TC 7

Smooth-Wall Coilable Polyethylene Electrical Plastic Conduit

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NEMA Standards Publication No. TC 7-2000

Smooth-Wall Coilable Polyethylene Electrical Plastic Conduit

Published by:

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Rosslyn, Virginia 22209

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Foreword

The purpose of this standards publication for high-density polyethylene (HDPE) conduit (duct) intended for underground use in the installation and protection of electrical cables is:

a. To list dimensions and other significant requirements.
b. To state the required properties of these products and to assist in selecting and obtaining the proper product for a particular need.

In addition, this standards publication addresses the factory installation of electrical cable or pull media commonly used to assist in the installation of cables.

User needs have been considered throughout the development of this standard. The Polymer Raceway Products Section of NEMA, through its members, works closely with such organizations as ASTM, the Plastic Pipe Institute, appropriate government agencies, testing laboratories, and others in the periodic review and revision of this standard. Proposed or recommended revisions should be addressed to:

Vice President, Engineering
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, Virginia 22209

TC 7-2000 revises and supercedes the NEMA standards publication for Electrical Polyethylene Conduit (EPEC-A), TC 7-1990. Prior to publication, the NEMA Standards, Suggested Standards for Future Design, and Authorized Engineering Information that appear in this publication unchanged since their appearance in TC 7-1990 were reaffirmed.

The Polymer Raceway Products Section developed this standards publication. Section approval of the standard does not necessarily imply that section members voted for its approval or participated in its development. At the time it was approved, the group/section was composed of the following members:

Arnco Corporation—Elyria, OH
Dura-Line Corporation—Dallas, TX
Carlon—Cleveland, OH
Plexco—Bensenville, IL
PWPipe—Eugene, OR

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Section 1
GENERAL

1.1 SCOPE

This standard covers the following types of electrical high-density polyethylene (HDPE) conduit. The designations “40” and “80” refer to Schedule 40 and 80, respectively, of iron pipe dimensions.

EPEC-A-HDPE – HDPE conduit designed for applications below ground, either concrete encased applications or direct burial. This type represents the *nominal* dimensions for HDPE conduit as specified by ASTM D 3485 and UL 651B for trade sizes 4 through 6.

EPEC-B-HDPE – HDPE conduit designed for applications below ground, either concrete encased applications or direct burial. This type represents the *nominal* dimensions for HDPE conduit as specified by ASTM D 3035, SDR 13.5. The two and one-half inch trade size is taken from UL 651B.

EPEC-40-HDPE – HDPE conduit designed for application below ground, either concrete encased applications or direct burial. This type represents the *nominal* dimensions for HDPE conduit as specified by ASTM D 2447, Schedule 40.

EPEC-80-HDPE – HDPE conduit designed for applications below ground, either concrete encased applications or direct burial. This type represents the *nominal* dimensions for HDPE conduit as specified by ASTM D 2447, Schedule 80.

NOTE–The values stated in U.S. customary units are to be regarded as the standard.

1.2 REFERENCED STANDARDS

In this publication, reference is made to the standards listed below. Copies are available from the indicated sources.

American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

D 618-99	*Standard Practice for Conditioning Plastics for Testing*
D 638-99	*Standard Test Method for Tensile Properties of Plastics*
D 746-98	*Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact*
D 790-99	*Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials*
D 792-98	*Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*

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D 883-99	*Standard Terminology Relating to Plastics*
D 1238-99	*Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer*
D 1248-98	*Standard Specification for Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable*
D 1505-98	*Standard Test Method for Density of Plastics by the Density-Gradient Technique*
D 1600-99	*Standard Terminology for Abbreviated Terms Relating to Plastics*
D 1693-00	*Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*
D 2122-98	*Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings*
D 2412-96a	*Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*
D 2444-99	*Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*
D 2447-99	*Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter*
D 3035-95	*Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter*
D 3350-99	*Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*
D 3485-97	*Standard Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable*
F 412-00	*Standard Terminology Relating to Plastic Piping Systems*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02669

NFPA 70-1999	*National Electric Code**

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL651B *(First edition)*	*Continuous Length HDPE Conduit*

* Also available from the American National Standards Institute, 1430 Broadway, New York, NY 10018

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Section 2
DEFINITIONS AND ABBREVIATIONS

2.1 DEFINITIONS

Definitions of terms used in this standard shall be in accordance with ASTM F 412 or ASTM D 883, or both. Abbreviations shall be in accordance with ASTM D 1600, unless otherwise specified.

