



Designation: **A1018/A1018M – 18** **A1018/A1018M – 23**

Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength¹

This standard is issued under the fixed designation A1018/A1018M; 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, heavy-thickness coils beyond the size limits of Specification **A1011/A1011M**.

1.2 The product is available in six designations: Commercial Steel, Drawing Steel, Structural Steel, High-Strength Low-Alloy Steel, High-Strength Low-Alloy Steel with Improved Formability, and Ultra-High Strength Steel.

1.3 This material is available only in coils described as follows:

Product	Width, in. [mm]	Size Limits, Coils Only	Thickness, in. [mm]
Strip	Over 8 to 12, incl [Over 200 to 300]		0.230 to 1.000, incl [From 6.0 through 25]
Sheet	Over 12 [Over 300]		0.230 to 1.000, incl [From 6.0 through 25]

NOTE 1—The changes in width limits with the publication of **A635/A635M – 06a** result in a change in tensile testing direction for material from 0.180 in. [4.5 mm] to 0.230 in. exclusive [6.0 mm exclusive] over 48 in. [1200 mm] wide as that material is now covered by Specification **A568/A568M – 06a**.

The purchaser is advised to discuss this change with the supplier.

1.4 Sheet and strip in coils of sizes noted in 1.3 are covered by this specification only with the following provisions:

1.4.1 The material is to be fed directly from coils into a blanking press, drawing or forming operation, tube mill, rolling mill, or sheared or slit into blanks for subsequent drawing or forming.

1.4.2 The material is not to be converted into steel plates for structural or pressure vessel use unless tested in complete accordance with the appropriate sections of Specifications **A6/A6M** (plates provided from coils) or **A20/A20M** (plates produced from coils). Plate converted from coils is no longer governed by this sheet steel specification and since this material is now a plate, the requirements of the appropriate plate specification shall apply, except in cases where there is a conflict between the requirements of the plate specification and this specification. In these cases, the more restrictive limits of either specification shall apply.

¹ 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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*A Summary of Changes section appears at the end of this standard

1.4.3 The dimensional tolerances of Specification **A635/A635M** are applicable to material produced to this specification.

1.4.4 Not all strength levels are available in all thicknesses. The user should consult the producer for appropriate size limitations.

1.5 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.

1.6 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.7 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:²

A6/A6M Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

A20/A20M Specification for General Requirements for Steel Plates for Pressure Vessels

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

A572/A572M Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

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

A751 Test Methods and Practices for Chemical Analysis of Steel Products

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

A1011/A1011M 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

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

G101 Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels

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

3.2.1.1 *Discussion*—

Inclusions, especially those elongated during the rolling process, create the conditions for initiating or propagating cracks, or both, when the material is stretched or bent during the manufacture of a part. 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.

4. General Requirements for Delivery

4.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification **A635/A635M**, unless otherwise provided herein.

5. Classification

5.1 Heavy thickness coils are available in the following designations:

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.

5.1.1 *Commercial Steel (CS Types A, B, and C):*

5.1.1.1 *Commercial Steel*, CS Types A and B combined with chemistry grade in accordance with Specification **A635/A635M** Table X1.3. (CS Type A-1006, CS Type A-1008, and so forth).

5.1.1.2 *Commercial Steel Designations*, in accordance with Specification **A635/A635M** Table X1.1, with no type specified, (CS-1005, CS-1006, CS-1020, and so forth).

5.1.2 *Drawing Steel (DS Types A and B):*

5.1.2.1 *Drawing Steel*, DS Types A and B combined with chemistry grade per Specification **A635/A635M** Table X1.3. (DS Type A-1005, DS Type B-1006, and so forth.)

5.1.3 *Structural Steel*—(SS Grades 30[205], 33[230], 36[250] Types 1 and 2, ~~40[275] and 45[310]~~40[275], 45[310], 50 [340], and 55 [380]).

5.1.4 *High-Strength Low-Alloy Steel*—(HSLAS Grades 45[310], 50[340], 55[380], 60[410], 65[450], 70[480]) in Classes 1 and 2.

5.1.4.1 This material is intended for miscellaneous applications where greater strength and savings in weight are important. The material is available in two classes. They are similar in strength level, except that Class 2 offers improved weldability and more formability than Class 1. Atmospheric corrosion resistance of these steels is equivalent to plain carbon steels. With copper specified, the atmospheric corrosion is somewhat enhanced.

5.1.5 *High-Strength Low-Alloy Steel with Improved Formability*—(HSLAS-F Grades 50[340], 60[410], 70[480], 80[550]).

