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Standard Specification for Extra-High-Strength and Ultra-High-Strength Class A Zinc–5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Use in Overhead Electrical Conductors[1]

This standard is issued under the fixed designation B958/B958M; 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 round, extra-high-strength, and ultra-high-strength, Class A coated zinc–5 % aluminum-mischmetal (Zn–5Al–MM) alloy-coated, steel core wire for use in Overhead Electrical Conductors.

1.2 This specification covers wire of diameter from 0.0500 to 0.1900 in. inclusive or 1.27 to 4.82 mm inclusive.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *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.*

1.5 *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

A751 Test Methods and Practices for Chemical Analysis of Steel Products

B193 Test Method for Resistivity of Electrical Conductor Materials

B750 Specification for GALFAN (Zinc-5 % Aluminum-Mischmetal) Alloy in Ingot Form for Hot-Dip Coatings

E1277 Test Method for Analysis of Zinc-5 % Aluminum-Mischmetal Alloys by ICP Emission Spectrometry

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

2.2 *Other Standard:*

GF-1 Standard Practice for Determination of Cerium and Lanthanum Compositions in Galfan Alloy (5 % Al-0.04 % La-0.04 % Ce-Bal SHG Zn)[3]

3. Terminology

3.1 *Abbreviations:*

3.1.1 *MM*—mischmetal

3.1.2 *Zn–5Al–MM*—zinc–5 % aluminum mischmetal alloy

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lot, n*—unless otherwise specified in the contract or order, a lot shall consist of all coils of wire of the same diameter and unit lengths submitted for inspection at the same time.

3.2.2 *product code, n*—defines product coating type, coating class, and strength grade.

3.2.2.1 *Extra High Strength Grade Zn–5Al–MM, Class A Coated*—use Code MA4.

3.2.2.2 *Ultra High Strength Grade Zn–5Al–MM, Class A Coated*—use Code MA5.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information:

4.1.1 Quantity of each size,

4.1.2 Wire diameter in inches or millimeter (Section 13),

4.1.3 Certification, if required (Section 18),

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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 the International Lead Zinc Research Organization (ILZRO), 1822 NC Highway 54 East, Suite 120, Durham NC 27713, http://www.ilzro.org.

4.1.4 Test report, if required (Section 18),
4.1.5 Package size (Section 19), and
4.1.6 Product code.

5. Materials and Manufacture

5.1 The base metal shall be steel produced by the open-hearth, electric furnace, or basic oxygen process.

5.2 The wire shall be cold drawn and coated with Zn–5Al–MM alloy to produce the desired properties.

6. Chemical Composition

6.1 The steel shall conform to the requirements prescribed in Table 1.

6.2 Chemical analysis of the steel shall be conducted in accordance with Test Methods and Practices A751.

6.3 The ingot form of zinc-5 % aluminum-mischmetal alloy shall conform to Specification B750.

6.3.1 For a two-step coating operation where the first coating is zinc (hot-dip galvanized or electro-galvanized), the final bath may have an aluminum content of up to 7.2 %, to prevent depletion of the aluminum content of the bath.

6.3.2 *Method of Coating Material Analysis*—Refer to Specification B750.

7. Tensile Test

7.1 The Zn–5Al–MM alloy-coated steel core wire shall conform to the ordered tensile and elongation requirements prescribed in Table 2, Table 3, Table 4, or Table 5 and a minimum breaking strength (lb [N]) calculated from the minimum required tensile and nominal wire diameter. The wire tensile strength used to determine compliance to Table 2, Table 3, Table 4, or Table 5 shall be calculated using the actual wire breaking strength and the nominal finished diameter of the wire.

7.2 Tensile tests shall be conducted in accordance with Test Methods and Definitions A370, using the initial settings for determining stress at 1 % extension given in Table 6 or Table 7 of this specification.

7.3 *Test Specimens*—The test specimens shall be free of bends or kinks other than the curvature resulting from the usual coiling operations. Any hand straightening necessary to permit insertion of the specimen in the jaws of the testing machine shall be performed by drawing between wood blocks or by some other equally satisfactory means.

