Designation: A924/A924M – 22

Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process[1]

This standard is issued under the fixed designation A924/A924M; 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 the general requirements that, unless otherwise specified in the product specification, apply to steel sheet in coils and cut lengths, metallic-coated on continuous lines by the hot-dip process. The product is intended for applications requiring corrosion resistance. The product specifications contain requirements for specific strength levels, heat resistance, paintability, or formability, or a combination thereof.

1.2 Subject to individual product specification provisions, steel sheet is available as Commercial Steel (CS) Types A, B, and C, Forming Steel (FS), Drawing Steel (DS), Deep Drawing Steel (DDS), Extra Deep Drawing Steel (EDDS), High Temperature Steel (HTS), Structural Steel (SS), and High Strength Low Alloy Steel (HSLAS). Steel sheet is produced with the following metallic coatings. Specific information on each of the following is contained in the individual product specification:

1.2.1 Zinc or zinc-iron alloy coated,
1.2.2 Zinc-5 % aluminum alloy coated,
1.2.3 55 % aluminum-zinc alloy coated,
1.2.4 Aluminum or aluminum-silicon alloy coated,
1.2.5 Zinc-aluminum-magnesium alloy coated.

1.3 Products covered by this general requirements specification are described in the following product standards: Specifications A463/A463M; A653/A653M; A755/A755M; A792/A792M; A875/A875M; A929/A929M; A1046/A1046M; A1057/A1057M; A1063/A1063M; and A1079.

1.4 Metallic-coated steel sheet is produced to various coating designations, as shown in the individual product specifications. Except for differentially coated sheet, the coating is always expressed as the total coating of both surfaces.

1.5 In case of any conflict in requirements, the requirements of the individual product specifications shall prevail over those of this general specification.

1.6 The purchaser is permitted to specify additional requirements that do not negate any of the provisions of this general specification or of the individual product specifications. Such additional requirements, the acceptance of which are subject to negotiation with the supplier, shall be included in the order information.

1.7 For purposes of determining conformance with this specification and the various product specifications referenced in 1.3, measured values, calculated values, or observed values shall be rounded to the nearest unit in the right-hand place of figures used in expressing the limiting values (except to the nearest 5 MPa for SI strength values) in accordance with the rounding method of Practice E29.

1.7.1 Ordered values, identified in tables, specified such as over 30 through 48 or 30 exclusive to 48 inclusive, cover all ordered values specified as 30.1, 30.01, 30.001 etc., up to and including 48.000 etc., but does not cover ordered values specified as 30.000 etc., or less, nor does it cover ordered values specified as 48.1, 48.01, 48.001 etc.

1.8 Metallic-coated steel sheet covered by this specification is produced to thickness requirements expressed to 0.001 in. [0.01 mm] for both coils and cut lengths. The thickness is the total of the base steel and the coating.

1.9 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.10 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.11 This specification and some of the applicable product specifications are expressed in both inch-pound and SI units. However, unless the order specifies the applicable "M" specification designation (SI units), the product shall be furnished to inch-pound units.

1.12 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the*

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

responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.13 *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]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A428/A428M Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles

A463/A463M Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A700 Guide for Packaging, Marking, and Loading Methods for Steel Products for Shipment

A751 Test Methods and Practices for Chemical Analysis of Steel Products

A754/A754M Test Method for Coating Weight [Mass] of Metallic Coatings on Steel by X-Ray Fluorescence

A755/A755M Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products

A792/A792M Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process

A875/A875M Specification for Steel Sheet, Zinc-5 % Aluminum Alloy-Coated by the Hot-Dip Process

A902 Terminology Relating to Metallic Coated Steel Products

A929/A929M Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

A1030/A1030M Practice for Measuring Flatness Characteristics of Steel Sheet Products

A1046/A1046M Specification for Steel Sheet, Zinc-Aluminum-Magnesium Alloy-Coated by the Hot-Dip Process

A1057/A1057M Specification for Steel, Structural Tubing, Cold Formed, Welded, Carbon, Zinc-Coated (Galvanized) by the Hot-Dip Process

A1063/A1063M Specification for Steel Sheet, Twin-Roll Cast, Zinc-Coated (Galvanized) by the Hot-Dip Process

A1073/A1073M Practice for Using Hand Micrometers to Measure the Thickness of Uncoated Steel Sheet and Nonmetallic and Metallic-Coated Steel Sheet

A1079 Specification for Steel Sheet, Complex Phase (CP), Dual Phase (DP) and Transformation Induced Plasticity (TRIP), Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A1087/A1087M Practice for Using Hand Calipers to Measure the Width of Steel Sheet

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

E376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods

2.2 *Federal Standard:*[3]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

3. Terminology

3.1 *Definitions*—For definitions of items used in this specification, refer to Terminology A902.

