.

3.2.2.1 *Discussion*—Inclusions, especially those elongated during the rolling process, create the conditions for initiating or propagating cracks when the material is stretched or bent during the manufacture of a part (or both). The adverse effects of inclusions are minimized by reducing the content of inclusions in the steel or by altering the shape of inclusions through the use of additions during the steelmaking process that change the elongated shape of the inclusions to less harmful small, well dispersed globular inclusions (or both).

<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.

Current edition approved May 1, 2023. Published June 2023. Originally approved in 2000. Last previous edition approved in 2018 as A1011/A1011M – 18a. DOI: 10.1520/A1011\_A1011M-23.

<sup>2</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



3.2.3 *stabilization, n*—addition of one or more nitride or carbide forming elements, or both, such as titanium and columbium, to control the level of the interstitial elements carbon and nitrogen in the steel.

3.2.3.1 *Discussion*—Stabilization improves formability and increases resistance to aging.

3.2.4 *vacuum degassing, n*—process of refining liquid steel in which the liquid is exposed to a vacuum as part of a special technique for removing impurities or for decarburizing the steel.

3.2.5 *Special Forming Steel (SFS), n*—Steel ordered to 1010 chemistry or greater levels of carbon, manganese or both, which exhibits enhanced formability or mechanical properties.

3.2.5.1 *Discussion*—Steel grades such as CS – 1010 or CS – 1020 for example, adheres to chemistry requirements only, whereas SFS – 1010 or SFS – 1020, also provide enhanced formability. Due to greater carbon content, SFS – 1020 is not as formable as SFS – 1010.

## 4. Classification

4.1 Hot-rolled steel sheet and steel strip is available in the following designations:

4.1.1 Commercial Steel (CS Types A, B, C, and D, as specified in Table 1),

4.1.2 Commercial Steel (CS Types A and B combined with chemistry grade in accordance with Specification A568/A568M Table X2.3),

4.1.3 Drawing Steel (DS Types A and B, as specified in Table 1),

4.1.4 Drawing Steel (DS Types A and B combined with chemistry grade in accordance with Specification A568/A568M Table X2.3),

4.1.5 Commercial Steel Chemistry grade in accordance with Specification A568/A568M Table X2.1, with no type specified (CS – 1005, CS – 1008, CS – 1020, and so forth),

4.1.6 Special Forming Steel (SFS), chemistry as specified in Table 1 with carbon & manganese limits in accordance with

Specification A568/A568M Tables X2.1 or X2.2 (examples: SFS – 1010, SFS – 1020, SFS – C 0.12–0.18 % & Mn 0.50–0.80 %).

4.1.7 Structural Steel (SS grades 30[205], 33[230], 36[250] Types 1 and 2, 40[275], 45[310] Types 1 and 2, 50[340], 55[380], 60[410], and 70[480].

4.1.8 High-Strength Low-Alloy Steel (HSLAS, classes 1 and 2, in grades 45[310], 50[340], 55[380], 60[410], 65[450], and 70[480].

4.1.9 High-Strength Low-Alloy Steel with Improved Formability (HSLAS-F grades 50[340], 60[410], 70[480], and 80[550]).

4.1.9.1 HSLAS-F steel has improved formability when compared to HSLAS. The steel is fully deoxidized, made to a fine grain practice, and includes microalloying elements such as columbium, vanadium, and zirconium. The steel shall be treated to achieve inclusion control.

4.1.10 Ultra-High Strength (UHSS Types 1 and 2, in Grades 90 [620] and 100 [690]).

4.1.10.1 UHSS steel has increased strength compared with HSLAS-F. The steel is killed and made to a fine ferritic grain practice, and includes microalloying elements such as columbium (niobium), titanium, vanadium, molybdenum, and so forth. The steel shall be treated to achieve inclusion control. The material is intended for miscellaneous applications where higher strength, savings in weight, and weldability are important. Atmospheric corrosion resistance of these steels is equivalent to plain carbon steels. With copper specified, the atmospheric corrosion resistance is somewhat enhanced.

