



Standard Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process¹

This standard is issued under the fixed designation A1046/A1046M; 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.

1. Scope*

1.1 This specification covers zinc-aluminum-magnesium alloy-coated steel sheet in coils and cut lengths.

1.2 This product is intended for applications requiring corrosion resistance and paintability.

1.3 The steel sheet is produced in a number of designations, types, grades and classes designed to be compatible with differing application requirements.

1.4 Product furnished under this specification shall conform to the applicable requirements of the latest issue of Specification [A924/A924M](#), unless otherwise provided herein.

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes, excluding those in tables and figures, shall not be considered as requirements of the standard.

1.6 This specification is applicable to orders in either inch-pound units (as A1046) or SI units (as A1046M). Values in inch-pound and SI units are not necessarily equivalent. Within the text, SI units are shown in brackets. Each system shall be used independently of the other.

1.7 Unless the order specifies the “M” designation (SI units), the product shall be furnished to inch-pound units.

1.8 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

¹ This specification is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.11 on Sheet Specifications.

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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.

[A90/A90M Test Method for Weight \[Mass\] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings](#)
[A568/A568M Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for](#)
[A902 Terminology Relating to Metallic Coated Steel Products](#)
[A924/A924M Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process](#)
[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:

See Terminology [A902](#) for definitions of general terminology relating to metallic-coated hot-dip products.

4. Classification

4.1 The material is available in several designations as follows:

4.1.1 Commercial Steel—CS Types A, B, and C,

4.1.2 Deep Drawing Steel—DDS,

4.1.3 Extra Deep Drawing Steel—EDDS,

4.1.4 Forming Steel—FS Types A and B,

4.1.5 High Strength Low Alloy Steel—HSLAS,

4.1.6 High Strength Low Alloy Steel with Improved Formability—HSLAS-F.

4.1.7 Structural Steel—SS,

4.2 Structural steel and high strength low alloy steel are available in several grades based on mechanical properties. Structural Steel Grade 50 [340] is available in four classes based on tensile strength.

4.3 The product is available in several coating weights [masses] with the coating designation in accordance with [Table 1](#).

5. Ordering Information

5.1 Zinc-aluminum-magnesium alloy-coated steel sheet in coils and cut lengths is produced to thickness requirements expressed to 0.001 in. [0.01 mm]. The thickness of the sheet includes the base metal and the coating.

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

TABLE 1 Weight [Mass] of Coating Requirement^A

Coating Designation	Inch-Pound Units	
	Minimum Requirement	
	Triple-Spot Test Total Both Sides, oz/ft ²	Single-Spot Test Total Both Sides, oz/ft ²
ZM20	0.20	0.16
ZM30	0.30	0.25
ZM40	0.40	0.30
ZM50	0.50	0.40
ZM60	0.60	0.50
ZM70	0.70	0.60
ZM75	0.75	0.65
ZM90	0.90	0.80
ZM100	1.00	0.90
ZM115	1.15	1.00
ZM140	1.40	1.20
ZM165	1.65	1.40
ZM210	2.10	1.80

Coating Designation	SI Units	
	Minimum Requirement	
	Triple-Spot Test Total Both Sides, g/m ²	Single-Spot Test Total Both Sides, g/m ²
ZMM60	60	50
ZMM90	90	75
ZMM120	120	90
ZMM150	150	120
ZMM180	180	150
ZMM210	210	180
ZMM220	220	190
ZMM275	275	235
ZMM300	300	270
ZMM350	350	300
ZMM450	450	385
ZMM500	500	425
ZMM600	600	510

^AThe coating designation number is the term by which this product is specified. Because of the many variables and changing conditions that are characteristic of continuous hot-dip coating lines, the weight [mass] of the coating is not always evenly divided between the two surfaces of a sheet, nor is the coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40 % of the single-spot test limit will be found on either surface.

5.2 Orders for product to this specification shall include the following information, as necessary, to adequately describe the desired product:

5.2.1 Name of product (steel sheet, zinc-aluminum-magnesium alloy-coated),

5.2.2 Designation of sheet steel {CS (Type A, B, or C), FS (Type A or B), DDS, EDDS, SS, HSLAS or HSLAS-F},

5.2.2.1 When a CS type is not specified, CS Type B will be furnished. When an FS type is not specified, FS Type B will be furnished.

