Designation: A1055/A1055M – 10$^{\varepsilon 1}$

Standard Specification for Zinc and Epoxy Dual-Coated Steel Reinforcing Bars[1]

This standard is issued under the fixed designation A1055/A1055M; 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.

ε[1] NOTE—Mathematical corrections to A1.3.8 were made in December 2011.

1. Scope*

1.1 This specification covers deformed and plain steel reinforcing bars with a dual coating of zinc alloy and an epoxy coating. The zinc-alloy layer is applied by the thermal spray coating method (metallizing) followed by an epoxy coating applied by the electrostatic spray method.

NOTE 1—The coating applicator is identified throughout this specification as the manufacturer.

1.2 Requirements of the zinc coating are contained in Table 1.

1.3 Requirements for fusion-bonded powder coatings are contained in Annex A1.

1.4 Guidelines for construction practices at the job-site are presented in Appendix X1.

1.5 This specification is applicable for orders in either inch-pound or SI units.

1.6 The values stated in either inch-pound units or SI units are to be regarded as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other, except as specifically noted in Table 2. Combining values from the two systems may result in nonconformance with this specification.

1.7 *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]

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

A944 Test Method for Comparing Bond Strength of Steel Reinforcing Bars to Concrete Using Beam-End Specimens

A996/A996M Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

B117 Practice for Operating Salt Spray (Fog) Apparatus

B833 Specification for Zinc and Zinc Alloy Wire for Thermal Spraying (Metallizing) for the Corrosion Protection of Steel

D4060 Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser

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

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

G8 Test Methods for Cathodic Disbonding of Pipeline Coatings

G14 Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test)

G20 Test Method for Chemical Resistance of Pipeline Coatings

G62 Test Methods for Holiday Detection in Pipeline Coatings

2.2 *American Welding Society:*[3]

ANSI/AWS A5.33 Specification for Solid and Ceramic Wires and Ceramic Rods for Thermal Spraying

AWS C2.23M/C2.23 Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection for Steel

AWS C2.25/C2.25M Specification for Thermal Spray Feedstock—Solid and Composite Wire and Ceramic Rods

[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 A01.05 on Steel Reinforcement.

Current edition approved Dec. 1, 2010. Published December 2010. Originally approved in 2008. Last previous edition approved in 2008 as A1055 – 08a$^{\varepsilon 1}$. DOI: 10.1520/A1055_A1055M-10E01.

[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 Welding Society (AWS), 550 NW LeJeune Rd., Miami, FL 33126, http://www.aws.org.

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

TABLE 1 Chemical Composition Requirements for Zinc and Zinc-Alloy Wires

Common Name (UNS)[A]	Al, max unless noted	Cd, max	Cu, max	Fe, max	Pb, max	Sn, max	Sb, max	Ag, max	Bi, max	As, max	Ni, max	Mg, max	Mo, max	Ti, max	Zn, min	Other, Total max
99.99 Zinc[B] (Z13005)	0.002[C]	0.003	0.005	0.003	0.003	0.001	...[D]	...	...	...	...	...	...	...	99.99	...
99.99 Zinc[B] (Z15005)	0.01	0.02	0.02	0.02	0.03	...	...	...	...	...	...	...	...	...	99.9	0.10 total non-Zn
99.995 Zinc (...)[E]	0.001	0.003	0.001	0.002	0.003	0.003	...	...	...	...	...	...	...	...	99.995	0.005
99.95 Zinc (...)	0.01	0.02	0.001	0.02	0.03	0.001	...	...	...	...	...	...	...	...	99.95	0.050
99.95 Zinc (...)	0.01	0.005	0.7	0.01	0.005	0.001	...	...	...	...	...	0.01	0.01	0.18	99	1.0
98Zn/2Al (Z30402)	1.5-2.5	0.005	0.005	0.02	0.005	0.003	0.10	0.015	0.02	0.002	0.005	0.02	...	...	remainder	...

[A] UNS designations were established in accordance with Practice E527.
[B] In accordance with ANSI/AWS A5.33.
[C] The following applies to all specified limits in this table. For the purposes of determining conformance with this specification, an observed value obtained from analysis shall be rounded off to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding method of Practice E29.
[D] ... indicates that the element is not applicable.
[E] (...) indicates no Unified Numbering System (UNS) designation for this option.

