Designation: A1008/A1008M – 16

Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, 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, 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.

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

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 of Terms Specific to This Standard:*

3.1.1 For definitions of other terms used in this specification, refer to Terminology A941.

3.1.2 *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.

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

3.1.3 *bake hardenable steel, n*—steel in which significant aging is realized when moderate heat treatment, such as that used for paint baking, follows straining or cold working.

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

3.1.4.1 *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.

3.1.5 *solid-solution hardened steel or solution hardened steel, n*—steel strengthened through additions of elements, such as Mn, P, or Si, that can be dissolved within the crystalline structure of steels.

3.1.5.1 *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.

[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**

3.1.6 *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.

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

3.1.7 *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.

3.1.8 *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.

3.1.8.1 *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.

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 & 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 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]).

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), and

4.1.13 Bake hardenable steel (BHS).

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.” For details on processing, attributes and limitations, and inspection standards, refer to Specification A568/A568M.

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[B]	Mo	V	Cb/Nb[L]	Ti[C]	N	B
CS Type A[D,E,F,G]	0.10	0.60	0.025	0.035	[A]	[A]	0.20[H]	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
CS Type B[D]	0.02 to 0.15	0.60	0.025	0.035	[A]	[A]	0.20[H]	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
CS Type C[D,E,F,G]	0.08	0.60	0.10	0.035	[A]	[A]	0.20[H]	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
DS Type A[E,I]	0.08	0.50	0.020	0.020	0.01 min	[A]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
DS Type B	0.02 to 0.08	0.50	0.020	0.020	0.02 min	[A]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
DDS[F,G]	0.06	0.50	0.020	0.020	0.01 min	[A]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]
EDDS[J]	0.02	0.40	0.020	0.020	0.01 min	[A]	0.10	0.10	0.15	0.03	0.10	0.10	0.15	[A]	[A]
SFS	[K]	[K]	0.020	0.020	0.01 min	[A]	0.20	0.20	0.15	0.06	0.008	0.008	0.025	[A]	[A]

[A] There is no specified limit, but the analysis shall be reported.
[B] Chromium is permitted, at the producer’s option, to 0.25 % maximum when the carbon content is less than or equal to 0.05 %.
[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] 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.
[I] If produced utilizing a continuous anneal process, stabilized steel is permissible at the producer’s option, and Footnotes F and G apply.
[J] Shall be furnished as a vacuum degassed and stabilized steel.
[K] Carbon & manganese chemistry limits shall be specified in accordance with Specification A568/A568M Tables X2.1 or X2.2.
[L] Columbium (Cb) and Niobium (Nb) are considered interchangeable names for Element 41 in the periodic table and both names are acceptable for use.

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, 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 (in other words, 1010, 1020, and so forth), or carbon & manganese in accordance with Specification A568/A568M Table X2.2 (in other words, C 0.12–.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, and EDDS. 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, and

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 mm by 760 mm 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.

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),

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

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

[A] There is no specified limit, but the analysis shall be reported.
[B] When copper is specified, the copper limit is a minimum requirement. When copper steel is not specified, the copper limit is a maximum requirement.
[C] Titanium is permitted for SS designations, at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.
[D] 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.
[E] 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).
[F] 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.
[G] Columbium (Cb) and Niobium (Nb) are considered interchangeable names for Element 41 in the periodic table and both names are acceptable for use.

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 to 40	[140 to 275]	≥30	[F]	[F]
DS Types A and B	22 to 35	[150 to 240]	≥36	1.3 to 1.7	0.17 to 0.22
DDS	17 to 29	[115 to 200]	≥38	1.4 to 1.8	0.20 to 0.25
EDDS	15 to 25	[105 to 170]	≥40	1.7 to 2.1	0.23 to 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.

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.

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.

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

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 gage 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.

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.

involved, or where stretching or drawing are also a consideration, the producer shall be consulted.

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.

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.

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. Certification

11.1 A report of heat analysis shall be supplied, if requested, for CS, DS, DDS, EDDS, and SFS steels. For material 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.

11.2 The report shall include the purchase order number, the ASTM designation number and year date, product designation, grade, type or class, as applicable, the heat number, and as required, heat analysis and mechanical properties as indicated by the tension test.

11.3 A signature is not required on the test report. However, the document shall clearly identify the organization submitting the report. Notwithstanding the absence of a signature, the organization submitting the report is responsible for the content of the report.

11.4 A Material Test Report, Certificate of Inspection, or similar document printed from or used in electronic form from an electronic data interchange (EDI) transmission shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document must meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

12. Product Marking

12.1 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, 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.

13. Keywords

13.1 bake hardenable steel; bake hardening index; carbon steel sheet; cold-rolled steel sheet; commercial steel; deep drawing steel; drawing steel; extra deep drawing steel; high-strength low-alloy steel; high-strength low-alloy steel with improved formability; solution hardened steel; steel sheet; structural steel

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.

