Designation: A1008/A1008M – 21

Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable[1]

This standard is issued under the fixed designation A1008/A1008M; 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.

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

1. Scope*

1.1 This specification covers cold-rolled, carbon, structural, high-strength low-alloy, high-strength low-alloy with improved formability, required hardness, full hard, solution hardened, and bake hardenable steel sheet, in coils and cut lengths.

1.2 Cold rolled steel sheet is available in the designations as listed in 4.1.

1.3 This specification does not apply to steel strip as described in Specification A109/A109M.

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:*[2]

A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled

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

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

A1092 Specification for Steel Sheet, as Cold-Reduced, for Conversion to Annealed Cold-Rolled Steel Sheet, and Hot Dip Metallic-Coated Steel Sheet

E18 Test Methods for Rockwell Hardness of Metallic Materials

E517 Test Method for Plastic Strain Ratio ***r*** for Sheet Metal

E646 Test Method for Tensile Strain-Hardening Exponents (***n*** -Values) of Metallic Sheet Materials

3. Terminology

3.1 *Definitions:*

3.1.1 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 that has been slightly cold worked (such as by temper rolling) is stored for some time.

3.2.1.1 *Discussion*—Aging increases the tendency of a steel to exhibit stretcher strains and fluting.

3.2.2 *Bake Hardenable Steel (BHS), n*—steel in which significant aging is realized when moderate heat treatment, such as that used for paint baking, follows straining or cold working.

3.2.3 *Full Hard Steel (FHS), n*—steel that is cold reduced and exhibits a microstructure consisting of non-recrystallized grains.

3.2.3.1 *Discussion*—Chemical composition shall be determined by the producer unless there is prior agreement between producer and user, or seller and buyer.

[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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[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.

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

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

3.2.4.1 *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, or both, 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.

3.2.5 *Required Hardness Steel (RHS), n*—steel that adheres to a specified hardness range, at the time of shipment; may also be referenced as Specified Hardness Steel.

3.2.5.1 *Discussion*—Chemical composition shall be determined by the producer unless there is prior agreement between producer and user, or seller and buyer.

3.2.6 *Solid-solution Hardened Steel or Solution Hardened Steel (SHS), n*—steel strengthened through additions of elements, such as Mn, P, or Si, that can be dissolved within the crystalline structure of steels.

3.2.6.1 *Discussion*—Alloying elements that form a solid-solution with iron provide strengthening as a result of local distortions in atomic arrangements, which arise as a result of the mismatch between the atomic sizes of such elements and that of iron.

3.2.7 *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.

3.2.7.1 *Discussion*—Steel grades such as CS – 1010 or CS – 1020 for example, adhere 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.

3.2.8 *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 of carbon and nitrogen in the steel.

3.2.8.1 *Discussion*—Stabilizing improves formability and increases resistance to aging.

3.2.9 *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.

4. Classification

4.1 Cold-rolled steel sheet is available in the following designations:

4.1.1 Commercial Steel (CS Types A, B, and C).

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 Type 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 and 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 % and Mn 0.50–0.80 %).

4.1.7 Deep Drawing Steel (DDS).

4.1.8 Extra Deep Drawing Steel (EDDS).

4.1.9 Structural Steel (SS Grades 25 [170], 30 [205], 33 [230] Types 1 and 2, 40 [275] Types 1 and 2, 45 [310], 50 [340], 60 [410], 70 [480], and 80 [550]).

TABLE 1 Chemical Composition for Cold Rolled Steel Sheet Designations CS, DS, DDS, EDDS, and SFS

