Designation: A1046/A1046M – 17

Standard Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process[1]

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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]

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.

[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.

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

TABLE 1 Weight [Mass] of Coating Requirement[A]

Coating Designation	Minimum Requirement	
	Triple-Spot Test Total Both Sides, oz/ft^2	Single-Spot Test Total Both Sides, oz/ft^2
Inch-Pound Units		
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
SI Units		
Coating Designation	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

[A]The 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 Coating bath composition type (see section 6.2).

5.2.7 Chemically treated or not chemically treated,

5.2.8 Oiled or not oiled,

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

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

5.2.11 Packaging,

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

5.2.13 Application (show part identification and description), and

5.2.14 Special requirements (if any).

5.2.14.1 When the purchaser requires thickness tolerances for ⅜-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 value. When the amount of vanadium, titanium or columbium

TABLE 2 Chemical Requirements[A]

	Composition, %-Heat Analysis Element, max (unless otherwise shown)												
Designation	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	...

[A]Where an ellipsis (...) appears in this table, there is no requirement, but the analysis shall be reported.
[B]For 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.
[C]When 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.
[D]Steel is permitted to be furnished as a vacuum degassed or chemically stabilized steel, or both, at the producer's option.
[E]For 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.
[F]For CS and FS, specify Type B to avoid carbon levels below 0.02 %.
[G]Shall not be furnished as a stabilized steel.
[H]Minimum Al content is not required if agreed to by purchaser and supplier.
[I]Shall be furnished as a stabilized steel.

TABLE 3 Chemical Requirements[A]

	Composition, %-Heat Analysis Element, max (unless otherwise shown)											
Designation	C	Mn	P	S	Cu	Ni	Cr	Mo	V[B]	Cb[B]	Ti[B,C,D]	N
SS Grade												
33 [230]	0.20	1.35	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
37 [255]	0.20	1.35	0.10	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
40 [275]	0.25	1.35	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	1.35	0.20	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
50 [340] Class 3	0.25	1.35	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
55 [380]	0.25	1.35	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
60 [410]	0.25	1.35	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
70 [480]	0.25	1.35	0.04	0.040	0.20	0.20	0.15	0.06	0.008	0.008	0.025	...
80 [550]	0.20	1.35	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	...
55 [380] Class 1	0.25	1.35	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	
55 [380] Class 2	0.15	1.20	...	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	...
55 [380] Class 1	0.20	1.35	...	0.035	0.20	0.20	0.15	0.16	0.01 min	0.005 min	0.01 min	...
55 [380] Class 2	0.15	1.20	...	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	...

[A]Where an ellipsis (...) appears in this table there is no requirement, but the analysis shall be reported.
[B]For 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.
[C]Titanium is permitted for SS steels to 0.025 % provided the ratio of % titanium to % nitrogen does not exceed 3.4.
[D]For 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.
[E]HSLAS 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.
[F]The producer has the option to treat HSLAS-F steels by means of small alloy additions to effect sulfide inclusion control.

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 0.5 to 13 % aluminum, 0.4 to 4 % magnesium, up to 1 % total additional alloying elements (except iron) and the balance zinc.

Four types are available, as follows (see Annex A1 for a visual representation):

Type 1: 5 to 13 % aluminum, 2 to 4% magnesium

Type 2: 3 to less than 5% aluminum, 2 to 4% magnesium

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
	55	55	70	11
	60	60	70	10[E]
	70	70	80	9[E]
	80[B]	80[C]	82	...
HSLAS	40	40	50[D]	22
	50	50	60[D]	20
	55 Class 1	55	70[D]	16
	55 Class 2	55	65[D]	18
	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
	55 Class 1	55	70[D]	18
	55 Class 2	55	65[D]	20
	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
	380	380	480	11
	410	410	490	10[E]
	480	480	550	9[E]
	550[B]	550[C]	570	...
HSLAS	275	275	340[D]	22
	340	340	410[D]	20
	380 Class 1	380	480[D]	16
	380 Class 2	380	450[D]	18
	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
	380 Class 1	380	480[D]	18
	380 Class 2	380	450[D]	20
	410	410	480[D]	18
	480	480	550[D]	14
	550	550	620[D]	12

[A]Where an ellipsis (...) appears in this table there is no requirement.
[B]For 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.
[C]As 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.
[D]If a higher tensile strength is required, the user should consult the producer.
[E]For sheet thickness of 0.028 in. [0.71 mm] or thinner, the elongation requirement is reduced two percentage points for SS Grades 60 [410] and 70 [480].