4. Ordering Information

4.1 Ordering information for all products is shown in the individual product specifications.

5. Materials and Manufacture

5.1 Hot-dip metallic coatings are used to provide corrosion protection to steel sheets. Hot-dip metallic coatings are available in five different types: zinc and zinc-iron alloy, aluminum, 55 % aluminum-zinc alloy, zinc-5 % aluminum alloy, and zinc-aluminum-magnesium alloy. Each coating type is available in various coating weights which provide varying degrees of corrosion protection and the consumer should consult the individual producers for applicability to the intended application and to obtain product information.

5.2 Hot-dip metallic coated products may be subject to changes in mechanical properties after coating. As such changes are functions of the chemistry and processing history of the material, the consumer should consult the individual producers for applicability to the intended application.

6. Chemical Composition

6.1 *Base Steel:*

6.1.1 Chemical composition requirements of the base steel are shown in the individual product specifications.

6.1.2 An analysis of each heat shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus, sulfur, and any other elements specified or restricted by the individual product specification.

6.1.3 When desired, product analysis shall be made by the purchaser on finished product. The product analysis so determined shall meet the tolerances shown in Table 1.

6.1.3.1 Capped or rimmed steels are not technologically suited to product analysis due to the nonuniform character of their chemical composition, and therefore, the tolerances in Table 1 do not apply. Product analysis is appropriate on these steels only when misapplication is apparent.

[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.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

TABLE 1 Product Analysis Tolerances

Element	Limited or Maximum of Specified Element, %	Tolerance	
		Under Minimum Limit	Over Maximum Limit
Carbon	To 0.15, incl	0.02	0.03
	Over 0.15 to 0.40, incl	0.03	0.04
	Over 0.40 to 0.80, incl	0.03	0.05
Manganese	To 0.60, incl	0.03	0.03
	Over 0.60 to 1.15, incl	0.04	0.04
	Over 1.15 to 1.65, incl	0.05	0.05
Phosphorus	. . .	. . .	0.01
Sulfur	. . .	. . .	0.01
Silicon	To 0.30, incl	0.02	0.03
	Over 0.30 to 0.60	0.05	0.05
Copper	. . .	0.02	. . .
Titanium	To 0.10, incl	0.01[A]	0.01
Vanadium	To 0.10, incl	0.01[A]	0.01
	Over 0.10 to 0.25, incl	0.02	0.02
	Minimum only specified	0.01	. . .
Columbium	To 0.10, incl	0.01[A]	0.01

[A] If the minimum of the range is 0.01 %, the under tolerance is 0.005 %.

6.1.3.2 Product analysis for phosphorus or sulfur is not technologically appropriate because of segregation of these elements in non-killed steels. Product analysis is appropriate only when misapplication is apparent.

6.1.3.3 Samples for product analysis shall be secured from areas stripped free of coating. At least one sample shall be secured from the product of each mill lift or coil.

6.1.3.4 When supplying High-Strength Low-Alloy Steel (HSLA), some producers use one or more microalloying elements as strengthening agents or use alloy additions to effect inclusion control, or both. The producer shall be consulted for the specific chemical composition applied. If any alloying addition is known to be of concern to the user, the producer shall be notified of this concern.

6.1.4 *Method of Analysis*—The determination of chemical composition is permitted to be made by any test method, except in case of dispute, where the referee test methods listed in the section on test methods of Test Methods A751 shall be used.

6.2 *Coating:*

6.2.1 *Coating Analysis*—The nominal composition of the coating is described in the individual product specification.

