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Electrical Rigid Steel Conduit

National Electrical Manufacturers Association

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American National Standard for Electrical Rigid Steel Conduit

Secretariat:

National Electrical Manufacturers Association

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American National Standards Institute, Inc.

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Foreword (This Foreword is not part of American National Standard C80.1-2015.)

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 will establish uniform dimensions and standard construction requirements for Electrical Rigid Steel Conduit, Steel Electrical Metallic Tubing, Electrical Intermediate Metal Conduit, and Electrical Aluminum Rigid Conduit raceway products and their associated components.

This standard was originally approved in 1950 and revised in 1953, 1959, 1963, 1966, 1977, 1983, 1990, 1994, 2004, and 2005.

Suggestions for improvement of this standard are welcome. They should be sent to:

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This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee (ASC C80), Raceways for Electrical Wiring Systems. 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:

M. J. Brett, Jr, Chairman
J. G. Solis, Secretary

Organization Represented:	*Name of Representative:*
Allied Tube & Conduit, a Part of Atkore International	R. Horner
Appleton Group	S. Blais
International Association of Electrical Inspectors	D. Humphrey
International Brotherhood of Electrical Workers	P. Hickman
National Electrical Contractors Association	M. Johnston
R & N Associates	R. Loyd
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SAPA Extrusion North America	H. E. Harper, Jr.
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The following members of the NEMA Steel Conduit & Electrical Metallic Tubing - Codes/Communications/ Technical Committee worked on this standard prior to its publication:

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Contents

1 Scope

This standard covers the requirements for electrical rigid steel conduit for use as a raceway for wires or cables of an electrical system. Finished conduit is produced in nominal 10 ft (3.05 m) lengths, threaded on each end with one coupling attached. It is protected on the exterior surface with a metallic zinc coating or alternate corrosion protection coating (as specified in clauses 5.3.3, 6.2.4, 7.8, and 7.9 in UL 6) and on the interior surface with a zinc or organic coating.

This standard also covers conduit couplings, elbows, nipples, and conduit lengths other than 10 ft (3.05 m).

Properly assembled systems of conduit, couplings, elbows, and nipples, manufactured in accordance with this standard, and other identified fittings provide for the electrical continuity required of an equipment grounding conductor.

2 Normative References

The following standards contain provisions that, through reference in this text, constitute requirements of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below unless otherwise specified.

ASME B1.20.1 - 13	*Pipe Threads, General Purpose (Inch)*
ASTM A239 – 14	*Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles*
ASTM B117 – 11	*Standard Practice for Operating Salt Spray (Fog) Apparatus*
ASTM B499 – 09 (2014)	*Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals*
ASTM D638 – 14	*Standard Test Method for Tensile Properties of Plastics*
ASTM D1654 – 08	*Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*
ASTM D2444 – 99 (2010)	*Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*
ASTM D3359 – 09e2	*Standard Test Method for Measuring Adhesion by Tape Test*
ASTM G 151 – 10	*Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources*
ASTM G 153 – 13	*Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G 155 – 13	*Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*
UL 6 - 07	*Electrical Rigid Metal Conduit - Steel*
UL 514B - 12	*Conduit, Tubing, and Cable Fittings*

3 Definitions

alternate corrosion-resistant coating (ACRC): coating(s), other than one consisting solely of zinc, which upon evaluation, has demonstrated the ability to provide the level of corrosion resistance required on the exterior of conduit. It is not prohibited that the coatings include zinc. See clauses 5.3.3, 6.2.4, 7.8, and 7.9 in UL 6.

elbow: a manufactured curved section of ERSC threaded on each end.

electrical rigid steel conduit (ERSC): a threadable steel raceway of circular cross-section designed for the physical protection and routing of wire conductors and use as an equipment grounding conductor.

finished conduit: a straight length of ERSC with one coupling attached.

nipple: a straight length of ERSC not more than 2 ft (0.61 m) long and threaded on each end.

straight conduit: a straight length of ERSC without a coupling.

threaded coupling: an internally threaded steel cylinder for joining the components of an ERSC system.

4 Units of Measurement

The values stated in inch-pound units are to be regarded as the standard. The metric dimensions are exact conversions for safety considerations.

5 General Requirements

5.1 CIRCULAR CROSS-SECTION

Electrical rigid steel conduit shall have a circular cross-section sufficiently accurate to permit the cutting of threads in accordance with Table 1.

5.2 WALL THICKNESS

The wall thickness shall be uniform throughout, except for localized surface imperfections as permitted in 8. 4.

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 workmanlike manner.