5.1.5.1 This material has improved formability when compared with HSLAS. The steel is killed and made to a fine ferritic grain practice and includes microalloying elements such as columbium, titanium, vanadium, zirconium, 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, improved formability, 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.

NOTE 2—For methods of establishing the atmospheric corrosion resistance of low-alloy steels, see Guide **G101**.

5.1.6 *Ultra-High Strength Steel*—(UHSS Grades 90 [620] and 100 [690], Types 1 and 2).

5.1.6.1 This material 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.

5.1.7 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.

5.2 The limits for copper, chromium, nickel, and molybdenum are available in two levels, Limits A and Limits B (see **Table 1**).

6. Ordering Information

6.1 Orders for material under this specification shall include the following information, as required, to describe adequately the desired material.

6.1.1 ASTM specification number and year of issue.

6.1.2 Name of material and designation (hot-rolled steel sheet or hot-rolled strip) (include grade and, as appropriate, type and class for CS, DS, SS, HSLAS, HSLAS-F, and UHSS) (see **5.1**).

6.1.2.1 For CS and DS, when a type is not specified, Type B will be furnished.

TABLE 1 Chemical Requirements: Cu, Ni, Cr and Mo for Commercial Steels, Structural Steels, High-Strength Low-Alloy Steels, and High-Strength Low-Alloy Steels with Improved Formability

Designation	Limits	% Heat Analysis, Element Maximum Unless Otherwise Shown			
		Cu ^{A,B}	Ni ^B	Cr ^{B,C}	Mo ^{B,C}
CS:					
Grades 1002–1095, 1515–1566	A	0.20	0.20	0.15	0.06
	B	0.40	0.40	0.30	0.12
SS:					
All grades	A	0.20	0.20	0.15	0.06
	B	0.40	0.40	0.30	0.12
HSLAS:					
All grades and classes except for Grade 70 [480]	A	0.20	0.20	0.15	0.06
	B	0.40	0.40	0.30	0.12
Grade 70 [480] Class 1 and Class 2	A	0.20	0.20	0.15	0.16
	B	0.40	0.40	0.30	0.16
HSLAS-F:					
Grades 50 [340] and 60 [410]	A	0.20	0.20	0.15	0.06
	B	0.40	0.40	0.30	0.12
Grade 70 [480] and 80 [550]	A	0.20	0.20	0.15	0.16
	B	0.40	0.40	0.30	0.16

^A When copper bearing steel is specified, the minimum limit for copper is 0.20 %. When copper bearing steel is not specified, the maximum limit for copper is as shown in the table.

^B For Limits B steels, 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 by the purchaser, the sum does not apply; in which case, only the individual limits on the remaining elements shall apply.

^C For Limits B steels, 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 elements shall apply.

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(1) When a chemistry grade is specified in accordance with Specification **A635/A635M** Table X1.3, the grade shall be furnished as CS Type B-1008, DS Type A-1005, and so forth.

(2) When only a Steel Designation is specified in accordance with Specification **A635/A635M** Table X1.1, with no reference to CS Type A, CS Type B, DS Type A or DS Type B, the grade shall be furnished as CS-1005, CS-1008, CS-1020, and so forth.

6.1.2.2 For SS Grade 36, when a type is not specified, Type 1 will be furnished (see 5.1).

6.1.2.3 For UHSS, when a type is not specified, Type 1 shall be furnished.

6.1.2.4 For HSLAS, when a class is not specified, Class 1 will be furnished (see 5.1),

6.1.3 Copper bearing, (if required),

6.1.4 For SS, HSLAS, and HSLAS-F and selected CS steels, specify the limits for chemical requirements listed in **Table 1** (elements Cu, Cr, Ni, and Mo). When Limits A or Limits B is not specified, Limits A shall be furnished.

6.1.5 *Condition*—Material in accordance with this specification is furnished in the hot rolled condition. Pickled (or blast cleaned) must be specified if required. Material ordered as pickled (or blast cleaned) will be oiled unless ordered dry,

6.1.6 Type of edge must be specified for hot rolled sheet coils and strip coils, either mill edge or cut edge (sheet), mill edge or slit edge (strip),

6.1.7 Dimensions (decimal thickness and width of material),

NOTE 3—Not all producers are capable of meeting all the limitations of the thickness tolerance tables in Specification **A635/A635M**. The purchaser should contact the producer regarding possible limitations prior to placing an order.

6.1.8 Coils size and weight requirements (must include inside diameter (ID), outside diameter (OD), and maximum weight),

6.1.9 Quantity (weight),

6.1.10 Application (part identification and description). Orders for conversion to plate shall include reference to the applicable ASTM plate specification.