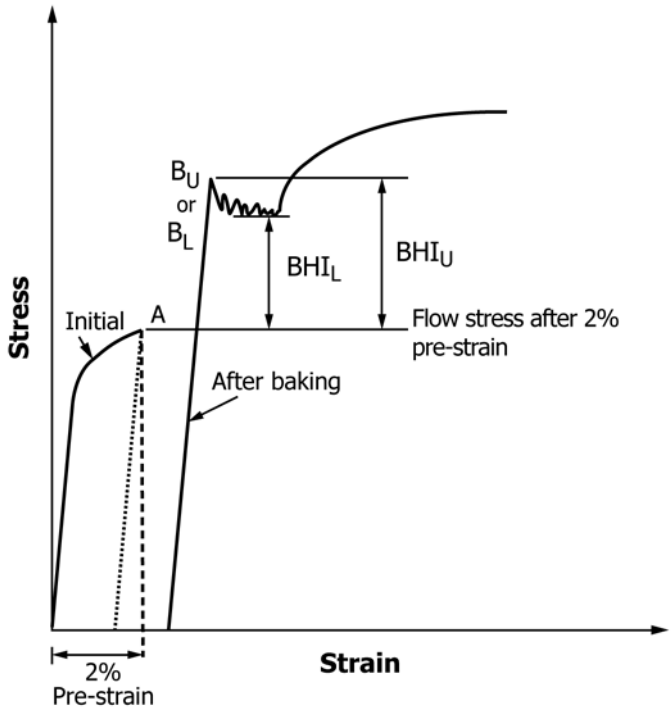

FIG. A1.1 Representation of Bake Hardening Index

APPENDIXES

(Nonmandatory Information)

X1. BENDING PROPERTIES

TABLE X1.1 Suggested Minimum Inside Radius for Cold Bending

NOTE 1—(*t*) Equals a radius equivalent to the steel thickness.

NOTE 2—The suggested radius should be used as a minimum for 90° bends in actual shop practice

NOTE 3—Material which does not perform satisfactorily, when fabricated in accordance with the requirements, may be subject to rejection pending negotiation with the steel supplier.

Designation	Grade	Minimum Inside Radius for Cold Bending	
Structural Steel	25 [170]	½ *t*	
	30 [205]	1 *t*	
	33 [230]	1½ *t*	
	40 [275]	2 *t*	
	45 [310]	2½ *t*	
	50 [340]	2½ *t*	
	60 [410]	3 *t*	
	70 [480]	4 *t*	
	80 [550]	not applicable	
High-Strength Low-Alloy Steel		Class 1	Class 2
	45 [310]	1½ *t*	1½ *t*
	50 [340]	2 *t*	1½ *t*
	55 [380]	2 *t*	2 *t*
	60 [410]	2½ *t*	2 *t*
	65 [450]	3 *t*	2½ *t*
	70 [480]	3½ *t*	3 *t*
High-Strength Low-Alloy Steel with Improved Formability	50 [340]	1 *t*	
	60 [410]	1½ *t*	
	70 [480]	2 *t*	
	80 [550]	2 *t*	
Solution Hardened Steel	26 [180]	½ *t*	
	31 [210]	1 *t*	
	35 [240]	1½ *t*	
	41 [280]	2 *t*	
	44 [300]	2 *t*	
Bake Hardenable Steel	26 [180]	½ *t*	
	31 [210]	1 *t*	
	35 [240]	1½ *t*	
	41 [280]	2 *t*	
	44 [300]	2 *t*	

X2. RELATED ISO STANDARDS

The ISO standards listed below may be reviewed for comparison with this ASTM standard. The relationship between the standards may only be approximate; therefore, the respective standards should be consulted for actual requirements. Those who use these documents must determine which specifications address their needs.

ISO 3574 Cold-Reduced Carbon Steel Sheet of Commercial and Drawing Qualities

ISO 4997 Cold-Reduced Steel Sheet of Structural Quality

ISO 13887 Cold-Reduced Steel Sheet of Higher Strength with Improved Formability

X3. HARDNESS PROPERTIES

TABLE X3.1 Typical Hardness Values

NOTE 1—The hardness values shown are at the time of shipment.

NOTE 2—Test for hardness shall be conducted in accordance with the requirements of Test Methods E18.

NOTE 3—The hardness values are Rockwell B scale as measured or converted from the appropriate Rockwell scales.

NOTE 4—The typical hardness values apply to the full range of steel sheet thickness. Hardness tends to increase as the steel sheet thickness decreases.

NOTE 5—Hardness testing is commonly used to assess the relative formability of various designations of uncoated steel sheet. This assessment done by many users is recognized to be only an approximation of the relative formability and therefore cannot be used as a specification requirement.

Designation	Hardness-Rockwell B Scale
CS Type A	70 or less
CS Type B	70 or less
CS Type C	70 or less
DS Type A	60 or less
DS Type B	60 or less
DDS	55 or less
EDDS	45 or less

SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A1008/A1008M – 15) that may impact the use of this standard. (Approved Sept. 1, 2016.)

(1) Special Forming Steel was added as noted in the addition or adjustment to the following: Subsections 3.1.8, 3.1.8.1, 4.1.6, 5.1.2, 5.1.2.2, 5.1.2.4, 11.1, 12.1, and Table 1.

(2) Editorial change made in Tables 1 and 2 footnote A and reference to Niobium (Nb) being interchangeable with Columbium (Cb) was added.

Committee A01 has identified the location of selected changes to this standard since the last issue (A1008/A1008M – 13) that may impact the use of this standard. (Approved May 1, 2015.)

(1) P levels changed in CS-A and -B (Table 1).

(2) S levels changed in DS-A, DS-B, and DDS (Table 1).