American National Standard

ANSI C80.3-1994

# Electrical Metallic Tubing—Zinc Coated (EMT)

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American National Standard

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ANSI® C80.3-1994

AMERICAN NATIONAL STANDARD

# for Electrical Metallic Tubing — Zinc Coated (EMT)

Secretariat
**National Electrical Manufacturers Association**

Approved May 1995
**American National Standards Institute, Inc.**

**Abstract**

This standard has been developed to specify dimensions and weights for zinc coated steel electrical metallic tubing, elbows and bends for use as an electrical raceway. Trade sizes designators (metric size designators) range from 1/2 (16 EMT) to 4 (103 EMT). Requisite tests for mechanical properties of the tubing and for the zinc coating are included.

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## Foreword (This Foreword is not part of American National Standard C80.3-1994)

This standard was developed by the Accredited Standards Committee on Raceways for Electrical Wiring Systems, C80. The objective of the committee is to produce a comprehensive specification that would establish uniform dimensions and standard construction requirements for rigid metal conduit, electrical metallic tubing, intermediate metal conduit and aluminum rigid conduit raceway products and their associated components.

The standard was originally approved in 1950 and revised in 1953, 1959, 1963, 1966, 1977, 1983, and 1991.

Suggestions for improvement of this standard will be welcome. They should be sent to the National Electrical Manufacturers Association, 1700 W. 17th Street, Rosslyn, Virginia 22209.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Raceways for Electrical Wiring Systems, C80. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C80 Committee had the following members:

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# American National Standard for Electrical Metallic Tubing — Zinc Coated (EMT)

## 1 Scope

1.1 This standard covers the requirements for electrical metallic tubing (steel) for use as a raceway for the wires or cables of an electrical system. The tubing is furnished in nominal 10-ft (3.05-m) lengths with plain ends, protected on the exterior surface with a metallic zinc coating and on the interior surface with zinc, enamel, or equivalent corrosion-resistant coating.

1.2 This standard also covers elbows and bends for electrical metallic tubing.

## 2 Normative references

## 3 Definition of elbows and bends

An elbow or bend is a curved section of electrical metallic tubing.

## 4 Units of measurements

The values stated in inch-pound units are to be regarded as the standard. The metric equivalents may be approximate.

## 5 General requirements

### 5.1 Circular cross section
Electrical metallic tubing shall have a circular cross section sufficiently accurate to permit the application of standard EMT couplings and fittings.

### 5.2 Wall thickness
The wall thickness shall be uniform throughout.

### 5.3 Interior surface
The interior surface shall be free from injurious defects.

### 5.4 Welding
The welding of all seams shall be continuous and done in a professional manner.

### 5.5 Cleaning
The tubing shall be adequately cleaned before the application of the protective coating. The cleaning process shall leave the exterior and interior surfaces of the tubing in such a condition that the protective coating shall be firmly adherent and smooth.

### 5.6 Protective coating
The exterior surface shall be thoroughly and evenly coated with metallic zinc applied directly to the surface of the steel so that metal-to-metal contact and galvanic protection against corrosion are provided. The interior surface shall be protected by a zinc, enamel, or other suitable corrosion-resistant coating.



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## 6 Detailed requirements

### 6.1 Zinc coating

The zinc content of the coating on the outside surface shall be equivalent to a minimum thickness of 0.0008 in. (0.02 mm).

### 6.2 Enamel or equivalent coating

Enamel or other equivalent protective coating shall have a smooth, continuous surface. An occasional variation due to uneven flow of coating shall be acceptable. The coating shall not soften at a temperature of 120°F (49°C), and shall be sufficiently elastic to meet the test described in 7.3.

### 6.3 Chamfering

Each end of each tube shall be chamfered or otherwise treated before coating to remove any burrs or sharp edges.

### 6.4 Identification

Electrical metallic tubing shall be identified as such by the marking "EMT," indented on the exterior surface of the tubing at intervals of not more than 10 ft (3.03 m). The letters shall not be less than 1/8 in. (3.19 mm) high. In addition, each length of electrical metallic tubing shall be marked with the manufacturer's name or trademark.

### 6.5 Dimensions

The dimensions and weight of electrical metallic tubing shall be in accordance with table 1.