6.1.11 A report is required of heat analysis and mechanical properties as determined by the tension test, and

6.1.12 Special requirements (if any).

6.1.12.1 When the purchaser requires a limit on “carbon equivalent” (see Supplementary Requirement S1), this requirement shall be specified in the purchase order or contract.

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

NOTE 4—A typical ordering description is as follows: (inch pound units) ASTM A1018/A1018M: Grade 50, High-Strength, Low-Alloy Steel, Class 2, Limits B, hot rolled sheet coils, pickled and oiled, cut edge, 0.500 by 40 in. by coil; ID 24 in., OD 72 in., maximum; coil weight 40 000 lb, maximum;

**TABLE 2 Chemical Requirements
Commercial and Drawing Steels^A**

Designation	% Heat Analysis, Element Maximum Unless Otherwise Shown														
	C	Mn	P	S	Al	Si	Cu	Ni	Cr	Mo	V	Nb ^B	Ti ^C	N	B
CS Type A ^{D,E,F}	0.10	0.60	0.030	0.035	^G	^G	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	^G	^G
CS Type B	0.02 to 0.15	0.60	0.030	0.035	^G	^G	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025	^G	^G
CS Type C ^{D,E,F}	0.08	0.60	0.10	0.035	0.20 ^H	0.20	0.15	0.06	0.008	0.008	0.025
DS Type A ^{D,F}	0.08	0.50	0.020	0.030	0.01 min	^G	0.20	0.20	0.15	0.06	0.008	0.008	0.025	^G	^G
DS Type B	0.02 to 0.08	0.50	0.020	0.030	0.01 min	^G	0.20	0.20	0.15	0.06	0.008	0.008	0.025	^G	^G

^A For additional chemistry grades/designations, refer to Specification **A635/A635M** Appendix X1, Tables X1.1 and X1.3.

^B The names Columbium (Cb) and Niobium (Nb) for Periodic Table Element 41 are considered interchangeable within A01 Product specifications.

^C Titanium is permitted at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.

^D 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.

^E When an aluminum deoxidized steel is required, it is permissible to order a minimum of 0.01 % total aluminum.

^F It is permissible to furnish as a vacuum degassed or chemically stabilized steel, or both, at producer's option.

^G There is no specified limit, but the analysis shall be reported.

^H 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.

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200 000 lb for roll forming shapes; (SI units) ASTM A1018/A1018M: Grade 340, High-Strength Low-Alloy Steel, Class 2, Limits B, hot-rolled sheet coils, pickled and oiled, cut edge; 10 by 900 mm by coil; ID 600 mm, OD 1800 mm, maximum; coil weight 18 000 kg maximum; 90 000 kg for roll forming shapes. For conversion to plate: (inch-pound units) ASTM A1018/A1018M: Grade 50, High-Strength Low-Alloy Steel, Class 1, Limits A, hot-rolled sheet coils, as rolled, mill edge, 0.500 by 50 in. by coil, ID 24 in., OD 72 in., maximum; coil weight 40 000 lb, maximum; 200 000 lb for conversion to plate, Specification **A572/A572M** Grade 50; (SI units) ASTM A1018/A1018M: Grade 340, Structural Steel, hot-rolled sheet coils, as rolled, mill edge; 10 by 1000 mm by coil; ID 600 mm, OD 1800 mm, maximum; coil weight 18 000 kg maximum; 100 000 kg for conversion to plate, Specification **A572/A572M** Grade 340.

7. Chemical Composition

7.1 The heat analysis of commercial steel and drawing steel shall conform to the requirements of **Table 2**, and where appropriate, Specification **A635/A635M** Table X1.1 and X1.3.

7.2 The heat analysis of structural steel, high-strength low-alloy steel, high-strength low-alloy steel with improved formability, and ultra-high strength steel shall conform to the requirements of **Tables 2 and 3**.

7.3 **Table 1** describes the heat analysis requirements for two sets of limits (A and B) for the elements copper, chromium, nickel, and molybdenum. The required set of limits (A and B) for these elements shall be specified on the order.