	% Heat Analysis, Element Maximum Unless Otherwise Shown														
Designation	C	Mn	P	S	Al	Si	Cu	Ni	Cr[A]	Mo	V	Cb/Nb[B]	Ti[C]	N	B
CS Type A[D,E,F,G]	0.10	0.60	0.025	0.035	H	H	0.20[I]	0.20	0.15	0.06	0.008	0.008	0.025	H	H
CS Type B[D]	0.02–0.15	0.60	0.025	0.035	H	H	0.20[I]	0.20	0.15	0.06	0.008	0.008	0.025	H	H
CS Type C[D,E,F,G]	0.08	0.60	0.10	0.035	H	H	0.20[I]	0.20	0.15	0.06	0.008	0.008	0.025	H	H
DS Type A[E,J]	0.08	0.50	0.020	0.020	0.01 min	H	0.20	0.20	0.15	0.06	0.008	0.008	0.025	H	H
DS Type B	0.02–0.08	0.50	0.020	0.020	0.02 min	H	0.20	0.20	0.15	0.06	0.008	0.008	0.025	H	H
DDS[F,G]	0.06	0.50	0.020	0.020	0.01 min	H	0.20	0.20	0.15	0.06	0.008	0.008	0.025	H	H
EDDS[K]	0.02	0.40	0.020	0.020	0.01 min	H	0.10	0.10	0.15	0.03	0.10	0.10	0.15	H	H
SFS	L	L	0.020	0.020	0.01 min	H	0.20	0.20	0.15	0.06	0.008	0.008	0.025	H	H

[A] Chromium is permitted, at the producer's option, to 0.25 % maximum when the carbon content is less than or equal to 0.05 %.
[B] Columbium (Cb) and niobium (Nb) are considered interchangeable names for Element 41 in the periodic table and both names are acceptable for use.
[C] For steels containing 0.02 % or more carbon, titanium is permitted at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.
[D] When an aluminum deoxidized steel is required for the application, it is permissible to order Commercial Steel (CS) to a minimum of 0.01 % total aluminum.
[E] Specify Type B to avoid carbon levels below 0.02 %.
[F] It is permissible to furnish as a vacuum degassed or chemically stabilized steel, or both, at the producer's option.
[G] For carbon levels less than or equal to 0.02 %, it is permissible to use vanadium, columbium or titanium, or a combination thereof, as stabilizing elements at the producer's option. In such cases, the applicable limit for vanadium or columbium shall be 0.10 % max. and the limit on titanium shall be 0.15 % max.
[H] There is no specified limit, but the analysis shall be reported.
[I] 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.
[J] If produced utilizing a continuous anneal process, stabilized steel is permissible at the producer's option, and Footnotes F and G apply.
[K] Shall be furnished as a vacuum degassed and stabilized steel.
[L] Carbon and manganese chemistry limits shall be specified in accordance with Specification A568/A568M Tables X2.1 or X2.2.

4.1.10 High-strength Low-alloy Steel (HSLAS, in Classes 1 and 2, in Grades 45 [310], 50 [340], 55 [380], 60 [410], 65 [450], and 70 [480] in Classes 1 and 2), and

4.1.11 High-strength Low-alloy Steel with Improved Formability (HSLAS-F Grades 50 [340], 60 [410], 70 [480], and 80 [550]).

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

4.1.12 Solution Hardened Steel (SHS).

4.1.13 Bake Hardenable Steel (BHS).

4.1.14 Required Hardness Steel (RHS).

4.1.15 Full Hard Steel (FHS).

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

4.3 Cold-rolled steel sheet is supplied for either exposed or unexposed applications. Within the latter category, cold-rolled sheet is specified either "temper rolled" or "annealed last" or "full hard." For details on processing, attributes and limitations, and inspection standards, refer to Specification A568/A568M.

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:

5.1.1 ASTM specification number and year of issue.

5.1.2 Name of material and designation (cold-rolled steel sheet) (include grade, type, and class, as appropriate, for CS, DS, DDS, EDDS, SFS, SS, HSLAS, HSLAS-F, RHS, FHS, SHS, or BHS) (see 4.1).

5.1.2.1 When a Chemistry grade is specified in accordance with Specification A568/A568M Table X2.3, the grade shall be furnished as CS Type B – 1008, DS Type A – 1005, and so forth.

5.1.2.2 When a Chemistry grade is specified in accordance with Specification A568/A568M Table X2.1, with no reference to CS Type A, CS Type B, DS Type A, DS Type B, or SFS, the grade shall be furnished as CS – 1005, CS – 1008, CS – 1020, and so forth, and meet chemistry specified in accordance with Specification A568/A568M Table X2.1.