Type 3: 3 to 6% aluminum, 0.4 to less than 2% magnesium
Type 4: 0.5 to less than 3% aluminum, 0.4 to 2.6 % magnesium.

Due to differences in coating bath chemistry, the properties provided by each type may differ and the user shall specify the type suitable for the application accordingly.

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.

TABLE 5 Typical Ranges of Mechanical Properties (Nonmandatory)[A,B]

Designation	(Longitudinal Direction) Yield Strength ksi	Yield Strength MPa	Elongation in 2 in. [50 mm] %	r_m Value[C]	N Value[D]
CS Type A	25/55	[170/380]	≥20	[E]	[E]
CS Type B	30/55	[205/380]	≥20	[E]	[E]
CS Type C	25/60	[170/410]	≥15	[E]	[E]
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.
[B]These 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.
[D]N Value—Strain-hardening exponent as determined by Test Method E646.
[E]No typical mechanical properties have been established.
[F]EDDS Sheet will be free from changes in mechanical properties over time, that is, nonaging.

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 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 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 relationships in Table 6 to estimate the coating thickness from the coating weight [mass].

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

8.1.3.1 1.00 oz/ft^2 coating weight = 305 g/m^2 coating mass.

8.2 *Coating Weight [Mass] Tests:*

TABLE 6 Coating Thickness Estimation

Coating Bath Composition	Al%	Mg%	Coating Thickness per 1000 oz/ft^2 Coating Weight	Coating Mass per 1.00 µm Coating Thickness
Type 1	5 to 9	2 to 4	2.00 mils	6.01 g/m^2
	9 to 13	2 to 4	2.10 mils	5.70 g/m^2
Type 2	3 to < 5	2 to 4	1.95 mils	6.17 g/m^2
Type 3	3 to 6	0.4 to < 2	1.87 mils	6.43 g/m^2
Type 4	0.5 to < 3	0.4 to 2.6	1.81 mils	6.65 g/m^2

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 7. 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

TABLE 7 Coating Bend Test Requirements

Inch-Pound Units

Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)

Coating Designation[A]	CS, FS, DDS, EDDS Sheet Thickness			SS Grade[B]			HSLAS[B]			HSLAS-F				
	Through 0.039 in.	Over 0.039 through 0.079 in.	Over 0.079 in.	33	37	40	40	50	60	40	50	60	70	80
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

Ratio of the Bend Diameter to Thickness of the Specimen (Any Direction)

Coating Designation[A]	CS, FS, DDS, EDDS Sheet Thickness			SS Grade[C]			HSLAS[C]			HSLAS-F				
	Through 1.0 mm	Over 1.0 through 2.0 mm	Over 2.0 mm	230	255	275	275	340	410	275	340	410	480	550
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								

[A] If other coatings are required, the user should consult the producer for availability and suitable bend test requirements.
[B] SS Grades 50 and 80 and HSLAS Grades 70 and 80 are not subject to bend test requirements.
[C] SS Grades 340 and 550 and HSLAS Grades 480 and 550 are not subject to bend test requirements.

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.