4.1.11 When required for HSLAS, HSLAS-F, and UHSS steels, limitations on the use of one or more of the microalloy elements shall be specified on the order.

## 5. Ordering Information

5.1 It is the purchaser's responsibility to specify in the purchase order all ordering information necessary to describe the required material. Examples of such information include, but are not limited to, the following:

**TABLE 1 Chemical Composition  
For Hot Rolled Steel Sheet and Strip Designations CS, DS, and SFS**

|                              | Composition, % Heat Analysis           |              |       |       |              |              |                   |      |                 |      |       |                    |       |              |              |
|------------------------------|----------------------------------------|--------------|-------|-------|--------------|--------------|-------------------|------|-----------------|------|-------|--------------------|-------|--------------|--------------|
|                              | Element maximum unless otherwise shown |              |       |       |              |              |                   |      |                 |      |       |                    |       |              |              |
|                              | C                                      | Mn           | P     | S     | Al           | Si           | Cu                | Ni   | Cr <sup>B</sup> | Mo   | V     | Cb/Nb <sup>C</sup> | Ti    | N            | B            |
| CS Type A <sup>D,E,F,G</sup> | 0.10                                   | 0.60         | 0.030 | 0.035 | <sup>A</sup> | <sup>A</sup> | 0.20 <sup>H</sup> | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |
| CS Type B <sup>F</sup>       | 0.02–0.15                              | 0.60         | 0.030 | 0.035 | <sup>A</sup> | <sup>A</sup> | 0.20 <sup>H</sup> | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |
| CS Type C <sup>D,E,F,G</sup> | 0.08                                   | 0.60         | 0.10  | 0.035 | <sup>A</sup> | <sup>A</sup> | 0.20 <sup>H</sup> | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |
| CS Type D <sup>F</sup>       | 0.10                                   | 0.70         | 0.030 | 0.035 | <sup>A</sup> | <sup>A</sup> | 0.20 <sup>H</sup> | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.008 | <sup>A</sup> | <sup>A</sup> |
| DS Type A <sup>D,E,G</sup>   | 0.08                                   | 0.50         | 0.020 | 0.030 | 0.01 min     | <sup>A</sup> | 0.20              | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |
| DS Type B                    | 0.02–0.08                              | 0.50         | 0.020 | 0.030 | 0.01 min     | <sup>A</sup> | 0.20              | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |
| SFS                          | <sup>I</sup>                           | <sup>I</sup> | 0.020 | 0.030 | 0.01 min     | <sup>A</sup> | 0.20              | 0.20 | 0.15            | 0.06 | 0.008 | 0.008              | 0.025 | <sup>A</sup> | <sup>A</sup> |

<sup>A</sup> There is no specified limit, but the analysis shall be reported.

<sup>B</sup> Chromium is permitted, at the producer's option, to 0.25 % maximum when the carbon content is less than or equal to 0.05 %.

<sup>C</sup> Columbium (Cb) and niobium (Nb) are considered interchangeable names for element 41 in the periodic table and both names are acceptable for use.

<sup>D</sup> Specify Type B to avoid carbon levels below 0.02 %.

<sup>E</sup> For carbon levels less than or equal to 0.02 %, it is permissible to use vanadium, columbium, or titanium, or combinations thereof, as stabilizing elements at the producer's option. In such case, the limits for these elements are 0.10 % for vanadium or columbium and 0.15 % for titanium.

<sup>F</sup> When an aluminum deoxidized steel is required, it is permissible to order a minimum of 0.01 % total aluminum.

<sup>G</sup> It is permissible to furnish as a vacuum degassed or chemically stabilized steel, or both, at producer's option.

<sup>H</sup> When copper steel is specified, the copper limit is a minimum requirement. When copper steel is not specified, the copper limit is a maximum requirement.

<sup>I</sup> Carbon & manganese chemistry limits shall be specified in accordance with Specification A568/A568M, Tables X2.1 or X2.2.