7.4 Chemical analysis shall be conducted in accordance with Test Methods, Practices, and Terminology **A751**.

7.5 Each of the elements listed in **Tables 2 and 4** shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium, or molybdenum is less than 0.02 %, report the analysis as <0.02 % or the actual value. When the amount of

**TABLE 4 Chemical Requirements
Ultra-High Strength Steels**

Designation	% Heat Analysis, Element Maximum Unless Otherwise Shown											
	C	Mn	P	S	Cu ^A	Ni	Cr	Mo	V ^B	Nb ^B	Ti ^B	N
UHSS												
Grade 90 [620] Type 1	0.15	2.00	0.020	0.025	0.20	0.20	0.15	0.40	0.005 min	0.005 min	0.005 min	C
Grade 90 [620] Type 2	0.15	2.00	0.020	0.025	0.60	0.50	0.30	0.40	0.005 min	0.005 min	0.005 min	C
Grade 100 [690] Type 1	0.15	2.00	0.020	0.025	0.20	0.20	0.15	0.40	0.005 min	0.005 min	0.005 min	C
Grade 100 [690] Type 2	0.15	2.00	0.020	0.025	0.60	0.50	0.30	0.40	0.005 min	0.005 min	0.005 min	C

^A When copper steel is specified, a minimum of 0.20 % is required. When copper steel is not specified, the copper limit is a maximum requirement.
^B UHSS steels contain the strengthening elements columbium (niobium), vanadium, and titanium added singly or in combination. The minimum requirements only apply to the microalloy elements selected for strengthening of the steel. The names Columbium (Cb) and Niobium (Nb) for Periodic Table Element 41 are considered interchangeable within A01 Product specifications.
^C The purchaser has the option of restricting the nitrogen content. It should be noted that, depending on the microalloying scheme (for example, use of vanadium) of the producer, nitrogen may be a deliberate addition. Consideration should be made for the use of nitrogen binding elements (for example, vanadium, titanium).

**TABLE 3 Chemical Requirements
Structural Steels, High-Strength Low-Alloy Steels, and High-Strength Low-Alloy Steels with Improved Formability**

Designation	% Heat Analysis, Element Maximum Unless Otherwise Shown										
	C	Mn	P	S	Al	Si	V	Nb ^A	Ti	N	
SS^B											
Grade 30 [205]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 33 [230]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 36 [250] Type 1	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 36 [250] Type 2	0.25	<u>1.50</u>	<u>0.035</u>	<u>0.04</u>	<u>C</u>	<u>C</u>	<u>0.008</u>	<u>0.008</u>	<u>0.025</u>	<u>0.014</u>	
Grade 36 [250] Type 2	0.25	<u>D</u>	<u>0.035</u>	<u>0.04</u>	<u>C</u>	<u>C</u>	<u>0.008</u>	<u>0.008</u>	<u>0.025</u>	<u>0.014</u>	
Grade 40 [275]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 45 [310]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 50 [340]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
Grade 55 [380]	0.25	1.50	0.035	0.04	C	C	0.008	0.008	0.025	0.014	
HSLAS^E											
Grade 45 [310] Class 1	0.22	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	C	
Grade 45 [310] Class 2	0.15	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 50 [340] Class 1	0.23	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	C	
Grade 50 [340] Class 2	0.15	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 55 [380] Class 1	0.25	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	C	
Grade 55 [380] Class 2	0.15	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 60 [410] Class 1	0.26	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	C	
Grade 60 [410] Class 2	0.15	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 65 [450] Class 1	0.26	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 65 [450] Class 2	0.15	1.50	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 70 [480] Class 1	0.26	1.65	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 70 [480] Class 2	0.15	1.65	0.04	0.04	C	C	0.005 min	0.005 min	0.005 min	F	
HSLAS-F^E											
Grade 50 [340]	0.15	1.65	0.025	0.035	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 60 [410]	0.15	1.65	0.025	0.035	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 70 [480]	0.15	1.65	0.025	0.035	C	C	0.005 min	0.005 min	0.005 min	F	
Grade 80 [550] ^D	0.15	1.65	0.025	0.035	C	C	0.005 min	0.005 min	0.005 min	F	

^A The names Columbium (Cb) and Niobium (Nb) for Periodic Table Element 41 are considered interchangeable within A01 Product specifications.
^B Titanium is permitted for SS designations, at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.
^C There is no specified limit, but the analysis shall be reported. See Table 1 for requirements for Cu, Ni, Cr, and Mo.
^D For SS Grade 36 Type 2 greater than 0.75 in. [20 mm] in thickness, the manganese requirement is 0.80 to 1.20 %. 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 1.35 % for SS Grade 36 Type 2 and to a maximum of 1.90 % for HSLAS-F Grade 80.
^E HSLAS and HSLAS-F steels contain the strengthening elements columbium, vanadium, and titanium added singly or in combination. The minimum requirements only apply to the microalloy elements selected for strengthening of the steel.
^F The purchaser has the option of restricting the nitrogen content. It should be noted that, depending on the microalloying scheme (for example, use of vanadium) of the producer, nitrogen may be a deliberate addition. Consideration should be made for the use of nitrogen binding elements (for example, vanadium, titanium).

columbium, titanium, or vanadium is less than 0.008 %, report the analysis as <0.008 % or the actual determined value. When the amount of boron is less than 0.0005 %, report the analysis as <0.0005 % or the actual determined value.