5.2.3 When an SS or HSLAS designation is specified, state the grade or class, or combination thereof.

5.2.4 ASTM designation number and year of issue, such as A1046-___ for inch-pound units or A1046M-___ for SI units,

5.2.5 Coating designation,

5.2.6 Chemically treated or not chemically treated,

5.2.7 Oiled or not oiled,

5.2.8 Dimensions (show thickness, minimum or nominal, width, flatness requirements (if appropriate), and length (if cut length)).

5.2.9 Coil size requirements (specify maximum outside diameter (OD), acceptable inside diameter (ID), and maximum weight [mass]),

5.2.10 Packaging,

5.2.11 Certification, if required, and heat analysis and mechanical property report,

5.2.12 Application (show part identification and description), and

5.2.13 Special requirements (if any).

5.2.13.1 When the purchaser requires thickness tolerances for ³/₈-in. [10-mm] minimum edge distance (see Supplementary Requirement in specification [A924/A924M](#)), this requirement shall be specified in the purchase order or contract.

NOTE 1—Typical ordering descriptions are as follows:
Steel sheet, zinc-aluminum-magnesium alloy coated, Forming Steel Type B, ASTM A1046-___, coating designation ZM90, chemical treatment, no oil, minimum 0.034 by 48 in. by coil, 60-in. maximum OD, 24-in. ID, 10,000-lb maximum, for inner door panel, or steel sheet, zinc-aluminum-magnesium alloy coated, Commercial Steel Type B, ASTM A1046M-___, coating designation ZMM275, not chemically treated, oiled, minimum 0.85 by 900 mm by coil, 1200-mm maximum OD, 610-mm ID, 9,000-kg maximum, for building panels.

6. Chemical Composition

6.1 Base Metal:

6.1.1 The heat analysis of the base metal shall conform to the requirements shown in [Table 2](#) for CS (Types A, B, and C), FS (Types A and B), DDS and EDDS, and [Table 3](#) for SS, HSLAS and HSLAS-F.

6.1.2 Each of the elements listed in [Tables 2 and 3](#) shall be included in the report of heat analysis. When the amount of copper, nickel, chromium, or molybdenum is less than 0.02 %, report the analysis as either <0.02 % or the actual determined

TABLE 2 Chemical Requirements^A

Designation	Composition, %-Heat Analysis Element, max (unless otherwise shown)												
	C	Mn	P	S	Al, min	Cu	Ni	Cr	Mo	V	Cb	Ti ^B	N
CS Type A ^{C,D,E}	0.10	0.60	0.030	0.035	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
CS Type B ^{C,F}	0.02 to 0.15	0.60	0.030	0.035	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
CS Type C ^{C,D,E}	0.08	0.60	0.100	0.035	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
FS Type A ^{C,G}	0.10	0.50	0.020	0.035	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
FS Type B ^{C,F}	0.02 to 0.10	0.50	0.020	0.030	...	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
DDS ^{D,E,H}	0.06	0.50	0.020	0.025	0.01	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
EDDS ^{H,I}	0.02	0.40	0.020	0.020	0.01	0.20	0.20	0.15	0.06	0.10	0.10	0.15	...

^AWhere an ellipsis (...) appears in this table, there is no requirement, but the analysis shall be reported.

^BFor steels containing more than 0.02 % carbon, titanium is permitted to 0.025 % provided the ratio of % titanium to % nitrogen does not exceed 3.4.

^CWhen a deoxidized steel is required for the application, the purchaser has the option to order CS and FS to a minimum of 0.01 % total aluminum.

^DSteel is permitted to be furnished as a vacuum degassed or chemically stabilized steel, or both, at the producer's option.

^EFor carbon levels less than or equal to 0.02 %, vanadium, columbium, or titanium, or combinations 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.

^FFor CS and FS, specify Type B to avoid carbon levels below 0.02 %.

^GShall not be furnished as a stabilized steel.

^HMinimum Al content is not required if agreed to by purchaser and supplier.

^IShall be furnished as a stabilized steel.