### 6.6 Elbows and bends

Elbows and bends shall be made of a grade of steel similar to that employed in straight lengths of electrical metallic tubing, and shall be treated, coated, and marked for identification in accordance with the applicable requirements for electrical metallic tubing. The minimum radius of a 90-degree elbow, and the minimum straight length at each end shall be as indicated in table 2.

## 7 Test procedures

### 7.1 Bending properties

#### 7.1.1 Ductility of conduit

The tubing shall be capable of being bent cold by means of a bending tool designed for the purpose, with the seam in either compression or tension, into a quarter of a circle to a centerline radius as shown in table 2 without developing cracks in the metal or showing any visible signs of splits or injurious defects in the weld area.

#### 7.1.2 Ductility of zinc coating

The protective coatings used on the exterior and interior surfaces of electrical metallic tubing shall be sufficiently elastic to prevent their cracking or flaking off when a finished sample of trade size designator 1/2 (16 EMT) or the smallest trade size manufactured is tested. Tests shall be performed within 1 year after the time of manufacture, by bending 1/2 (16 EMT) into a half-circle around a mandrel, the radius of which is shown in table 2 or by bending other trade size designators into a quarter-circle around a mandrel, the radius of which is shown in table 2.

Compliance of all trade size designators shall be determined by bending the conduit with any suitable bending equipment.



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### 7.2 Thickness of zinc coating

One of the following test methods shall be employed for measuring the thickness or extent of the external zinc coating on electrical metallic tubing:

— Magnetic test
— Preece test (Material which will withstand four 1-minute immersions shall be considered as meeting the requirement of 6.1).

### 7.3 Quality of enamel coating for use on interior surfaces

Test pieces of uncoated sheet steel, 3 in. (76.2 mm) wide, 5 in. (127.00 mm) long, and 0.010 in. (0.25 mm) thick, shall be cleaned with a suitable solvent to remove all grease and foreign material. Each piece shall be dipped into the enamel that is used for coating the conduit and the coated test pieces shall be allowed to air-dry for 30 minutes before being placed in the baking oven. Each piece shall be suspended by means of short wires in the baking oven and the samples shall be baked for a period of 5 hours at the normal baking temperature for the enamel in question, except that if the normal baking temperature is less than 275°F (135°C) or if the enamel is regularly air-dried, the oven temperature shall be maintained at 275°F to 302°F (135°C to 150°C).

At the end of the 5-hour period, the test samples shall be removed from the oven and allowed to air-cool to room temperature. Each test piece shall be gripped in a vise and then bent from the opposite side back and forth ten times through an angle of 180 degrees, the radius of the bend being 1/16 in. (1.59 mm). When so tested, the enamel coating on the sample shall not crack or flake.

## 8 Examination of product

### 8.1 Place of inspection

All tests and inspections shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere with normal manufacturing processes.

### 8.2 Visual inspection

Each length of tubing shall be examined visually both on the exterior and interior surfaces to determine if the product is free from slivers, burrs, scales, or other similar injurious defects, and if coverage of coating is complete.

### 8.3 Retests

If any samples of electrical metallic tubing tested as prescribed in this specification should fail, two additional samples shall be tested, both of which shall comply with requirements of this specification.

## 9 Marking identification

Electrical metallic tubing shall be identified as such by the marking "EMT," indented on the exterior surface of the tubing at intervals of not more than 10 ft. (3.03 m). The letters shall not be less than 1/8 in. (3.19 mm) high. In addition, each length of electrical metallic tubing shall be marked with the manufacturer's name or trademark.



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## Table 1 – Dimensions and weights of electrical metallic tubing