5.1.2.3 When a type is not specified for CS or DS and there is no reference to a chemistry grade such as 1005, 1006, and so forth, Type B will be furnished (see 4.1).

5.1.2.4 When SFS is specified, a chemistry grade designation shall also be specified in accordance with Specification A568/A568M Table X2.1 (that is, 1010, 1020, and so forth), or carbon and manganese in accordance with Specification A568/A568M Table X2.2 (that is, C 0.12–0.18 %, Mn 0.50–0.80 %, and so forth). The characteristics identifying the enhanced formability or mechanical properties shall be specified by the user or purchaser, on the purchase order. If requested, the producer or seller shall provide verification of special practices or mechanical properties supporting enhanced formability.

5.1.2.5 When a class is not specified for HSLAS, Class 1 will be furnished (see 4.1).

5.1.2.6 When a type is not specified for SS 33 [230] and SS 40 [275], Type 1 will be furnished (see 4.1).

5.1.3 Classification (either exposed, unexposed, temper rolled, or annealed last) (see 4.3).

5.1.4 Finish (see 9.1).

5.1.5 Oiled or not oiled, as required (see 9.2).

5.1.6 Dimensions (thickness, width, and whether cut lengths or coils).

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

5.1.7 Coil size (must include inside diameter, outside diameter, and maximum weight).

5.1.8 Copper bearing steel (if required).

5.1.9 Quantity.

5.1.10 Application (part identification and description).

5.1.11 A report of heat analysis will be supplied, if requested, for CS, DS, DDS, EDDS, SFS, RHS, and FHS. For materials with required mechanical properties, SS, HSLAS, HSLAS-F, SHS, and BHS, a report is required of heat analysis and mechanical properties as determined by the tension test.

5.1.12 Special requirements (if any).

5.1.12.1 When the purchaser requires thickness tolerances for ⅜ in. [10 mm] minimum edge distance (see Supplementary Requirement in Specification A568/A568M), this requirement shall be specified in the purchase order or contract.

5.1.12.2 Tighter requirements can be specified based on agreement between seller and purchaser.

NOTE 2—A typical ordering description is as follows:

ASTM A1008-XX, cold rolled steel sheet, CS Type A, exposed, matte finish, oiled, 0.035 by 30 in. by coil, ID 24 in., OD 48 in., max weight 15 000 lbs, 100 000 lb, for part No. 4560, Door Panel; or

ASTM A 1008M-XX, cold-rolled steel sheet, SS Grade 275, unexposed, matte finish, oiled, 0.88 by 760 by 2440 mm, 10 000 kg, for shelf bracket.

6. General Requirements for Delivery

6.1 Material furnished under this specification shall conform to the applicable requirements of the current edition of Specification A568/A568M unless otherwise provided herein.

7. Chemical Composition

7.1 The heat analysis of the steel shall conform to the chemical composition requirements of the appropriate designation shown in Table 1 for CS, DS, DDS, EDDS, and SFS, and in Table 2 for SS, HSLAS, HSLAS-F, SHS, and BHS.

7.2 Each of the elements listed in Tables 1 and 2, and Specification A568/A568M Table X2.3 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 determined value. When the amount of vanadium, columbium, or titanium 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.

TABLE 2 Chemical Composition for Cold Rolled Steel Sheet Designations SS, HSLAS, HSLAS-F, SHS, and BHS