TABLE 3 Chemical Requirements^A

Designation	Composition, %-Heat Analysis Element, max (unless otherwise shown)											
	C	Mn	P	S	Cu	Ni	Cr	Mo	V ^B	Cb ^B	Ti ^{B,C,D}	N
SS Grade												
33 [230]	0.20	...	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
37 [255]	0.20	...	0.10	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
40 [275]	0.25	...	0.10	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
50 [340] Class 1,2 and 4	0.25	...	0.20	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
50 [340] Class 3	0.25	...	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
80 [550]	0.20	...	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.015	0.025	...
HSLAS ^E												
40 [275]	0.20	1.50	...	0.035	...	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
50 [340]	0.20	1.50	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
60 [410]	0.20	1.50	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
70 [480]	0.20	1.65	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
80 [550]	0.20	1.65	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
HSLAS-F ^F												
40 [275]	0.15	1.50	...	0.035	...	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
50 [340]	0.15	1.50	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
60 [410]	0.15	1.50	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
70 [480]	0.15	1.65	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
80 [550]	0.15	1.65	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...

^AWhere an ellipsis (...) appears in this table there is no requirement, but the analysis shall be reported.

^BFor carbon levels less than or equal to 0.02 %, vanadium, columbium, or titanium, or combinations 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.

^CTitanium is permitted for SS steels to 0.025 % provided the ratio of % titanium to % nitrogen does not exceed 3.4.

^DFor steels containing more than 0.02 % carbon, titanium is permitted to 0.025 %, provided the ratio of % titanium to % nitrogen does not exceed 3.4.

^EHSLAS and HSLAS-F steels commonly 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.

^FThe producer has the option to treat HSLAS-F steels by means of small alloy additions to effect sulfide inclusion control.

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

6.1.3 See Specification **A924/A924M** for chemical analysis procedures and product analysis tolerances.

6.2 *Coating Bath Composition*—The bath metal used for zinc-aluminum-magnesium alloy-coated sheet shall contain 5 to 13 % aluminum, 2 to 4 % magnesium, up to 1 % total additional alloying elements (except iron) and the balance zinc.

7. Mechanical Properties

7.1 Structural steel and high strength low alloy steel shall conform to the mechanical property requirements of **Table 4** for the grade or class or combination thereof, specified.

7.2 The typical mechanical properties for CS (Types A, B, and C), FS (Types A and B), DDS, EDDS steel sheet designations are listed in **Table 5**. These mechanical property values are non-mandatory. They are intended solely to provide the purchaser with as much information as possible to make an informed decision on the steel to be specified. Values outside these ranges are to be expected.

7.3 When base metal mechanical properties are required, all tests shall be conducted in accordance with the methods specified in Specification **A924/A924M**.

7.4 Bending Properties:

7.4.1 *Minimum Cold Bending Radii*—Structural steel sheet is commonly fabricated by cold bending. There are many interrelated factors that affect the ability of a steel to cold form

TABLE 4 Mechanical Property Requirements, Base Metal (Longitudinal)

Inch-Pound Units				
Designation	Grade	Yield Strength, min, ksi	Tensile Strength, min, ksi ^A	Elongation in 2 in., min, % ^A
SS	33	33	45	20
	37	37	52	18
	40	40	55	16
	50 Class 1	50	65	12
	50 Class 2	50	...	12
	50 Class 3	50	70	12
	50 Class 4	50	60	12
	80 ^B	80 ^C	82	...
HSLAS	40	40	50 ^D	22
	50	50	60 ^D	20
	60	60	70 ^D	16
	70	70	80 ^D	12
	80	80	90 ^D	10
HSLAS-F	40	40	50 ^D	24
	50	50	60 ^D	22
	60	60	70 ^D	18
	70	70	80 ^D	14
	80	80	90 ^D	12
SI Units				
Designation	Grade	Yield Strength, min, MPa	Tensile Strength, min, MPa ^A	Elongation in 50 mm, min, % ^A
SS	230	230	310	20
	255	255	360	18
	275	275	380	16
	340 Class 1	340	450	12
	340 Class 2	340	...	12
	340 Class 3	340	480	12
	340 Class 4	340	410	12
	550 ^B	550 ^C	570	...
HSLAS	275	275	340 ^D	22
	340	340	410 ^D	20
	410	410	480 ^D	16
	480	480	550 ^D	12
	550	550	620 ^D	10
HSLAS-F	275	275	340 ^D	24
	340	340	410 ^D	22
	410	410	480 ^D	18
	480	480	550 ^D	14
	550	550	620 ^D	12

^AWhere an ellipsis (...) appears in this table there is no requirement.