5.5 CLEANING

The conduit shall be adequately cleaned before application of the protective coating. The cleaning process shall leave the exterior and interior surfaces of the conduit in such condition that the protective coating shall be smooth and adhere firmly.

5.6 PROTECTIVE COATING FOR CORROSION RESISTANCE

5.6.1 The exterior surface shall be either thoroughly and evenly coated with metallic zinc or protected with an alternate corrosion-resistant coating (ACRC: See clauses 5.3.3, 6.2.4 7.8, and 7.9 in UL 6).

5.6.2 The interior surface shall be protected by a zinc or an organic coating. The interior coating shall have a smooth continuous surface. An occasional variation due to uneven flow of coating shall be acceptable.

5.7 SURFACE TREATMENTS

Any surface treatment not exceeding 0.00015 in. (0.0038 mm) that is employed as a topcoat or conversion coating is not required to meet the requirements for an ACRC or organic coating.

6 Detailed Requirements

6.1 EXTERIOR COATING

6.1.1 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), as tested in accordance with 7.2.

6.1.2 Alternate Corrosion-Resistant Coating (ACRC)

See clauses 5.3.3, 6.32.4, 7.8, and 7.9 in UL 6.

6.2 INTERIOR COATING

6.2.1 The zinc coating shall be tested in accordance with 7.1.2.

6.2.2 The organic coating shall not soften at a temperature of 120°F (49°C) and shall be sufficiently elastic to meet the test described in 7.4.

6.3 THREADING AND CHAMFERING

Each length of conduit, nipple, and elbow shall be threaded on both ends and each end shall be chamfered or otherwise treated to remove burrs and sharp edges.

Threads shall comply with the requirements of 6.6. If threads are cut after the zinc coating has been applied, the threads shall be treated with a protective coating to prevent corrosion before installation. This treatment shall not impair electrical continuity through couplings or fittings after installation.

6.4 IDENTIFICATION

Each length of conduit, nipple, and elbow shall be identified with markings in accordance with 9.

6.5 DIMENSIONS

The dimensions and weights of ERSC shall be in accordance with Table 2.

6.6 THREADS

The number of threads per inch (threads per 25.4 mm) and the length of the threaded portion at each end of each length of conduit, nipple, and elbow shall be as indicated in Table 1 and shall conform to ANSI/ASME B1.20.1. The perfect thread shall be tapered for its entire length, and the taper shall be ¾ in./ft (1 in 16).

6.7 COUPLINGS

Couplings shall comply with the following requirements:

6.7.1 The exterior surface of couplings shall be protected against corrosion in the same manner as required for conduit, and shall comply with the requirements of 6.1.1 and, if applicable, 6.1.2. The interior surface shall be treated to inhibit corrosion from taking place prior to installation.

6.7.2 Couplings shall be so made that all threads on the conduit will be covered when the coupling is "pulled tight" on standard conduit threads.

6.7.3 Both ends of the couplings shall be chamfered to prevent damage to the starting thread.

6.7.4 The outside diameter, length, pitch diameter, and chamfer diameter of couplings shall be as indicated in Table 3.

6.7.5 Couplings shall be straight tapped.

6.7.6 Couplings shall be marked as in 9.1. 3.

6.8 ELBOWS AND NIPPLES

Conduit elbows and nipples shall be made of a similar grade of steel to that employed in straight lengths of ERSC and shall be treated, coated, threaded, and marked for identification according to the applicable requirements for ERSC. The dimensions of 90-degree elbows and the weights of nipples shall be as indicated in Table 4.