6.2.2 *Method of Analysis*—The determination of chemical composition shall be made in accordance with acceptable chemical, spectrochemical, or other test methods.

7. Tests for Mechanical Properties

7.1 Test specimens shall be prepared from finished metallic-coated product.

7.2 *Mechanical Properties-Base Metal*—When base metal mechanical properties are specified, tests shall be conducted in accordance with Test Methods A370. Requirements for all mechanical properties are included in the individual product specifications.

7.2.1 *Tension Tests*—Specimens for base-metal tension tests shall be taken longitudinally, approximately midway between the center and edge of the product as rolled, and shall conform to the requirements for the sheet-type test specimen in the figure for rectangular tension test specimens of Test Methods A370.

7.2.1.1 The determination of the yield strength and tensile strength values shall be based on the as-produced base-metal thickness that shall be obtained by one of the following methods. Unless specified in the order, the producer shall determine the method to be used; however, in the event of a dispute, the method in 7.2.1.2 shall be used.

7.2.1.2 The base metal thickness shall be determined by stripping the coating from the ends of the specimen contacting the grips of the tension testing machine. The thickness measurement shall be made before testing on an end of the specimen that has been stripped free of coating.

7.2.1.3 The base metal thickness shall be determined by subtracting the coating thickness from the measured thickness of the tension test specimen. The coating thickness shall be calculated from the coating weight [mass] test.

7.2.1.4 *Number of Tests*—Two tension tests shall be made from each strength grade of finished material produced from a single heat of 50 tons [45 000 kg] or greater. When the amount of finished material from each strength grade produced from a single heat is less than 50 tons [45 000 kg], one test shall be made. When testing is performed on a per coil basis, only one test shall be made for each master coil. When the finished material rolled from a heat of 50 tons [45 000 kg] or greater differs by more than 0.020 in. [0.51 mm] in thickness for cold rolled substrate or 0.050 in. [1.27 mm] for hot rolled substrate, one tension test shall be made from the thickest and thinnest material. When the finished material rolled from a heat of less than 50 tons [45 000 kg] differs by 0.020 in. [0.51 mm] or less in thickness for cold rolled substrate or 0.050 in. [1.27 mm] for hot rolled substrate, one test shall be made.

(1) Requirements specified in 7.2.1.4 are minimum testing requirements. Additional testing may be performed at the producer's option, or upon agreement between producer and user or seller and purchaser.

(2) Testing of non-strength required grades may also be performed as described in 7.2.1.4, for each specific non-strength grade ordered, upon agreement between producer and user or seller and purchaser.

8. Tests for Coating Properties

8.1 *Coating Weight [Mass]:*

8.1.1 Coating weight [mass] shall conform to the requirements prescribed in the individual product specifications (see 1.3).

8.1.2 The coating weight [mass] is ordered as total both sides requirements, or if requested on those product specifications permitting it, to single side/single spot coating mass requirements.

8.1.3 *Total Both Sides Requirements:*

8.1.3.1 The coating weight [mass] of equally coated product is the total amount on both sides of the sheet, expressed in ounces per square foot [grams per square metre] of sheet.

8.1.3.2 For differentially coated product, the coating weight [mass] on each surface is nominally one half of the stated coating designation.

8.1.4 *Single Side/Single Spot Requirements:*

8.1.4.1 The coating mass for each surface shall be specified separately, for example, 60G60G, and each single spot test shall meet the specified requirements for the coating designation.

8.2 *Coating Weight [Mass] Tests*—One of the following test methods shall be used:

8.3 *Weigh-Strip-Weigh Method:*

8.3.1 The weigh-strip-weigh method, described in Test Methods A90/A90M and A428/A428M, is a destructive test that determines coating weight [mass] by measuring the difference in weight [mass] between a coated and a stripped (uncoated) sample. If one surface is protected suitably during the initial stripping, coating weight [mass] can be determined for each surface independently.

8.3.2 Test specimens for product over 18 in. [450 mm] in width shall be taken from a representative sample piece approximately 1 ft [300 mm] in length by the associated width. Three test specimens shall be taken from the sample, one from the middle of the width and one from each edge. The edge samples shall not be taken closer than 2 in. [50 mm] from each edge. The test specimen shall have a minimum area of 5 $in.^2$ [3200 mm^2].

