

Australian Standard®

**Continuous hot-dip metallic coated steel
sheet and strip—Coatings of zinc and
zinc alloyed with aluminium and
magnesium**



AS/NZS	
1050	Methods for the analysis of iron and steel (all parts)
1365	Tolerances for flat-rolled steel products
ASTM	
A754	Test method for coating weight (mass) of metallic coatings on steel by X-ray fluorescence
ISO	
7966	Acceptance control charts

1.3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.3.1 Batch

An identifiable amount of 50 t or less of one product type, i.e. of a particular thickness of steel grade, coating type and coating mass, processed sequentially under similar conditions.

1.3.2 Coating mass

The total mass of coating on both surfaces of the steel base, measured in grams per square metre of sheet or strip. In the case of differential coatings, the different surfaces are stated separately.

NOTE: The coating thickness is not subject to specification as it depends upon the coating alloy density, which varies with composition. The approximate coating thickness for various coating classes is given in Table C2 in Appendix C.

1.3.2.1 *One surface single spot coating mass*

The minimum coating mass on any one surface of any one of the three specimens used for the triple spot test.

1.3.2.2 *Single sided coating mass—applicable for differential coatings, see Table 3.6*

The mass of coating on any one surface of the steel base, measured in grams per square metre of sheet or strip, based on the average of three specimens selected from a sample representing the original cross section of the sheet or strip.

1.3.2.3 *Single spot coating mass*

The coating mass for one of the three specimens used for the triple spot coating mass test.

1.3.2.4 *Triple spot coating mass*

The average coating mass of three specimens selected from a sample representing the original cross-section of the sheet or strip.

1.3.3 Coating type

The compositions of many of the metallic coatings described in this Standard are based around a nominal element, e.g. zinc, or a nominal combination of elements, e.g. 55% aluminium with balance zinc. In certain coatings there are additions of elements considered minor in their percentage, or influence in terms of the coating performance, e.g. the addition of 0.20% aluminium to control alloying in zinc type coatings.

The reference to ‘minor additions of control elements’ in this Standard is to cover these instances, i.e. minor additions of control elements are present at less than 1% by mass and do not fundamentally alter the overall properties of the coating type within which they are contained. Percentages referenced in the standard are mass %.

1.3.3.1 *Zinc coating*

A hot-dip coating of 99% zinc incorporating less than 1% of minor additions of control elements (Type Z) or a coating of zinc converted to a zinc/iron alloy (Type ZF).

1.3.3.2 *Zinc/aluminium coating*

A hot-dip coating of zinc with 3% to 15% aluminium and incorporating less than 1% of minor additions of control elements (Type ZA).

1.3.3.3 *Zinc/aluminium/magnesium coating*

A hot-dip coating of zinc with 5% to 13% aluminium, 2% to 4% magnesium and incorporating less than 1% of minor additions of control elements (Type ZM).

1.3.3.4 *Aluminium/zinc alloy coating*

A hot-dip coating of 50% to 60% aluminium, 1% to 2% silicon, with the remainder zinc, and incorporating less than 1% of minor additions of control elements. (Type AZ).

1.3.3.5 *Aluminium/zinc/magnesium alloy coating*

A hot-dip coating of 47% to 57% aluminium, 1% to 3% magnesium, 1% to 2% silicon with the remainder zinc, and incorporating less than 1% of minor additions of control elements (Type AM).

1.3.4 **Differential coating**

A coating whereby the manufacturer has deliberately applied a different coating mass to each side of the steel.

In the case of a differential coating the designation states the coating mass in g/m² of sheet for each side separately, see Example 6 in Clause 1.5.3.

For a non-differential coating, the single sided coating mass in a single spot cannot be less than 40% of the stated total coating mass.

1.3.5 **Sheet**

A flat rolled product of any width and thickness coated by hot-dipping and supplied in cut lengths.

1.3.6 **Strip**

A flat rolled product of any width and thickness coated by hot-dipping and supplied in coil form.

1.4 **SURFACE CONDITIONING AND SURFACE TREATMENT**

1.4.1 **General**

Metallic coated steel products can be conditioned mechanically after coating, and can be supplied with a number of surface treatments. The required surface condition and treatment should be specified upon ordering with the supplier (see Appendix A).