7 Test Procedures

7.1 BENDING PROPERTIES

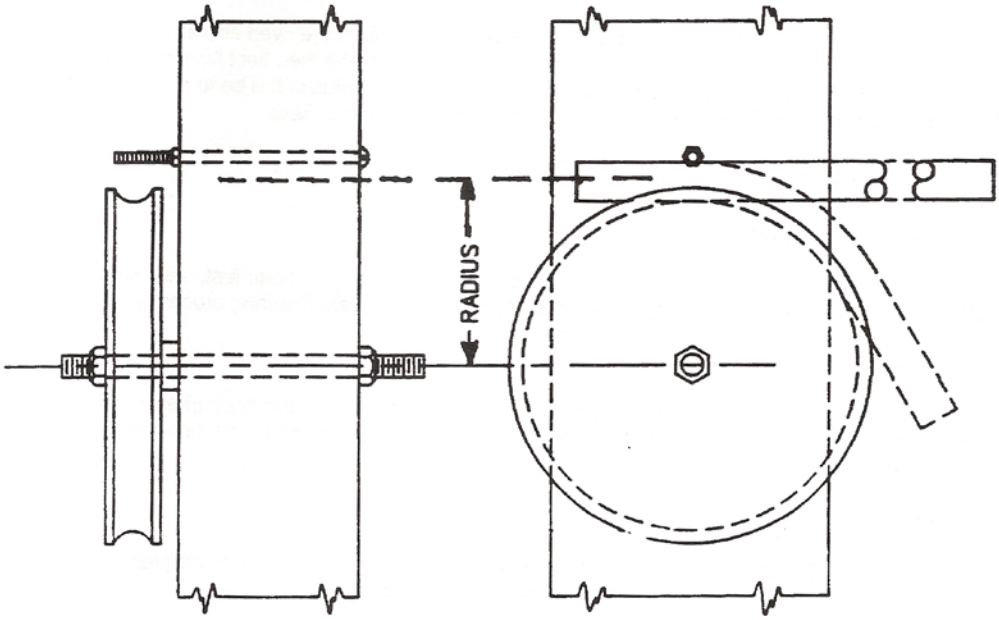
7.1.1 Ductility of Steel

Conduit shall be capable of being bent, at ambient temperature, 90 degrees around a mandrel, the radius of which is shown in Table 4, without developing cracks at any portion of the bend and without opening the weld.

7.1.2 Ductility of Coating at Ambient Temperature

The protective coatings used on the exterior and interior surfaces of ERSC shall be sufficiently elastic to prevent their cracking or flaking off when a finished sample of trade size ½ (16) or the smallest trade size manufactured is tested at ambient temperature. The test shall be performed within one year after the time of manufacture by bending trade size ½ (16) conduit 180 degrees around a mandrel, the radius of which is shown in Table 4. Samples of other trade sizes shall be bent 90 degrees around a mandrel, the radius of which is shown in Table 4.

Compliance for trade sizes ½ (16) and ¾ (21) shall be determined by bending the conduit with a form, as shown in the figure below. Compliance for trade sizes larger than ¾ (21) shall be determined by bending the conduit with any suitable bending equipment.



Test Apparatus for Bending Conduit

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 conduit:

a) Magnetic test in accordance with ASTM B 499.
b) Copper sulfate test (Preece Test) in accordance with ASTM A 239. Material that will withstand four one-minute immersions shall be considered as meeting the requirements of 6.1.1.
c) Copper sulfate test method for zinc coating in accordance with UL 6, Section 15.1.

7.3 ALTERNATE CORROSION-RESISTANT COATINGS (ACRC)

See UL 6, 13th edition, clauses 5.3.3, 6.2.4, 7.8, and 7.9.

7.4 QUALITY OF ORGANIC COATING FOR USE ON INTERIOR SURFACE

Two test pieces of uncoated sheet steel, 3 in. x 5 in. x 0.010 in. (76.2 mm x 127.0 mm x 0.25 mm) shall be cleaned with a suitable solvent to remove all grease and foreign material. Each piece shall be dipped into the material used for the inside coating of the conduit. 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 five hours at the normal baking temperature used in production. If the normal baking temperature is less than 275°F (135°C) or if the coating 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 five-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 five times through an angle of 180 degrees, the radius of the bend being $^{1}/_{16}$ in. (1.59 mm). When so tested, the 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 OF CONDUIT

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

8.3 VISUAL INSPECTION OF ELBOWS

Elbows are to be examined as described in 8.2 as straight lengths before the lengths are bent. In addition, elbows are to be monitored during the bending operation for evidence of flaking or other damage.

8.4 RESTRICTIONS ON LOCALIZED SURFACE IMPERFECTIONS

Localized surface imperfections shall not exceed a depth of 12½% of the nominal wall thickness, as shown in Table 2.

8.5 RETESTS

If any sample of electrical rigid metal conduit or elbow tested as prescribed in this specification fails, two additional samples shall be tested; both of which shall comply with the requirements of this specification.

9 Markings

9.1 GENERAL

9.1.1 Each length of conduit, elbow, and nipple shall be marked “Rigid Steel Conduit,” along with the manufacturer’s name, trade name or trademark, or other descriptive marking by which the organization responsible for the product can be identified. A traceable code can be used to identify the manufacturer when a private labeler uses its own brand or trademark on the product. When a product is produced in more than one factory, each finished length of conduit, elbow, and nipple shall bear a distinctive marking by which it can be identified as the product of a particular factory. This marking may be in code. Additionally, each piece shall be legibly and durably marked “Consult manufacturer for proper installation” or equivalent wording.