TABLE 2 Bend Test Requirements

A615, A706, or A996		A615M, A706M, or A996M		Bend Angle (After Rebound, degrees)	Time to Completion max, s
Bar No.	Mandrel Diameter in.[A]	Bar No.	Mandrel Diameter mm[A]		
3	3	10	75	180	15
4	4	13	100	180	15
5	5	16	125	180	15
6	6	19	150	180	15
7	7	22	175	180	45
8	8	25	200	180	45
9	9	29	230	180	45
10	10	32	250	180	45
11	11	36	280	180	45
14	17	43	430	90	45
18	23	57	580	90	45

[A] Mandrel diameters specified for similar size (shown on the same line) inch-pound bars and metric may be interchanged.

2.3 *NACE International Standard:*[4]

RP-287 Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surface Using a Replica Tape

2.4 *Society for Protective Coatings Specifications:*[5]

SSPC-PA 2 Measurement of Dry Coating Thickness with Magnetic Gages

SSPC-SP 10 Near-White Blast Cleaning

SSPC-VIS 1 Pictorial Surface Preparation standards for Painting Steel Surfaces

2.5 *Concrete Reinforcing Steel Institute:*[6]

Voluntary Certification Program for Fusion Bonded Epoxy Coating Applicator Plants

2.6 *American Concrete Institute Standard:*[7]

ACI 301 Specifications for Structural Concrete

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *disbonding, n*—loss of adhesion between the fusion-bonded powder coating and the zinc-coated steel reinforcing bar.

3.1.2 *fusion-bonded powder coating, n*—a product containing pigments, thermosetting resins, cross-linking agents, and other additives, which is applied in the form of a powder onto a clean, heated metallic substrate and fused to form a continuous barrier coating.

3.1.3 *holiday, n*—a discontinuity in a coating that is not discernible to a person with normal or corrected vision.

3.1.4 *patching material, n*—a liquid two-part, epoxy coating used to repair damaged or uncoated areas.

3.1.5 *thermal spray coating (metallizing), n*—a zinc and zinc alloy, or both, wire used in depositing a metallized layer of zinc by thermal spraying (metallizing) using oxy-fuel or electric-arc thermal spraying which is applied onto a clean, heated metallic substrate to form a continuous coating.

3.1.6 *wetting agent, n*—a material that lowers the surface tension of water allowing it to penetrate more effectively into small discontinuities in the coating giving a more accurate indication of the holiday count.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for the coated steel reinforcing bars under this specification. Such requirements to be considered include but are not limited to the following:

4.1.1 Reinforcing bar specification and year of issue,

4.1.2 Quantity of bars,

4.1.3 Size and grade of bars,

4.1.4 Requirements for the zinc coating (5.2),

4.1.5 Requirements for the powder coating and provision of test data (5.3 and 5.4),

4.1.6 Requirements for patching material (5.5),

4.1.7 Quantity of patching material,

[4] Available from National Association of Corrosion Engineers (NACE), 1440 South Creek Dr., Houston, TX 77084-4906, http://www.nace.org.

[5] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.

[6] Available from Concrete Reinforcing Steel Institute (CRSI), 933 North Plum Grove Rd., Schaumburg, IL 60173-4767, http://www.crsi.org.

[7] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.aci-int.org.

4.1.8 Specific requirements for test frequency (9.1),

4.1.9 Whether a report on tests performed on the coated steel reinforcing bars being furnished is required (8.4.1 and Section 14),

4.1.10 Additional specimens to be provided to the purchaser for testing from the coated steel reinforcing bars being furnished (12.1), and

4.1.11 Manufacturer qualification and certification requirements (if any).

NOTE 2—It is recommended that the coating application procedures and processes be audited by an independent certification program for coating applicator plants such as that provided by the Voluntary Certification Program or equivalent.

5. Materials

5.1 Steel reinforcing bars to be coated shall meet the requirements of one of the following specifications: A615M, A706M, or A996M [A615, A706, or A996] as specified by the purchaser and shall be free of contaminates such as oil, grease, or paint.

NOTE 3—Prior to coating, the steel reinforcing bars should be inspected for their suitability for coating. Bars with sharp edges on the deformations, rolled-in slivers, or other surface imperfections are difficult to coat properly and should not be coated. The coating will flow away from the sharp edges and may result in inadequate coating thickness at these points.

5.2 *Zinc-Alloy Wire:*

5.2.1 The thermal spray coating feedstock material shall be specified according to Specification B833 or to AWS C2.25/C2.25M.

5.2.2 The wire shall conform to one of the chemical composition requirements prescribed in Table 1.

5.2.3 The wire shall be clean and free of corrosion, adhering foreign material, scale, seams, nicks, burrs, and other defects which would interfere with the operation of thermal spraying equipment. The wire shall uncoil readily and be free of bends or kinks that would prevent its passage through the thermal spray gun.