	% Heat Analysis, Element Maximum Unless Otherwise Shown													
Designation	C	Mn	P	S	Al	Si	Cu[A]	Ni	Cr	Mo	V	Cb/Nb[B]	Ti	N
SS:[C]														
Grade 25 [170]	0.20	0.60	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 30 [205]	0.20	0.60	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 33 [230] Type 1	0.20	0.60	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 33 [230] Type 2	0.15	0.60	0.20	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 40 [275] Type 1	0.20	1.35	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 40 [275] Type 2	0.15	0.60	0.20	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 45 [310]	0.20	1.35	0.070	0.025	0.08	0.60	0.20	0.20	0.15	0.06	0.008	0.008	0.008	0.030
Grade 50 [340]	0.20	1.35	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 60 [410]	0.20	1.35	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 70 [480]	0.20	1.35	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
Grade 80 [550]	0.20	1.35	0.035	0.035	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[D]
HSLAS:[E]														
Grade 45 [310] Class 1	0.22	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 45 [310] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 50 [340] Class 1	0.23	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 50 [340] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 55 [380] Class 1	0.25	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 55 [380] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 60 [410] Class 1	0.26	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 60 [410] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[D]
Grade 65 [450] Class 1	0.26	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[F]
Grade 65 [450] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[F]
Grade 70 [480] Class 1	0.26	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.16	0.005 min	0.005 min	0.005 min	[F]
Grade 70 [480] Class 2	0.15	1.65	0.04	0.04	[D]	[D]	0.20	0.20	0.15	0.16	0.005 min	0.005 min	0.005 min	[F]
HSLAS-F:[E]														
Grade 50 [340] and 60 [410]	0.15	1.65	0.020	0.025	[D]	[D]	0.20	0.20	0.15	0.06	0.005 min	0.005 min	0.005 min	[F]
Grade 70 [480] and 80 [550]	0.15	1.65	0.020	0.025	[D]	[D]	0.20	0.20	0.15	0.16	0.005 min	0.005 min	0.005 min	[F]
SHS[G]	0.12	1.50	0.12	0.030	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.008	[D]
BHS[G]	0.12	1.50	0.12	0.030	[D]	[D]	0.20	0.20	0.15	0.06	0.008	0.008	0.008	[D]

[A] When copper is specified, the copper limit is a minimum requirement. When copper steel is not specified, the copper limit is a maximum requirement.
[B] Columbium (Cb) and niobium (Nb) are considered interchangeable names for Element 41 in the periodic table and both names are acceptable for use.
[C] Titanium is permitted for SS designations, at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.
[D] There is no specified limit, but the analysis shall be reported.
[E] HSLAS and HSLAS-F steels contain 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.
[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).
[G] For carbon levels less than or equal to 0.02 % vanadium, columbium, or titanium, or a combination thereof, are permitted to be used as stabilizing elements at the producer's option. In such cases, the applicable limit for vanadium and columbium shall be 0.10 % max., and the limit for titanium shall be 0.15 % max.

7.3 Sheet steel grades defined by this specification are suitable for welding if appropriate welding conditions are selected. For certain welding processes, if more restrictive composition limits are desirable, they shall be specified at the time of inquiry and confirmed at the time of ordering.

8. Mechanical Properties

8.1 *CS, DS, DDS, and EDDS:*

8.1.1 Typical nonmandatory mechanical properties for CS, DS, DDS, EDDS, and Specification A568/A568M Table X2.3 are shown in Table 3.

8.1.2 The material represented by all grades specified in Table 1 and Specification A568/A568M Table X2.3 shall be capable of being bent, at room temperature, in any direction through 180° flat on itself without cracking on the outside of the bent portion (see Section 14 of Test Methods and Definitions A370). The bend test is not a requirement of delivery. However, if testing is performed by the purchaser, material not conforming to the requirement shall be subject to rejection.

8.1.3 Sheet of these designations except for EDDS are subject to aging dependent upon processing factors such as the method of annealing (continuous annealing or box annealing), and chemical composition. For additional information on aging, see Appendix X1 of Specification A568/A568M.

8.1.4 EDDS steel is stabilized to be nonaging and so is not subject to stretcher strains and fluting. Other steels are processed to be nonaging; please consult your supplier.

8.2 *SS, HSLAS, HSLAS-F, SHS, and BHS:*

8.2.1 The available strength grades for SS, HSLAS and HSLAS-F are shown in Table 4.

8.2.2 The available strength grades for SHS and BHS are shown in Table 5.

8.2.3 *Tension Tests:*

8.2.3.1 *Requirements*—Material as represented by the test specimen shall conform to the mechanical property requirements specified in Table 4. These requirements do not apply to the uncropped ends of unprocessed coils.