7.6 For Structural Steel (SS) the addition of microalloying elements, including columbium, vanadium, or titanium, as well as nitrogen, as strength enhancers is prohibited.

7.7 Sheet steel grades defined by this specification are suitable for welding if appropriate welding conditions are selected. For certain welding processes, more restrictive composition limits may be desirable and should be requested at the time of inquiry and ordering.

8. Mechanical Properties

8.1 Test specimen preparation and mechanical testing shall be in accordance with Test Methods and Definitions **A370**.

8.2 *Tensile Properties*—The material, structural steel, high-strength low-alloy steel, high-strength low-alloy steel with improved formability, and ultra-high strength steel, as represented by the test specimens shall conform to the mechanical property requirements as stated in **Table 5**. These requirements do not apply to the uncropped ends of unprocessed coils.

8.3 *Tension Test Specimen Location and Orientation*—Tension test specimens shall be taken sufficiently far from the as hot-rolled coil ends so that the sample is representative of material which received the designed processing. The test shall be taken approximately midway between the center and edge of the material as rolled. For coils wider than 24 in. [600 mm], Tension test specimens shall be taken such that the longitudinal axis of the specimens is perpendicular to the direction of rolling (transverse test). For coils through 24 in. [600 mm] in width, tension test specimens shall be taken such that longitudinal axis of the specimen is parallel to the direction of rolling (longitudinal test).

8.4 *Tension Tests*—Two tension tests shall be conducted from each heat or each of 50 tons [45 Mg]. When the amount of finished material from a heat is less than 50 tons [45 Mg], only one tension test shall be conducted. When material rolled from one heat differs 0.050 in. [1.3 mm] or more in thickness, one tension test shall be conducted from both the thickest and the thinnest material rolled regardless of the weight represented.

TABLE 5 Mechanical Property Requirements^A for Hot Rolled Heavy Thickness Coils

Designation	Designations SS, HSLAS, and HSLAS-F			
	Yield Strength min ksi [MPa]	Tensile Strength min ^B ksi [MPa]	Elongation in 2 in. [50 mm], min, %	Elongation in 8 in. [200 mm], min, %
SS				
Grade 30 [205]	30 [205]	49 [340]	22	17
Grade 33 [230]	33 [230]	52 [360]	22	16
Grade 36 [250] Type 1	36 [250]	53 [365]	21	15
Grade 36 [250] Type 2	36 [250]	58 to 80 [400 to 550]	21	18
Grade 40 [275]	40 [275]	55 [380]	19	14
Grade 45 [310]	45 [310]	60 [410]	18	13
Grade 45 [310]	45 [310]	60 [410]	18	13
Grade 50 [340]	50 [340]	65 [450]	17	12
Grade 55 [380]	55 [380]	70 [480]	15	10
HSLAS				
Grade 45 [310] Class 1	45 [310]	60 [410]	22	17
Grade 45 [310] Class 2	45 [310]	55 [380]	22	17
Grade 50 [340] Class 1	50 [340]	65 [450]	20	16
Grade 50 [340] Class 2	50 [340]	60 [410]	20	16
Grade 55 [380] Class 1	55 [380]	70 [480]	18	15
Grade 55 [380] Class 2	55 [380]	65 [450]	18	15
Grade 60 [410] Class 1	60 [410]	75 [520]	16	14
Grade 60 [410] Class 2	60 [410]	70 [480]	16	14
Grade 65 [450] Class 1	65 [450]	80 [550]	14	12
Grade 65 [450] Class 2	65 [450]	75 [520]	14	12
Grade 70 [480] Class 1	70 [480]	85 [590]	12	10
Grade 70 [480] Class 2	70 [480]	80 [550]	12	10
HSLAS-F				
Grade 50 [340]	50 [340]	60 [410]	22	16
Grade 60 [410]	60 [410]	70 [480]	16	14
Grade 70 [480]	70 [480]	80 [550]	12	10
Grade 80 [550]	80 [550]	90 [620]	12	10
UHSS				
Grade 90 [620] Types 1 and 2	90 [620]	100 [690]	10	8
Grade 100 [690] Types 1 and 2	100 [690]	110 [760]	10	8

^A For coil products, testing by the producer is limited to the end of the coil. Mechanical properties throughout the coil shall comply with the minimum values specified.

^B A minimum and maximum tensile strength are specified for SS Grade 36 Type 2.