5.2.4 The wire shall be a continuous length per spool, coil, or drum. Splices or welds are permitted, provided that they do not interfere with the thermal spray equipment or coating process.

5.2.5 The starting end of each coil shall be tagged to indicate winding direction and to be readily identifiable with ASTM designation.

5.3 *Powder Coating:*

5.3.1 The powder coating shall meet the requirements of Annex A1. Upon request, the purchaser shall be provided with the test report for review.

5.3.2 A written certification shall be furnished to the purchaser that properly identifies the number of each lot of powder coating used in the order material quantity represented, date manufacture, name and address of the powder coating manufacturer, and a statement that the supplied powder coating is the same composition as that qualified according to Annex A1 of this specification.

5.3.3 The powder coating shall be stored in a temperature-controlled environment following the written recommendations of the powder coating manufacturer until ready for use. At that point, if the storage temperature is below the plant ambient temperature, the powder coating shall be given sufficient time to reach approximate plant ambient temperature. The powder coating shall be used within the powder coating manufacturer's written recommended shelf life.

5.4 If specified in the order, a representative 8-oz [0.2-kg] sample of the powder coating shall be supplied to the purchaser from each batch. The sample shall be packaged in an airtight container and identified by batch number.

5.5 If specified in the order, patching material compatible with the coating, inert in concrete, and approved by the powder coating manufacturer, shall be supplied to the purchaser.

6. Surface Preparation

6.1 The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive blast cleaning to near-white metal in accordance with SSPC-SP10. The following visual standard of comparison may be used to define the final surface condition: SSPC-VIS 1. Average blast profile maximum roughness depth readings of 1.5 to 4.0 mils [0.04 to 0.10 mm] as determined by replica tape measurements using NACE RP-287, shall be considered suitable as an anchor pattern.

NOTE 4—The use of a "profilometer"-type surface measurement instrument that measures the peak count as well as the maximum profile depth is recommended.

NOTE 5—Abrasive blast cleaning of steel reinforcing bars with a high degree (>90 %) of grit in the cleaning media provides the most suitable anchor profile for coating adhesion. After grit has been recycled, a small portion will take on the appearance of shot.

6.2 Multidirectional, high-pressure dry air knives shall be used after blasting to remove dust, grit, and other foreign matter from the blast-cleaned steel surface. The air knives shall not deposit oil on the steel reinforcing bars.

NOTE 6—It is recommended that incoming steel reinforcing bars and blast media be checked for salt contamination prior to use. Blast media found to be salt contaminated should be rejected. Steel reinforcing bars found to be salt contaminated from exposure to deicing salts or salt spray should be cleaned by acid washing or other suitable methods to remove salt contaminants from the surface prior to blast cleaning.

7. Coating Application

7.1 A thin zinc-alloy layer shall be applied by a thermal arc spray (metallization) system directly after the blast cleaning and before the powder coating in accordance with AWS C2.23M/C2.23 and the written specification of the zinc alloy supplier.

7.1.1 Thermal spray equipment shall be set up, calibrated, and operated according to the manufacturer's instructions and technical manuals or the Thermal Coating Spray applicator's recommendation.

7.2 The zinc-alloy coating shall be applied to the cleaned steel reinforcing bar surface as soon as possible after the bar has been cleaned and before visible oxidation of the surface occurs as discernible to a person with normal or corrected vision. In no case shall application of the coating be delayed more than 30 minutes after cleaning.

7.3 The fusion-bonded epoxy powder coating shall be applied in accordance with the written recommendations of the manufacturer of the powder coating for initial steel surface temperature range and post application curing requirements.

During continuous operations, the temperature of the surface immediately prior to coating shall be measured using infrared guns or temperature indicating crayons, or both, at least once every 30 minutes. At no time shall the temperature of the bar exceed 700°F [334°C].

NOTE 7—The use of both infrared and temperature-indicating crayon measurement of the steel reinforcing bars is recommended.

7.4 The powder coating shall be applied by electrostatic spray or other suitable method.

8. Requirements for Coated Steel Reinforcing Bars

8.1 *Coating Thickness:*

8.1.1 The coating thickness of the zinc layer shall be a minimum of 1.4 mils [35 µm].

8.1.2 The total coating thickness measurements of the combined zinc-alloy layer and the epoxy coating layer after curing shall be 7 to 12 mils [175 to 300 µm] for bars sizes Nos. 3 to 5 [Nos. 10 to 16] and 7 to 16 mils [175 to 400 µm] for bar sizes Nos. 6 to 18 [Nos. 19 to 57]. The upper thickness limit shall not apply to repaired areas of damaged coating.