TABLE 3 Typical Ranges of Mechanical Properties[A] (Nonmandatory)[B] for Cold Rolled Steel Sheet Designations CS, DS, DDS, and EDDS (Includes Grades in Accordance With Specification A568/A568M Table X2.3)

Designation	Yield Strength[C]		Elongation in 2 in. [50 mm] %[C]	r_m Value[D]	n-Value[E]
	ksi	MPa			
CS Types A, B, and C	20–40	[140–275]	≥30	[F]	[F]
DS Types A and B	22–35	[150–240]	≥36	1.3–1.7	0.17–0.22
DDS	17–29	[115–200]	≥38	1.4–1.8	0.20–0.25
EDDS	15–25	[105–170]	≥40	1.7–2.1	0.23–0.27

[A] These typical mechanical properties apply to the full range of steel sheet thicknesses. The yield strength tends to increase, the elongation decreases and some of the formability values tend to decrease as the sheet thickness decreases.
[B] The typical mechanical property values presented here are nonmandatory. They are provided to assist the purchaser in specifying a suitable steel for a given application. Values outside of these ranges are to be expected.
[C] Yield Strength and elongation are measured in the longitudinal direction in accordance with Test Methods and Definitions A370.
[D] Average plastic strain ratio (r_m value) as determined by Test Method E517.
[E] The strain hardening exponent (n-value) as determined by Test Method E646.
[F] No typical properties have been established.

TABLE 4 Mechanical Property Requirements[A] for Cold Rolled Steel Sheet Designations SS, HSLAS, and HSLAS-F

Designation	Yield Strength, min		Tensile Strength, min		Elongation in 2 in. or 50 mm, min, %
	ksi	[MPa]	ksi	[MPa]	
SS:					
Grade 25 [170]	25	[170]	42	[290]	26
Grade 30 [205]	30	[205]	45	[310]	24
Grade 33 [230] Types 1 and 2	33	[230]	48	[330]	22
Grade 40 [275] Types 1 and 2	40	[275]	52	[360]	20
Grade 45 [310]	45	[310]	60	[410]	20
Grade 50 [340]	50	[340]	65	[450]	18
Grade 60 [410]	60	[410]	75	[520]	12
Grade 70 [480]	70	[480]	85	[585]	6
Grade 80 [550]	80[B]	[550]	82	[565]	[C]
HSLAS:					
Grade 45 [310] Class 1	45	[310]	60	[410]	22
Grade 45 [310] Class 2	45	[310]	55	[380]	22
Grade 50 [340] Class 1	50	[340]	65	[450]	20
Grade 50 [340] Class 2	50	[340]	60	[410]	20
Grade 55 [380] Class 1	55	[380]	70	[480]	18
Grade 55 [380] Class 2	55	[380]	65	[450]	18
Grade 60 [410] Class 1	60	[410]	75	[520]	16
Grade 60 [410] Class 2	60	[410]	70	[480]	16
Grade 65 [450] Class 1	65	[450]	80	[550]	15
Grade 65 [450] Class 2	65	[450]	75	[520]	15
Grade 70 [480] Class 1	70	[480]	85	[585]	14
Grade 70 [480] Class 2	70	[480]	80	[550]	14
HSLAS-F:					
Grade 50 [340]	50	[340]	60	[410]	22
Grade 60 [410]	60	[410]	70	[480]	18
Grade 70 [480]	70	[480]	80	[550]	16
Grade 80 [550]	80	[550]	90	[620]	14

[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] On this full-hard product, the yield strength approaches the tensile strength and since there is no halt in the gauge or drop in the beam, the yield point shall be taken as the yield stress at 0.5 % extension under load.
[C] There is no requirement for elongation in 2 in. for SS Grade 80.

8.2.3.2 *Number of Tests*—Two tension tests shall be made from each heat or from each 50 tons [45 000 kg]. When the amount of finished material from a heat is less than 50 tons [45 000 kg], one test shall be made. When material rolled from heat differs 0.050 in. [1.27 mm] or more in thickness, one tension test shall be made from the thickest and thinnest material regardless of the weight represented.