^BFor sheet thickness of 0.028 in. [0.71 mm] or thinner, no tension test is required if the hardness result in Rockwell B85 or higher.

^CAs there is no discontinuous yield curve, the yield strength should be taken as the stress at 0.5 % elongation under load or 0.2 % offset.

^DIf a higher tensile strength is required, the user should consult the producer.

TABLE 5 Typical Ranges of Mechanical Properties (Nonmandatory)^{A,B}

Designation	(Longitudinal Direction)				
	Yield Strength		Elongation in 2 in. [50 mm] %	r_m Value ^C	N Value ^D
	ksi	MPa			
CS Type A	25/55	[170/380]	≥20	<i>E</i>	<i>E</i>
CS Type B	30/55	[205/380]	≥20	<i>E</i>	<i>E</i>
CS Type C	25/60	[170/410]	≥15	<i>E</i>	<i>E</i>
FS Types A and B	25/45	[170/310]	≥26	1.0/1.4	0.17/0.21
DDS	20/35	[140/240]	≥32	1.4/1.8	0.19/0.24
EDDS ^F	15/25	[105/170]	≥40	1.6/2.1	0.22/0.27

^A The typical mechanical property values presented here are nonmandatory. They are intended solely to provide the purchaser with as much information as possible to make an informed decision on the steel to be specified. Values outside of these ranges are to be expected. The purchaser may negotiate with the supplier if a specific range or a more restrictive range is required for the application.

^BThese typical mechanical properties apply to the full range of steel sheet thicknesses. The yield strength tends to increase and some of the formability values tend to decrease as the sheet thickness decreases.

^C r_m Value—Average plastic strain ratio as determined by Test Method E517.

^DN Value—Strain-hardening exponent as determined by Test Method E646.

^ENo typical mechanical properties have been established.

^FEDDS Sheet will be free from changes in mechanical properties over time, that is, nonaging.

over a given radius under shop conditions. These factors include: thickness, strength level, degree of restraint, relationship to rolling direction, chemistry and base metal microstructure.

Appendix X1 lists the suggested minimum inside radius for 90° cold bending for these steel sheets. They pre-suppose “hard way” bending (bend axis parallel to rolling direction) and

TABLE 6 Coating Bend Test Requirements

Inch-Pound Units														
Coating Designation ^A	Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)			SS Grade ^B			HSLAS ^B			HSLAS-F				
	CS, FS, DDS, EDDS Sheet Thickness			33	37	40	40	50	60	40	50	60	70	80
	Through 0.039 in.	Over 0.039 through 0.079 in.	Over 0.079 in.											
ZM20	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM30	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM40	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM50	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM60	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM70	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM75	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM90	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM100	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM115	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZM140	1	1	2	2	2	2½								
ZM165	2	2	2	2	2	2½								
ZM210	2	2	2	2	2	2½								

SI-Units														
Coating Designation ^A	Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)			SS Grade ^C			HSLAS ^C			HSLAS-F				
	CS, FS, DDS, EDDS Sheet Thickness			230	255	275	275	340	410	275	340	410	480	550
	Through 1.0 mm	Over 1.0 through 2.0 mm	Over 2.0 mm											
ZMM60	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM90	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM120	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM150	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM180	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM210	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM220	0	0	0	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM275	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM300	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM350	0	0	1	1½	2	2½	1½	1½	3	1	1	1	1½	1½
ZMM450	1	1	2	2	2	2½								
ZMM500	2	2	2	2	2	2½								
ZMM600	2	2	2	2	2	2½								

^AIf other coatings are required, the user should consult the producer for availability and suitable bend test requirements.

^BSS Grades 50 and 80 and HSLAS Grades 70 and 80 are not subject to bend test requirements.

^CSS Grades 340 and 550 and HSLAS Grades 480 and 550 are not subject to bend test requirements.

reasonably good shop forming practices. Where possible, the use of larger radii or “easy way” bending is recommended for improved performance.