| Trade Size Designator | Customary Inch-Pound Units | | | | |
|---|---|---|---|---|---|
| | Outside Diameter (Inches) | Reference Inside Diameter (Inches) | Reference Wall Thickness (Inches) | Length (Ft.) | Minimum Weight per 10 Unit Lengths (Lbs) |
| 1/2 | 0.706 | 0.622 | 0.042 | 10 | 28.5 |
| 3/4 | 0.922 | 0.824 | 0.049 | 10 | 43.5 |
| 1 | 1.163 | 1.049 | 0.057 | 10 | 64 |
| 1-1/4 | 1.510 | 1.380 | 0.065 | 10 | 95 |
| 1-1/2 | 1.740 | 1.610 | 0.065 | 10 | 110 |
| 2 | 2.197 | 2.067 | 0.065 | 10 | 140 |
| 2-1/2 | 2.875 | 2.731 | 0.072 | 10 | 205 |
| 3 | 3.500 | 3.356 | 0.072 | 10 | 250 |
| 3-1/2 | 4.000 | 3.834 | 0.083 | 10 | 325 |
| 4 | 4.500 | 4.334 | 0.083 | 10 | 370 |
| | Metric Units | | | | |
| Metric Trade Size Designator | Outside Diameter (mm) | Reference Inside Diameter (mm) | Reference Wall Thickness (mm) | Length (mm) | Minimum Weight per 10 Unit Lengths (kg) |
| 16 EMT | 17.93 | 15.80 | 1.067 | 3.05 | 12.93 |
| 21 EMT | 23.42 | 20.93 | 1.245 | 3.05 | 19.73 |
| 27 EMT | 29.54 | 26.64 | 1.448 | 3.05 | 29.03 |
| 35 EMT | 38.35 | 35.05 | 1.651 | 3.05 | 43.09 |
| 41 EMT | 44.20 | 40.90 | 1.651 | 3.05 | 49.90 |
| 53 EMT | 55.80 | 52.50 | 1.651 | 3.05 | 63.50 |
| 63 EMT | 73.03 | 69.37 | 1.829 | 3.05 | 92.99 |
| 78 EMT | 88.90 | 85.24 | 1.829 | 3.05 | 113.40 |
| 91 EMT | 101.60 | 97.38 | 2.108 | 3.05 | 147.42 |
| 103 EMT | 114.30 | 110.08 | 2.108 | 3.05 | 167.83 |

NOTE—Applicable tolerances: Length: ±1/4 in. (±6.35 mm).

Outside diameter: for trade sizes 1/2 (16 EMT) through 2 (53 EMT): ±0.005 in. (±0.13 mm).
for trade size 2-1/2 (63 EMT): ±0.010 in. (±0.25 mm)
for trade size 3 (78 EMT): ±0.015 in. (±0.38 mm)
for trade sizes 3-1/2 (91 EMT) and 4 (103 EMT): ±0.020 in. (±0.51 mm)

## Table 2 – Dimensions of 90-degree elbows

| Trade Size Designator | Customary Inch-Pound Units | | Metric Trade Size Designator | Metric Units | |
|---|---|---|---|---|---|
| | Minimum Radius to Center of Tubing (In.) | Minimum Straight Length $L_s$ at Each End (In.) | | Minimum Radius to Center of Tubing (mm) | Minimum Straight Length $L_s$ at Each End (mm) |
| 1/2 | 4 | 1-1/2 | 16 EMT | 101.60 | 38.10 |
| 3/4 | 4-1/2 | 1-1/2 | 21 EMT | 114.30 | 38.10 |
| 1 | 5-3/4 | 1-7/8 | 27 EMT | 146.05 | 47.63 |
| 1-1/4 | 7-1/4 | 2 | 35 EMT | 184.15 | 50.80 |
| 1-1/2 | 8-1/4 | 2 | 41 EMT | 209.55 | 50.80 |
| 2 | 9-1/2 | 2 | 53 EMT | 241.30 | 50.80 |
| 2-1/2 | 10-1/2 | 3 | 63 EMT | 266.70 | 76.20 |
| 3 | 13 | 3-1/8 | 78 EMT | 330.20 | 79.38 |
| 3-1/2 | 15 | 3-1/4 | 91 EMT | 381.00 | 82.55 |
| 4 | 16 | 3-3/8 | 103 EMT | 406.40 | 85.73 |



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## Appendix
(Informational)
## Referee Test for Thickness of Coating on Electrical Metallic Tubing, Zinc Coated

### A.1 Scope
This method of test covers the procedure for determining the thickness of a pure zinc coating equivalent to the weight of zinc found in the coating on the steel conduit or tubing.

### A.2 Test specimens
Test specimens for the determination of the thickness of coating shall be cut 4 in. (101.6 mm) in length. One specimen should be taken from one end, and the other from the middle section of the length of conduit selected for testing.

### A.3 Preparation of samples
The specimens shall be cleaned and have burrs removed from cut ends; if necessary, they shall be washed inside and out with solvent naphtha, chloroform, or other suitable solvent, then with alcohol, and dried thoroughly.