8.3.3 For product 18 in. [450 mm] in width and narrower, only one test specimen is required. Specimens shall be at least 2 in. [50 mm] from the edge, when possible. For product narrower than 2.25 in. [60 mm] the test specimen shall be chosen to give a minimum area of 5 $in.^2$ [3200 mm^2].

8.3.4 The triple-spot coating weight [mass] shall be the average of the determinations of the three tests done in accordance with the procedures in 8.3.2.

8.3.5 The total both sides minimum single-spot coating weight [mass] shall be that test result that is the lightest coating weight [mass], or in those cases where only one test is needed, it shall be that single test result.

8.3.6 The single side/single spot coating mass shall meet both the lower and upper limits of the specified coating designation.

8.3.7 The frequency of sampling shall be sufficient to adequately characterize the lot of material being tested.

8.4 *X-Ray Fluorescence Method:*

8.4.1 The X-ray fluorescence method is a nondestructive test that determines coating weight [mass] by converting X-ray fluorescence measurements to coating weight [mass] values. X-ray fluorescence gauges can be used as off-line laboratory instruments or as a means of continuous on-line testing for conformance to coating weight [mass] requirements, or both.

8.4.2 *Off-Line Testing*—X-ray fluorescence gauges can be used as off-line laboratory instruments to test for coating weight [mass] provided that they have been calibrated in accordance with Test Method A754/A754M and use the sample test locations as described in 8.3.2 or 8.3.3.

8.4.3 *On-Line Testing*—When X-ray fluorescence gauges are used for on-line testing, they shall be operated in accordance with Test Method A754/A754M. A minimum of five random full-width traverses shall be used to characterize each coil tested.

8.4.3.1 The triple-spot coating weight [mass] of a coil shall be determined using the following procedure: from the individual edge, center, edge readings provided by the minimum five full-width traverses, compute the average of one edge, the average of the center, and the average of the other edge. These three results shall then be averaged to obtain the triple-spot average of the coil.

8.4.3.2 The total both sides minimum single-spot coating weight [mass] shall be the lightest coating weight [mass] obtained from the individual edge, center, edge measurements provided by the minimum five full-width traverses (lightest of at least 15 readings—five from one edge, five from the center, and five from the other edge).

8.4.3.3 The single side/single spot minimum coating mass shall be the lightest coating mass obtained from the readings provided by the minimum five full-width traverses.

8.4.3.4 The single side/single spot maximum coating mass shall be the heaviest coating mass obtained from the readings provided by the minimum five full-width traverses.

8.5 *Coating Bend Test*—Refer to the individual product specification.

8.5.1 Coating bend test specimens shall be 2 to 4 in. [50 to 100 mm] wide. The specimen shall be cut not less than 2 in. [50 mm] from the edges of the test sheet.

9. Dimensions and Permissible Variations

9.1 The permissible variations for dimensions shall comply with the applicable limits in Tables 2-15.

9.2 The table of tolerances for thickness for measurements taken ⅜ in. from the edge are found in the Supplementary Requirements Section S1 of this specification. See the appropriate product specification for instructions on how to specify this table.

9.3 When thickness is measured using hand-held micrometers, refer to Practice A1073/A1073M.

9.4 When width is measured using hand-held calipers on product where decimal, not fraction, tolerances are indicated, refer to Practice A1087/A1087M.

9.5 *Coil Winding:*

9.5.1 Metallic-coated coils are typically wound with the intention that the sidewalls be nominally straight, that is, that the edges of each lap in the coil be nominally flush with each other throughout both walls of the coil. However, circumstances sometimes make it necessary to produce coils that have an intentional, back and forth, cyclic, stagger wound pattern on both sidewalls throughout the entire coil. The purchaser should contact the producer regarding any required limits on, or need for, stagger wound coils.

9.6 *Flatness Tolerances:*

9.6.1 Flatness tolerances for sheet are contained in Table 9 and in Table 10 for sheet specified to restricted flatness. Tables 11 and 12 contain flatness tolerances for SS, HSLAS, and HSLAS-F.

9.6.2 Measurement techniques for flatness characteristics are described in Practice A1030/A1030M.