7.4.2 Fabricators should be aware that cracks may initiate upon bending a sheared edge or cold-worked edge. This is not considered to be a fault of the steel, but is rather a function of the induced localized cold-work zone.

8. Coating Properties

8.1 Coating Weight [Mass]:

8.1.1 Coating weight [mass] shall conform to the requirements as shown in Table 1 for the specific coating designation.

8.1.2 Use the following relationships to estimate the coating thickness from the coating weight [mass]:

8.1.2.1 For product coated with bath Al content from 5 to 9 %, 1.00 oz/ft² coating weight = 2.00 mils coating thickness,

8.1.2.2 6.01 g/m² coating mass = 1.00 μm coating thickness,

8.1.2.3 For product coated with bath Al content from 9 to 13 %, 1.00 oz/ft² coating weight = 2.10 mils coating thickness, and

8.1.2.4 5.70 g/m² coating mass = 1.00 μm coating thickness.

8.1.3 Use the following relationship to convert coating weight to coating mass:

8.1.3.1 1.00 oz/ft² coating weight = 305 g/m² coating mass.

8.2 Coating Weight [Mass] Tests:

8.2.1 Coating weight [mass] tests shall be performed in accordance with the requirements stated in Specification [A924/A924M](#).

8.2.2 The referee method to be used shall be the dilute hydrochloric acid method, in Test Method [A90/A90M](#)

8.3 Coating Bend Test—The coating bend test specimens shall be capable of being bent through 180° in any direction without flaking of the coating on the outside of the bend only. The coating bend test inside diameter shall have a relation to the thickness of the specimen as shown in [Table 6](#). Flaking of the coating within 0.25 in. [6 mm] of the edge of the bend specimen shall not be cause for rejection.

9. Dimensions and Permissible Variations

9.1 All dimensions and permissible variations shall comply with the requirements of Specification [A924/A924M](#).

10. Keywords

10.1 coatings, metallic; steel sheet, metallic coated; zinc-aluminum-magnesium alloy coating

SUPPLEMENTARY REQUIREMENTS

The following standardized supplementary requirements are for use when desired by the purchaser. These additional requirements shall apply only when specified on the order.

S1. Base Metal Thickness

S1.1 The specified minimum thickness shall apply to the base metal only.

S1.2 The coating designation shown on the order indicates the coating to be applied to the specified minimum base metal thickness.

S1.3 The applicable tolerances for base metal thickness are shown in Tables 17 and 18, Thickness Tolerance of Cold-Rolled Sheet (Carbon and High-Strength, Low-Alloy Steel), of Specification **A568/A568M**.

APPENDIX

(Nonmandatory Information)

X1. BENDING PROPERTIES

X1.1 **Table X1.1** lists suggested minimum inside radii for cold bending.

TABLE X1.1 Suggested Minimum Inside Radii for Cold Bending^A

NOTE 1— t = radius equivalent to the steel thickness.

NOTE 2—The suggested radii should be used as minimums for 90° bends in actual shop practice.

Designation	Grade	Minimum Inside Radius for Cold Bending ^B
SS	33 [230]	1½ t
	37 [255]	2t
	40 [275]	2t
	50 [340]	not applicable
	(Classes 1, 2, 3, and 4) 80 [550]	not applicable
HSLAS	40 [275]	2t
	50 [340]	2½ t
	60 [410]	3t
	70 [480]	4t
	80 [550]	4½ t
HSLAS-F	40 [270]	1½ t
	50 [340]	2t
	60 [410]	2t
	70 [480]	3t
	80 [550]	3t

^AMaterial that does not perform satisfactorily, when fabricated in accordance with the requirements in this table, may be subject to rejection pending negotiation with the steel supplier.

^BBending capability may be limited by coating designation.

SUMMARY OF CHANGES

Committee A05 has identified the location of selected changes to this standard since the last issue (A1046/A1046M - 10a^{E1}) that may impact the use of this standard. (May 1, 2014)

- (1) Added coating designations ZM50, ZM75, ZM100, ZMM150, ZMM210, and ZMM300 to **Table 1**.
- (2) Added coating designations ZM50, ZM75, ZM100, ZMM150, ZMM220, and ZMM300 to **Table 6**.
- (3) The measure for thickness requirements has been corrected in **Section 5.1**.

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