### A.4 Test method

#### A.4.1 Solutions required
The following solutions are required for this test:

(1) Hydrochloric acid (1:1), specific gravity of 1.10 made by mixing 1 volume of concentrated HCl (specific gravity 1.18) with 1 volume of distilled water.
(2) Stannous chloride solution (5%). Dissolve 5 grams of $SnCl_2 \cdot 2H_2O$ in 10 ml (milliliters) of warm concentrated HCl: then dilute to 100 ml.
(3) Mercuric chloride solution (saturated). Add about 100 grams of $HgCl_2$ to 400 ml of hot water, shake, and cool to room temperature. More water may be added from time to time as long as crystals remain undissolved.
(4) Sodium diphenylamine sulfonate indicator solution (2 grams per liter) in water.
(5) Standard potassium dichromate solution (0.05 *N*). Dissolve 2.45 grams of dry $K_2Cr_2O_7$ (American Chemical Society Reagent Grade) in water and dilute to 1 liter in a volumetric flask.
(6) Phosphoric acid (1:3). Dilute 100 ml of 85% phosphoric acid (specific gravity 1.71) with 300 ml of water.

#### A.4.2 Procedure
The total zinc in the outside coating of each specimen shall be determined and the thickness of the zinc coating equivalent to the zinc found shall be calculated. The average of the results from the two specimens shall be taken as the thickness of the coating.

Each specimen shall be weighed to the nearest 0.01 gram. After weighing, the open ends shall be closed with solid rubber stoppers and the specimen immersed in 1:1 HCl and allowed to remain therein until the rate of evolution of hydrogen becomes small and constant. This requires about 1 minute for a thin electrodeposited coating and about 3 minutes for a thick hot-dipped or sherardized coating. The temperature of the stripping solution shall at no time exceed 100°F (38°C). After stripping, the specimen shall be rinsed thoroughly with water, inside and outside, allowing the rinse water to run into the stripping solution, and then thoroughly dried. The specimen shall then be reweighed to the nearest 0.01 gram. The loss in weight represents the total weight of the coating. Transfer the stripping solution to 500-ml volumetric flask and dilute to the mark with water. Mix the solution thoroughly. Transfer a 50-ml aliquot to a 250-ml beaker, evaporate the solution to 15 to 20 ml, and then wash down the sides of the beaker. Heat to boiling and add $SnCl_2 \cdot 2H_2O$ (5%), drop by drop, while swirling the beaker over a white background, until the yellow color of the ferric salt disappears. Add 1 drop of $SnCl_2$ in excess, but no more. Cool the reduced solution to room temperature, dilute it to 50 ml, stir, and add all at once 10 ml of a saturated solution of $HgCl_2$. Stir until no more precipitate forms. The resultant precipitate should be



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pure white in color, and the amount should be preferably not more than enough to give a pearly opalescence. If the precipitate is gray or dark, too much of $SnCl_2$ has been used and it will be necessary to discard the solution and start anew. To the properly reduced solution, add 10 ml of 1:3 phosphoric acid and 4 drops of sodium diphenylamine sulfonate indicator (2 grams per liter). The volume of the solution to be titrated should not exceed 100 ml. Titrate slowly with 0.05 *N* $K_2Cr_2O_7$ while stirring constantly, until the color of the solution changes from green to gray-green. Continue the titration, dropwise, until the first tinge of purple or violet-blue appears.

$$\text{Grams of iron in the coating} = \text{ml of } 0.05N\,K_2Cr_2O_7 \times 0.0279$$

### A.4.3 Calculations

The thickness of zinc in inches or centimeters equivalent to the zinc content of the coating of the specimen equals:

$$\frac{\text{weight of coating in grams} - \text{weight of iron in grams}}{\text{surface area of specimen in square inches} \times 0.00858} = \frac{\text{weight of coating in grams} - \text{weight of iron in grams}}{\text{surface area of specimen in square centimeters} \times 0.0553}$$

The thickness of zinc equivalent to the zinc content of the coating shall be the average thickness of the two specimens described in A2, Test Specimens.

NOTE—The iron determination may be omitted when the thickness of the coating as calculated from the total weight of the coating is less than the specified minimum value, or when it is known that the iron correction will not yield a thickness value less than the specified value. Recent studies indicate that usually the iron content of electroplated and sprayed zinc coatings is less than 2%; of hot-dipped coatings from 5 to 10%; and of sherardized coatings from 10 to 20%.



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