1.4.2 **Surface conditioning**

1.4.2.1 *Skin passing*

The metallic coated surface can be 'skin passed' after the coating process to produce a matte finish, typically for painting.

This process may disguise the natural spangled appearance of the product (see Clause 1.5.3.6.5 below) and is designated by the suffix 'S' after the coating mass, e.g. AZ150S.

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Table 5 Chemical composition

Unit: %

Symbol of grade	C	Mn	P	S
SGHC	0.15 max.	0.80 max.	0.05 max.	0.05 max.
SGH340	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGH400	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGH440	0.25 max.	2.00 max.	0.20 max.	0.05 max.
SGH490	0.30 max.	2.00 max.	0.20 max.	0.05 max.
SGH540	0.30 max.	2.50 max.	0.20 max.	0.05 max.
SGCC	0.15 max.	0.80 max.	0.05 max.	0.05 max.
SGCH	0.18 max.	1.20 max.	0.08 max.	0.05 max.
SGCD1	0.12 max.	0.60 max.	0.04 max.	0.04 max.
SGCD2	0.10 max.	0.45 max.	0.03 max.	0.03 max.
SGCD3	0.08 max.	0.45 max.	0.03 max.	0.03 max.
SGCD4	0.06 max.	0.45 max.	0.03 max.	0.03 max.
SGC340	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGC400	0.25 max.	1.70 max.	0.20 max.	0.05 max.
SGC440	0.25 max.	2.00 max.	0.20 max.	0.05 max.
SGC490	0.30 max.	2.00 max.	0.20 max.	0.05 max.
SGC570	0.30 max.	2.50 max.	0.20 max.	0.05 max.
Alloy elements other than those given in this table may be added as required.				

5 Coating

5.1 Plating bath composition

Plating bath shall be tested for composition in accordance with **13.2** and shall be as given in Table 6.

NOTE In the hot-dip coating process, the base metal is immersed in a molten metal bath at a high temperature, and then cooled to form a coating on the base metal surface. This molten metal bath is called plating bath.

Table 6 Plating bath composition

Unit: %

Elements other than Zn	Zn
1.0 max. ^{a)}	Remainder ^{b)}
<p>Notes ^{a)} The figure indicates the total amount of elements which are added intentionally.</p> <p>^{b)} The remainder may include elements which are mixed unavoidably.</p>	

5.2 Type of coating

The coating is classified into two types: non-alloy coating and alloy coating ²⁾.



Designation: A653/A653M – 20

Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process¹

This standard is issued under the fixed designation A653/A653M; 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 steel sheet, zinc-coated (galvanized) or zinc-iron alloy-coated (galvannealed) by the hot-dip process in coils and cut lengths.

1.2 The product is produced in various zinc or zinc-iron alloy-coating weights [masses] or coating designations as shown in [Table 1](#) and in [Table S2.1](#).

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

1.4 The product is available in a number of designations, grades, and classes in four general categories that are designed to be compatible with different application requirements.

1.4.1 Steels with mandatory chemical requirements and typical mechanical properties.

1.4.2 Steels with mandatory chemical requirements and mandatory mechanical properties.

1.4.3 Steels with mandatory chemical requirements and mandatory mechanical properties that are achieved through solid-solution or bake hardening.

1.5 This specification is applicable to orders in either inch-pound units (as A653) or SI units (as A653M). 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.

1.6 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 this specification.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.9 *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](#)

[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](#)

[B6 Specification for Zinc](#)

[B852 Specification for Continuous Galvanizing Grade \(CGG\) Zinc Alloys for Hot-Dip Galvanizing of Sheet Steel](#)

[D7396 Guide for Preparation of New, Continuous Zinc-Coated \(Galvanized\) Steel Surfaces for Painting](#)

[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](#)

2.2 ISO Standards:³

[ISO 3575 Continuous Hot-Dip Zinc-Coated Carbon Steel of Commercial and Drawing Qualities](#)

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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