8.1.3 Coating thicknesses shall be measured and recorded for both zinc and epoxy thickness. A single recorded steel reinforcing bar coating thickness measurement is the average of three individual gage readings obtained between four consecutive deformations. A minimum of five recorded measurements shall be taken approximately evenly spaced along each side of the test specimens (a minimum of ten recorded measurements per bar).

NOTE 8—The zinc thickness will be measured by either using a bar that has only the zinc coating applied or by use of a duplex measuring device capable of reading the zinc and epoxy coatings simultaneously.

8.1.4 For acceptance purposes, the average of all recorded coating thickness measurements shall not be less than the specified minimum thickness or more than the specified maximum thickness. No single recorded coating thickness measurement shall be less than 80 % of the specified minimum thickness or more than 120 % of the specified maximum thickness.

8.1.5 Thickness measurements shall be made in accordance with SSPC-PA-2 and in accordance with the manufacturer's instructions for the measuring device, following the instructions for calibration and use recommended by the thickness gage manufacturer. "Pencil-type" pull-off gages that require the operator to observe the reading at the instant the magnet is pulled from the surface shall not be used.

8.1.6 The coating thickness shall be measured on the body of a straight length of steel reinforcing bar between the deformations.

8.2 *Coating Continuity:*

8.2.1 The zinc coating shall be uniform without blisters, cracks, loose particles, or exposed steel as examined with 10× magnification.

8.2.2 The manufacturer's plant shall have an operational in-line 67.5 V, 80 000 Ω wet-sponge type direct-current holiday detector or equivalent method with an automated holiday counting system to determine the epoxy coating acceptability of the steel reinforcing bars prior to shipment.

NOTE 9—Hand-held holiday detector checks should be performed each production day to verify the accuracy of the in-line system. Hand-held holiday detectors offer a reliable way to correlate data obtained from the in-line holiday-detection system.

8.2.3 On average, there shall not be more than one holiday per foot [three holidays per metre] on a coated steel reinforcing bar. The average applies to the full production length of a bar.

8.2.4 A wetting agent shall be used in accordance with Test Methods G62 in the inspection for holidays on the coated steel reinforcing bars.

8.3 *Epoxy Coating Flexibility:*

8.3.1 The epoxy coating flexibility shall be evaluated by bending production coated steel reinforcing bars (with both the alloy zinc and the powder coating applied) at a uniform rate around a mandrel of specified size within a maximum specified time period as prescribed in Table 2. The two longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius. The test specimens shall be between 158 and 176°F [70 and 80°C].

8.3.2 Cracking or disbonding of the coating on the outside radius of the bent bar visible to a person with normal or corrected vision shall be considered cause for rejection of the coated steel reinforcing bars represented by the bend test sample.

NOTE 10—The qualification requirements for coating flexibility (see A1.3.5.1) prescribe bending a No. 6 [No. 19] deformed bar around a 6-in. [150-mm] diameter mandrel. The bend test requirements in Table 2 for evaluating the coating flexibility of production-coated steel reinforcing bars, for bar sizes Nos. 3 to 8 [Nos. 10 to 25], are not compatible with fabrication bending practices. Finished bend diameters for bar sizes Nos. 3 to 8 [Nos. 10 to 25] used in actual construction are smaller than the mandrel diameters in Table 2. Thus, the finished bends of production-coated bars, particularly the smaller bar sizes used for stirrups and ties, should be examined closely for hairline cracking on the outside radius of the bent bar. If hairline cracking is present, it should be repaired with patching material. To minimize the potential for damaging the coating, bending should be performed within the prescribed temperature range of 158 and 176°F [70 and 80°C].

8.3.3 A test in which fracture or partial failure of the steel reinforcing bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test occurs, shall be considered an invalid test and the test shall be repeated on a new specimen.

8.4 *Coating Adhesion:*

8.4.1 Coating adhesion shall be evaluated by testing production coated steel reinforcing bars according to the cathodic disbondment procedure described in A1.3.2.1. Data from testing pertaining to the coated steel reinforcing bars being furnished shall be made available to the purchaser upon request.

NOTE 11—It is recommended that the manufacturer retain test specimens for 30 days of production and use a 30-day rolling average of coating disbondment test data as a basis for its statistical process control program for the steel reinforcing bar coating operation.

8.5 The requirements for coated steel reinforcing bars shall be met at the manufacturer's plant prior to shipment.