9.1.2 Nipples with unthreaded areas less than 2 in. (51 mm) long may be marked with the requirements of 9.1.1 on the smallest unit of shipping carton.

9.1.3 Each coupling shall be die-stamped “EC” (electrical coupling) in letters not less than ⅛ in. (3 mm) high.

9.1.4 Conduit marking shall be at minimum once every 10 ft (3.05 m) and no less than once every piece.

9.2 SUPPLEMENTARY COATING MARKING

Finished conduit, elbows, and nipples provided with supplementary coating(s) not evaluated for providing corrosion resistance for the conduit shall be marked “Corrosion protection properties of the [Insert type of supplementary coating applied] coating were not investigated” or equivalent wording.

Table 1
Dimensions of Threads for Electrical Rigid Steel Conduit

English Units					SI (Metric) Units				
Trade Size	Threads per Inch	Pitch Diameter at End of Thread E_o, Taper ¾ in. per ft [b]	Length of Thread (in.)		Metric Designator	Threads per 25.4 mm	Pitch Diameter at End of Thread E_o, Taper 62.5 mm per Meter [b]	Length of Thread (mm)	
			Effective L_2	Overall L_4 [a]				Effective L_2	Overall L_4 [a]
½	14	0.758	0.53	0.78	16	14	19.3	13.5	19.8
¾	14	0.968	0.55	0.79	21	14	24.6	14.0	20.1
1	11½	1.214	0.68	0.98	27	11½	30.8	17.3	24.9
1¼	11½	1.557	0.71	1.01	35	11½	39.5	18.0	25.7
1½	11½	1.796	0.72	1.03	41	11½	45.6	18.3	26.2
2	11½	2.269	0.76	1.06	53	11½	57.6	19.3	26.9
2½	8	2.720	1.14	1.57	63	8	69.1	29.0	39.9
3	8	3.341	1.20	1.63	78	8	84.9	30.5	41.4
3½	8	3.838	1.25	1.68	91	8	97.5	31.8	42.7
4	8	4.334	1.30	1.73	103	8	110.1	33.0	43.9
5	8	5.391	1.41	1.84	129	8	136.9	35.8	46.7
6	8	6.446	1.51	1.95	155	8	163.7	38.4	49.5

NOTE—Applicable tolerances:
[a] Thread length (L_4): ±1 thread, recommended practice +0, -1
[b] Pitch diameter: ±1 turn is the maximum variation permitted from the gauging face of the working thread gauges

Table 2
Dimensions and Weights for Rigid Steel Conduit

English Units					
Trade Size	Nominal Inside Diameter (in.) [3]	Outside Diameter (in.)	Nominal Wall Thickness (in.)	Length Without Coupling [1] (ft and in.)	Minimum Weight of Ten Unit Lengths with Couplings Attached (lb) [2]
½	0.632	0.840	0.104	9'11¼"	79.0
¾	0.836	1.050	0.107	9'11¼"	105.0
1	1.063	1.315	0.126	9'11"	153.0
1¼	1.394	1.660	0.133	9'11"	201.0
1½	1.624	1.900	0.138	9'11"	249.0
2	2.083	2.375	0.146	9'11"	332.0
2½	2.489	2.875	0.193	9'10½"	527.0
3	3.090	3.500	0.205	9'10½"	682.6
3½	3.570	4.000	0.215	9'10¼"	831.0
4	4.050	4.500	0.225	9'10¼"	972.3
5	5.073	5.563	0.245	9'10"	1313.6
6	6.093	6.625	0.266	9'10"	1745.3
SI (Metric) Units					
Metric Designator	Nominal Inside Diameter (mm) [3]	Outside Diameter (mm)	Nominal Wall Thickness (mm)	Length Without Coupling (mm) [1]	Minimum Weight of Ten Unit Lengths with Couplings Attached (kg) [2]
16	16.1	21.3	2.6	3030	35.83
21	21.2	26.7	2.7	3030	47.63
27	27.0	33.4	3.2	3025	69.40
35	35.4	42.2	3.4	3025	91.17
41	41.2	48.3	3.5	3025	112.95
53	52.9	60.3	3.7	3025	150.60
63	63.2	73.0	4.9	3010	239.05
78	78.5	88.9	5.2	3010	309.63
91	90.7	101.6	5.5	3005	376.94
103	102.9	114.3	5.7	3005	441.04
129	128.9	141.3	6.2	2995	595.85
155	154.8	168.3	6.8	2995	791.67

NOTES—
[1] Straight Conduit
[2] Finished Conduit
[3] Inside dimensions are not a requirement. However, conduit meeting the required weight and Outside Diameter will nominally have the referenced dimensions.
Applicable tolerances:
Length: ± ¼ in. (6.35 mm) without coupling
Outside Diameter: for trade sizes ½ (16) through 1½ (41): ±0.015 in. (±0.38 mm); for trade sizes 2 (53) through 6 (155): ± 1%
Wall Thickness: See 8. 4.