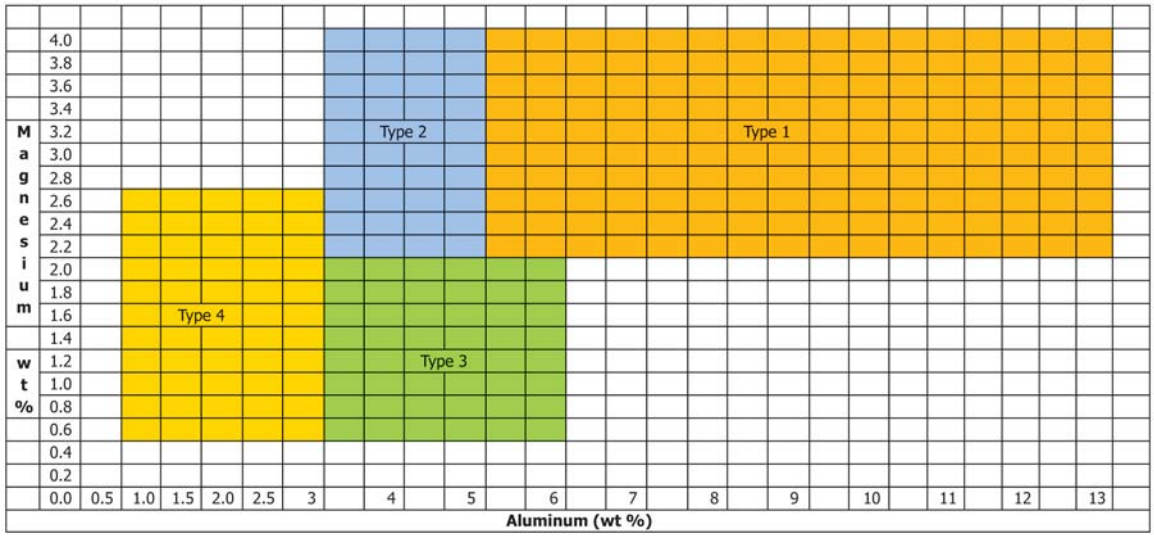
S1.3 The applicable tolerances for base metal thickness are shown in Tables 17 and 18, Thickness Tolerance of Cold-Rolled Sheet (Carbon and High-Strength, Low-Alloy Steel), of Specification A568/A568M.

ANNEX

(Mandatory Information)

A1. Zn-Al-Mg Coating Bath Composition Types

A1.1 Coating Bath Composition Types



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] (Classes 1, 2, 3, and 4)	not applicable
	55 [380]	not applicable
	60 [410]	not applicable
	70 [480]	not applicable
	80 [550]	not applicable
HSLAS	40 [275]	2t
	50 [340]	2½ t
	55 [380] Class 1	3t
	55 [380] Class 2	3t
	60 [410]	3t
	70 [480]	4t
	80 [550]	4½ t
HSLAS-F	40 [270]	1½ t
	50 [340]	2t
	55 [380] Class 1	2t
	55 [380] Class 2	2t
	60 [410]	2t
	70 [480]	3t
	80 [550]	3t

[A] Material 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.

[B] Bending 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–16) that may impact the use of this standard. (Approved February 1, 2017.)

(1) Added new 5.2.6 coating bath composition type and renumbered subsequent sections.
(2) In section 6.2, expanded the coating bath composition from 5 to 13% aluminum to 0.4 to 13% and 2 to 4% magnesium to 0.4 to 4%.
(3) In section 8.1.2, updated coating thickness to coating weight [mass] relationship by type.
(4) Created new Table 6 and renumbered current Table 7.
(5) Added new Annex A1 section.

Committee A05 has identified the location of selected changes to this standard since the last issue (A1046/A1046M – 14) that may impact the use of this standard. (November 1, 2016)

(1) Added Mn values for SS Grades 33 through 80 and added SS Grades 55 [380], 60 [410], 70 [480], HSLAS Grades 55 [380] Class 1 and 2, and HSLAS-F Grades 55[380] Class 1 and 2 steel designations to Table 3.
(2) Added SS Grades 55[380], 60 [410], 70 [480], HSLAS Grades 55 [380] Class 1 and 2, and HSLAS-F Grades 55[380] Class 1 and 2 steel designations and Note E to Table 4.
(3) Added SS Grades 55 [380], 60 [410], 70 [480], HSLAS Grades 55 [380] Class 1 and 2, and HSLAS-F Grades 55[380] Class 1 and 2 steel designations to Table X1.1.