7.4 The nominal diameter requested shall be used to determine the applicable strength specification from the tables.

TABLE 1 Chemical Requirements

Element	Composition, %
Carbon	0.50 to 1.00
Manganese	0.30 to 1.30
Phosphorus, max	0.035
Sulfur, max	0.045
Silicon	0.15 to 1.20

TABLE 2 Grade 4 Extra-High-Strength Tensile Requirements

Specified Diameter, in.	Stress at 1 % Extension, min, kpsi	Ultimate Tensile Strength, min, kpsi	Elongation in 10 in., min %
0.0500 to 0.0899, incl	225	265	3.0
0.0900 to 0.1199, incl	220	260	3.0
0.1200 to 0.1399, incl	215	255	3.5
0.1400 to 0.1900, incl	210	250	3.5

TABLE 3 Grade 4 Extra-High-Strength Tensile Requirements [Metric]

Specified Diameter, mm	Stress at 1 % Extension, min, MPa	Ultimate Tensile Strength, min, MPa	Elongation in 250 mm, min %
1.27 to 2.28, incl	1550	1825	3.0
2.29 to 3.04, incl	1515	1790	3.0
3.05 to 3.55, incl	1480	1760	3.5
3.56 to 4.82, incl	1450	1725	3.5

TABLE 4 Grade 5 Ultra-High-Strength Tensile Requirements

Specified Diameter, in.	Stress at 1 % Extension, min, kpsi	Ultimate Tensile Strength, min, kpsi	Elongation in 10 in., min %
0.0500 to 0.0899, incl	230	285	3.0
0.0900 to 0.1199, incl	225	275	3.0
0.1200 to 0.1399, incl	220	270	3.5
0.1400 to 0.1900, incl	215	265	3.5

TABLE 5 Grade 5 Ultra-High-Strength Tensile Requirements [Metric]

Specified Diameter, mm	Stress at 1 % Extension, min, MPa	Ultimate Tensile Strength, min, MPa	Elongation in 250 mm, min %
1.27 to 2.28, incl	1580	1965	3.0
2.29 to 3.04, incl	1550	1900	3.0
3.05 to 3.55, incl	1515	1860	3.5
3.56 to 4.82, incl	1480	1825	3.5

TABLE 6 Initial Settings for Determining Stress at 1 % Extension

Specified Diameter, in.	Initial Stress, kpsi	Initial Setting of Extensometer, in./in.
0.0500 to 0.0899, incl	18	0.0005 (0.05 % extension)
0.0900 to 0.1199, incl	36	0.0010 (0.10 % extension)
0.1200 to 0.1900, incl	54	0.0015 (0.15 % extension)

8. Wrap Test

8.1 The material, as represented by the test specimens, shall not fracture when the Zn–5Al–MM alloy-coated wire is wrapped at a rate not exceeding 15 turns/min in a helix of at least eight turns around a cylindrical mandrel with a diameter equal to four times the specified diameter of the wire under test, ±5 %. The edge-to-edge spacing of consecutive turns shall not exceed two times the diameter of the wire.

9. Coating Test

9.1 The Zn–5Al–MM alloy-coated wire shall conform to the coating requirements prescribed in Table 8 or Table 9.

TABLE 7 Initial Settings for Determining Stress at 1 % Extension [Metric]

Specified Diameter, mm	Initial Stress, MPa	Initial Setting of Extensometer, mm/mm
1.27 to 2.28, incl	125	0.0005 (0.05 % extension)
2.29 to 3.04, incl	250	0.0010 (0.10 % extension)
3.05 to 4.82, incl	375	0.0015 (0.15 % extension)

TABLE 8 Zn-5Al–MM Alloy Coating

Specified Diameter of Coated Wire, in.	Area Density of Zn–5Al–MM Alloy Coating min of Uncoated Wire Surface, oz/ft^2
0.0500 to 0.0599, incl	0.60
0.0600 to 0.0749, incl	0.65
0.0750 to 0.0899, incl	0.70
0.0900 to 0.1039, incl	0.75
0.1040 to 0.1199, incl	0.80
0.1200 to 0.1399, incl	0.85
0.1400 to 0.1799, incl	0.90
0.1800 to 0.1900, incl	1.00