- 5.2.5 Chemically treated or not chemically treated,
- 5.2.6 Oiled or not oiled,
- 5.2.7 Finish (minimized spangle, regular spangle, or spangle-free),
- 5.2.8 Extra smooth (if required),
- 5.2.9 Phosphatized (if required),
- 5.2.10 Dimensions (show thickness, minimum or nominal, width, flatness requirements, and length, (if cut lengths)),
- 5.2.11 Coil size requirements (specify maximum outside diameter (OD), acceptable inside diameter (ID), and maximum weight [mass]),
- 5.2.12 Packaging,
- 5.2.13 Certification, if required, heat analysis and mechanical property report,
- 5.2.14 Application (part identification and description), and
- 5.2.15 Special requirements (if any).
- 5.2.15.1 If required, the product may be ordered to a specified base metal thickness (see Supplementary Requirement S1).
- 5.2.15.2 If required, the product may be ordered to a specified single spot/single side coating mass (see Supplementary Requirement S2).
- 5.2.15.3 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-coated, commercial steel Type A, ASTM A653, Coating Designation G115, chemically treated, oiled, minimum 0.040 by 34 by 117 in., for stock tanks, or steel sheet, zinc-coated, high strength low alloy steel Grade 340, ASTM A653M, Coating Designation Z275, minimized spangle, not chemically treated, oiled, minimum 1.00 by 920 mm by coil, 1520-mm maximum OD, 600-mm ID, 10 000-kg maximum, for tractor inner fender.

NOTE 2—The purchaser should be aware that there are variations in manufacturing practices among the producers and therefore is advised to establish the producer's standard (or default) procedures for thickness tolerances.

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 (Types A and C), and EDDS, and Table 3 for SS, HSLAS, HSLAS-F, SHS, and BHS.

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 is less than 0.008 %, report the analysis as either <0.008 % or the actual determined value. When the amount of boron is less than 0.0005 %, report as <0.0005 % or the actual determined value.

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

6.2 Zinc Bath Analysis—The bath metal used in continuous hot-dip galvanizing shall contain not less than 99 % zinc, with a lead level not exceeding 0.009 %.

NOTE 3—To control alloy formation and promote adhesion of the zinc coating with the steel base metal, the molten coating metal composition normally contains a percentage of aluminum usually in the range from 0.05 to 0.25. This aluminum is purposely supplied to the molten coating bath, either as a specified ingredient in the zinc spelter or by the addition of a master alloy containing aluminum. Specification B852 specifies continuous galvanizing grade (CGG) zinc alloys, including multiple zinc alloys, that both enable the molten coating to be controlled within 0.05 to 0.25 % aluminum and to not exceed 0.009 % lead. Specification B6 specifies certain grades of zinc that do not exceed 0.009 % lead, but contain lower levels of aluminum.

NOTE 4—The producer can demonstrate compliance with the maximum lead level by way of chemical test certificates from the zinc supplier.

7. Mechanical Properties

7.1 Structural steel, high-strength low-alloy steel, high strength low alloy steel with improved formability, solution

TABLE 2 Chemical Requirements^A

Designation	Composition, %—Heat Analysis Element, max (unless otherwise shown)													
	Carbon	Manganese	Phosphorus	Sulfur	Aluminum, min	Cu	Ni	Cr	Mo	V	Cb/ Nb ^{F,I}	Ti ^B	N	B
CS Type A ^{C, D,E}	0.10	0.60	0.030	0.035	^A	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
CS Type B ^{F,C}	0.02 to 0.15	0.60	0.030	0.035	^A	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
CS Type C ^{C,D,E}	0.08	0.60	0.100	0.035	^A	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
FS Type A ^{C,G}	0.10	0.50	0.020	0.035	^A	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
FS Type B ^{F,C}	0.02 to 0.10	0.50	0.020	0.030	^A	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
DDS Type A ^{D,E}	0.06	0.50	0.020	0.025	0.01	0.25	0.20	0.15	0.06	0.008	0.008	0.025	^A	^A
DDS Type C ^{D,E}	0.02	0.50	0.020 to 0.100	0.025	0.01	0.25	0.20	0.15	0.06	0.10	0.10	0.15	^A	^A
EDDS ^H	0.02	0.40	0.020	0.020	0.01	0.25	0.20	0.15	0.06	0.10	0.10	0.15	^A	^A

^A There is no requirement, but the analysis shall be reported.

^B For steels containing 0.02 % carbon or more, titanium is permitted at the producer's option, to the lesser of 3.4N + 1.5S or 0.025 %.

^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 Shall be furnished as a stabilized steel.

^I Columbium (Cb) and Niobium (Nb) are considered interchangeable names for Element 41 in the periodic table and both names are acceptable for use.