8.2.3.3 Tension test specimens shall be taken at a point immediately adjacent to the material to be qualified.

8.2.3.4 Tension test specimens shall be taken from the full thickness of the sheet.

8.2.3.5 Tension 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 5 Mechanical Property Requirements[A,B] for Cold Rolled Steel Sheet Designations SHS and BHS

Designation	Yield Strength, min		Tensile Strength, min		Elongation in 2 in. or 50 mm, min., %	Bake Hardening Index, min Upper Yield/Lower Yield	
	ksi	[MPa]	ksi	[MPa]		ksi	[MPa]
SHS:							
Grade 26 [180]	26	[180]	43	[300]	32	. . .	. . .
Grade 31 [210]	31	[210]	46	[320]	30	. . .	. . .
Grade 35 [240]	35	[240]	50	[340]	26	. . .	. . .
Grade 41 [280]	41	[280]	53	[370]	24	. . .	. . .
Grade 44 [300]	44	[300]	57	[390]	22	. . .	. . .
BHS:							
Grade 26 [180]	26	[180]	43	[300]	30	4/3	25/20
Grade 31 [210]	31	[210]	46	[320]	28	4/3	25/20
Grade 35 [240]	35	[240]	50	[340]	24	4/3	25/20
Grade 41 [280]	41	[280]	53	[370]	22	4/3	25/20
Grade 44 [300]	44	[300]	57	[390]	20	4/3	25/20

[A] Where an ellipsis (. . .) appears in the table, there is no requirement.
[B] 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.

8.2.3.6 Tension test samples shall be taken with the lengthwise axis of the test specimen parallel to the rolling direction (longitudinal test).

8.2.3.7 *Test Method*—Yield strength shall be determined by either the 0.2 % offset method or the 0.5 % extension under load method unless otherwise specified.

8.2.3.8 Bake hardenable steel shall conform to bake hardening index requirements included in Table 5 for the grade specified. The method for measuring the bake hardening index is described in Annex A1. Bake hardenable steel shall exhibit a minimum increase in yield strength of 4 ksi [25 MPa] as based on the upper yield point or 3 ksi [20 MPa] as based on the lower yield stress, after a prestrained specimen has been exposed to a standard bake cycle (340 °F [170 °C]) for 20 min.

8.2.4 *Bending Properties:*

8.2.4.1 The suggested minimum inside radii for cold bending are listed in Appendix X1 and is discussed in more detail in Specification A568/A568M (Section 6). Where a tighter bend radius is required, where curved or offset bends are involved, or where stretching or drawing are also a consideration, the producer shall be consulted.

8.3 *RHS and FHS:*

8.3.1 The available hardness grades for RHS and FHS are shown in Table 6.

8.3.2 The steel represented by RHS grades and FHS shall meet the specified hardness shown in Table 6, as determined at the time of shipment.

8.3.2.1 Based on chemistry and processing parameters such as method of annealing (continuous or box annealing), and rolling practice, RHS grades may be subject to aging and potentially exhibit greater hardness when tested at a later date.

8.3.2.2 Due to the non-recrystallized microstructure, FHS is not expected to be subject to aging.

8.3.3 Hardness testing shall be performed by the producer, at the final processing step, prior to shipment, at a location not less than 1 in. [25 mm] from the edge of the sheet.

9. Finish and Appearance

9.1 *Surface Finish:*

9.1.1 Unless otherwise specified, the sheet shall have a matte finish. When required, specify the appropriate surface texture and condition. For additional information, see the Finish and Condition section of Specification A568/A568M (may not apply when steel is ordered full hard (FHS), since the final process step is typically the cold reduction mill). For additional information see "Finish and Condition" section of Specification A568/A568M.

9.2 *Oiling:*

9.2.1 Unless otherwise specified, the sheet shall be oiled (may not apply when steel is ordered full hard (FHS), since the final process step is typically the cold reduction mill).