Table 3
Dimensions of Couplings

English Units						
Trade Size	Outside Diameter [1] (in.)	Minimum Length (in.)	Pitch Diameter (in.)		Chamfer Diameter (in.)	
			Minimum	Maximum	Minimum	Maximum
½	1.010	1⅝	0.801	0.814	0.798	0.838
¾	1.250	1 41/64	1.011	1.024	1.008	1.048
1	1.525	1 31/32	1.267	1.283	1.260	1.300
1¼	1.869	2 1/32	1.612	1.628	1.605	1.645
1½	2.155	2 1/16	1.852	1.868	1.845	1.885
2	2.650	2⅛	2.327	2.343	2.320	2.360
2½	3.250	3 3/16	2.806	2.828	2.800	2.860
3	3.870	3 5/16	3.431	3.453	3.425	3.485
3½	4.500	3 13/32	3. 931	3.953	3.925	3.985
4	4.875	3 33/64	4.431	4.453	4.425	4.485
5	6.000	3 61/64	5.494	5.516	5.519	5.579
6	7.200	4¼	6.556	6.578	6.591	6.651
SI (Metric) Units						
Metric Designator	Outside Diameter [1] (mm)	Minimum Length (mm)	Pitch Diameter (mm)		Chamfer Diameter (mm)	
			Minimum	Maximum	Minimum	Maximum
16	25.7	41.3	20.35	20.68	20.27	21.29
21	31.8	41.7	25.68	26.01	25.60	26.62
27	38.7	50.0	32.18	32.59	32.00	33.02
35	47.5	51.6	40.94	41.35	40.77	41.78
41	54.7	52.4	47.04	47.45	46.86	47.88
53	67.3	54.0	59.11	59.51	58.93	59.94
63	82.6	81.0	71.27	71.83	71.12	72.64
78	98.3	84.1	87.15	87.71	87.00	88.52
91	114.3	86.5	99.85	100.40	99.70	101.20
103	123.8	89.3	112.60	113.10	112.40	113.90
129	152.4	100	139.60	140.10	140.20	141.70
155	182.9	108	166.50	167.10	167.40	168.90

NOTES—
[1] Outside diameter tolerances:
Plus tolerances: No requirements
Minus tolerances: for trade sizes smaller than 1¼ (35): 1/64 in. (-0.40 mm); for trade sizes 1¼ (35) and larger: -1%.

Chamfer angle shall be between 11 and 15 degrees.

All couplings shall have straight-tapped threads.

Table 4
Dimensions of 90-Degree Elbows and Weights of Nipples per Hundred

English Units					SI (Metric) Units				
Trade Size	Elbows		Nipples		Metric Designator	Elbows		Nipples	
	Minimum Radius to Center of Conduit (in.)	Minimum Straight Length L_s at Each End (in.)	A lb/in	B lb/100		Minimum Radius to Center of Conduit (mm)	Minimum Straight Length L_s at Each End (mm)	A Kg/ mm	B Kg/100
½	4	1½	0.065	3	16	102	38	0.0012	1.36
¾	4½	1½	0.086	4	21	114	38	0.0015	1.81
1	5¾	1⅞	0.125	9	27	146	48	0.0022	4.08
1¼	7¼	2	0.164	10	35	184	51	0.0029	4.54
1½	8¼	2	0.202	11	41	210	51	0.0036	4.99
2	9½	2	0.269	14	53	241	51	0.0048	6.35
2½	10½	3	0.430	60	63	267	76	0.0077	27.22
3	13	3⅛	0.561	70	78	330	79	0.0100	31.75
3½	15	3¼	0.663	90	91	381	83	0.0119	40.82
4	16	3⅜	0.786	115	103	406	86	0.0141	52.16
5	24	3⅝	1.060	170	129	610	92	0.0190	77.11
6	30	3¾	1.410	200	155	762	95	0.0252	90.72

NOTE—Each lot of 100 nipples shall weigh not less than the number of pounds (kg) determined by the formula:

$$W = 100 * (LA) - B$$

where:

W is the unit weight of 100 nipples
L is the length of one nipple
A is the nipple weight per unit length
B is the weight lost in threading 100 nipples

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