TABLE 9 Zn–5Al–MM Alloy Coating [Metric]

Specified Diameter of Coated Wire, mm	Area Density of Zn–5Al–MM Alloy Coating min of Uncoated Wire Surface, g/m^2
1.27 to 1.52, incl	183
1.53 to 1.90, incl	198
1.91 to 2.28, incl	214
2.29 to 2.64, incl	229
2.65 to 3.04, incl	244
3.05 to 3.55, incl	259
3.56 to 4.57, incl	274
4.58 to 4.82, incl	305

9.2 The coating test shall be conducted in accordance with Test Method A90/A90M.

10. Adherence of Coating Test

10.1 The Zn–5Al–MM alloy-coated wire shall be capable of being wrapped in a close helix at a rate not exceeding 15 turns/min around a cylindrical mandrel having a diameter as prescribed in Table 10 or Table 11, without cracking or flaking the coating to such an extent that any Zn–5Al–MM alloy can be removed by rubbing with the bare fingers.

11. Joints

11.1 No joints shall be made in the finished wire.

TABLE 10 Mandrel Size for Adherence Test

NOTE 1—Loosening or detachment during the adhesion test of superficial, small particles of Zn–5Al–MM alloy formed by mechanical polishing of the surface of the coated wire shall not be considered cause for rejection.

Specified Wire Diameter, in.	Ratio of Mandrel Diameter to Wire Diameter
0.0500 to 0.1399, incl	4
0.1400 to 0.1900, incl	5

TABLE 11 Mandrel Size for Adherence Test (Metric)

Specified Wire Diameter, mm	Ratio of Mandrel Diameter to Wire Diameter
1.27 to 3.55, incl	4
3.56 to 4.82, incl	5

11.2 Joints may be made at any stage of processing prior to final cold drawing by the electric butt-weld or flash-welding process.

11.3 Welding equipment and procedure shall be such that it can be demonstrated that the ultimate tensile strength of a finished wire specimen containing the welded section shall be not less than 96 % of the specified minimum stress at 1 % extension.

11.4 A welded section shall not be required to meet the stress at 1 % extension, elongation, and wrap tests.

12. Density and Resistivity

12.1 For the purpose of calculating mass per unit length, cross sections, and so forth, the density of Zn–5Al–MM alloy-coated steel wire at 20 °C shall be taken as 0.281 lb/in.^{3} [7780 kg/m^3].

12.2 A maximum resistivity of Zn–5Al–MM alloy-coated steel wire is not guaranteed but a typical value of 0.19157 Ω·mm^2/m may be used for calculating purposes. For conversion to other units of conductivity or resistivity, refer to Test Method B193.

13. Dimensions, Mass, and Permissible Variations

13.1 The specified diameter of the Zn–5Al–MM alloy-coated wire from Section 4 shall be expressed in decimal fractions of an inch to four decimal places, or in millimeters to two decimal places.

13.2 To determine the applicable tolerance range from Table 12 or Table 13, round the specified diameter to the nearest 0.001 in. [0.01 mm] in accordance with the rounding method of Practice E29.

13.3 Measure the largest and smallest diameter taken at the same cross section rounded to the nearest 0.001 in. [0.01 mm] in accordance with the rounding method of Practice E29.

TABLE 12 Permissible Variations in Diameter of Zn–5Al–MM Alloy-Coated Steel Wire

NOTE 1—It is recognized that the surface of coatings, particularly those produced by the hot-dip method of coating, are not perfectly smooth and devoid of irregularities. If the tolerances shown in the table are rigidly applied to such irregularities that are inherent to the product, unjustified rejections of wire that would actually be satisfactory for use could occur. It is intended that these tolerances be used in gaging the wires where there is a minimum of such diameter irregularities due to hot dip coating.

Specified Diameter, in.	Permissible Variation, in.	
	Plus	Minus
0.0500 to 0.0749, incl	0.0015	0.001
0.0750 to 0.1199, incl	0.002	0.002
0.1200 to 0.1399, incl	0.003	0.002
0.1400 to 0.1900, incl	0.004	0.003