9.2.2 When required, specify the sheet to be furnished not oiled (dry).

10. Retests and Disposition of Non-Conforming Material

10.1 Retests, conducted with the requirements of Subsection 11.1 of Specification A568/A568M, are permitted when an unsatisfactory test result is suspected to be the consequence of the test method procedure.

10.2 Disposition of non-conforming material shall be subject to the requirements of Subsection 11.2 of Specification A568/A568M.

11. Product Marking

11.1 In addition to the requirements of Specification A568/A568M, each lift or coil shall be marked with the designation shown on the order (CS (Type A, B, or C), DS (Type A or B), DDS, EDDS, SFS (Grade, Carbon or Manganese or both), SS, HSLAS, HSLAS-F, RHS, FHS, SHS, or BHS). The designation shall be legibly stenciled on the top of each lift or shown on a tag attached to each coil or shipping unit.

12. Keywords

12.1 bake hardenable steel; bake hardening index; carbon steel sheet; cold-rolled steel sheet; commercial steel; deep drawing steel; drawing steel; extra deep drawing steel; full hard steel; high-strength low-alloy steel; high-strength low-alloy

steel with improved formability; required hardness steel; solution hardened steel; special forming steel; steel sheet; structural steel

TABLE 6 Hardness Requirements for Cold Rolled Steel Sheet Designations and Grades RHS and FHS

NOTE 1—Hardness shall be measured using the appropriate hardness scale as stated in Test Methods E18, Figure A5.2, based on the steel thickness and hardness.

NOTE 2—References to HRB are directly associated with references to HRBW as specified in Test Methods E18 and A370 Subsection 18.2, in which the suffix letter W refers to the tungsten carbide ball indenter.

NOTE 3—Rockwell Hardness provides a measure of resistance to penetration by a ball indenter under a fixed load, which is typically associated with a measure of abrasion resistance. Test Methods A370 provides an approximate correlation to tensile strength, however hardness values are not as accurate a measure of ductility or strength, as compared to tensile test results and are not recommended as a substitute.

Designation/Grade	HRBW Requirements[A]
RHS	
HRB 35–50	35 min / 50 max
HRB 40–55	40 min / 55 max
HRB 45–60	45 min / 60 max
HRB 50–65	50 min / 65 max
HRB 55–70	55 min / 70 max
HRB 60–75	60 min / 75 max
HRB 65–80	65 min / 80 max
HRB 70–85	70 min / 85 max
FHS[B]	84 min[C]

[A] Rockwell Hardness values apply at the time of shipment. Due to potential aging, hardness may be greater when tested at a later date.
[B] If conversion to cold-rolled annealed sheet or hot-dip metallic-coated sheet is intended, then ordering to Specification A1092 may be considered.
[C] If tensile properties are required, SS Grade 80 may be considered.

ANNEX

(Mandatory Information)

A1. BAKE HARDENABLE STEELS

A1.1 Determination of Bake Hardening Index

A1.1.1 The bake hardening index (BHI) is determined by a two-step procedure using a standard longitudinal (rolling direction) tensile-test specimen, prepared in accordance with Test Methods and Definitions A370. The test specimen is first strained in tension. The magnitude of this tensile "pre-strain" shall be 2 % (extension under load). The test specimen is then removed from the test machine and baked at a temperature of 340 °F [170 °C] for a period of 20 min. Referring to Fig. A1.1, the bake hardening index (BHI) of the material is calculated as follows:

$$BHI = B - A \quad \text{(A1.1)}$$

where:

A = flow stress at 2 % extension under load, and
B = yield strength [upper yield strength (B_U) or lower yield strength (B_L)] after baking at 340 °F [170 °C] for 20 min.

A1.1.2 The original test specimen cross section (width and thickness) is used in the calculation of all engineering strengths in this test.

A1.1.3 The pre-straining of 2 % in tension is intended to simulate a modest degree of forming strain, while the subsequent baking is intended to simulate a paint-curing or similar treatment. In the production of actual parts, forming strains and baking treatments can differ from those employed here, and as a result, final properties can differ from the values obtained under these controlled conditions.