Quality Control Test – An in-plant test that is conducted on a given test frequency to determine whether a product is in accordance with the specification requirements.

Ovality – A conduit's deviation from roundness as a consequence of coiling, handling, or installation.

Qualification Test – A non-repetitive evaluation conducted on an existing, altered or new product to determine acceptability.

EPEC – The abbreviation for Electrical Polyethylene Conduit.

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Section 3
GENERAL REQUIREMENTS

3.1 MATERIALS

3.1.1 Electrical Conduit

Electrical polyethylene conduit (EPEC) shall be made from high-density polyethylene that meets *or exceeds* the requirements given in ASTM D 3350 *for a cell classification of* 334420 C or E, and, in addition, high-density polyethylene shall meet or exceed the requirements as shown in Table 3-1.

Clean, reworked material of the same type and grade from the manufacturer's own facility may be used providing the conduit produced meets the requirements of this standard.

3.2 DIMENSIONS AND LENGTHS

Polyethylene conduit shall meet the dimensions shown in Table 3-2.

3.2.1 Average Outside Diameter

The average outside diameter of the conduit shall be as shown in Table 3-2 and shall be measured in accordance with 5.2.1 of this standard.

3.2.2 Wall Thickness

The minimum and maximum wall thickness shall be as shown in Table 3-2 and shall be measured in accordance with 5.2.2 of this standard.

3.2.3 Ovality

The maximum allowable ovality will be as stated in 4.1.3 and shall be measured in accordance with 5.2.3.

3.2.4 Length

Contact the manufacturer for availability of conduit in coiled lengths.

3.3 WORKMANSHIP

Polyethylene conduit shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects that could cause damage or compromise the physical strength of the conduit. It shall be as uniform as practicable in color, opacity, density, and other physical properties.

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3.3.1 Bonding to Conduit

If pull media or cable is installed at the factory, there shall be no bonding of the material to the inner conduit wall. This shall be verified during the production of the conduit by free movement of the pull media or cable inside the conduit.

3.3.2 Excess Pull Member

If pull media is installed at the factory, its length shall be equal to or greater than the conduit length. In addition, the pull media and inside of the conduit may be coated with a lubricant that prevents abrasion of conduit bends during cable pulling and lowers pull tensions on the cable.

3.4 INSPECTIONS

The manufacturer shall inspect the conduit at the time of manufacture for compliance with dimensional requirements, performance requirements, and freedom from defects as defined in Section 4.

3.5 INTERNAL RIBS

Optional internal ribs shall be agreed upon between the manufacturer and customer. This conduit shall comply with all other requirements of this standard.

Table 3-1
MATERIAL REQUIREMENTS

Property	Requirements	Standards
Density	0.941 - 0.955	ASTM D 792 (or D 1505)
Melt Flow Index (190/2.160)	<.4 -.15 g/10 minutes max	ASTM D 1238
Flexural Modulus	80,000 psi minimum	ASTM D 790
Tensile Strength at Yield, Minimum	3000 psi	ASTM D 638
Environmental Stress Crack Resistance, Minimum	Condition B, F50 Max, 10% Igepal, for 24 hrs.	ASTM D 1693
Brittleness Temperature	-75 degree C	ASTM D 746
Elongation, Minimum	400%	ASTM D 638
Class E	Colored with UV Stabilizer	ASTM D 3350
Class C	Minimum 2% carbon black	ASTM D 3350

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Table 3-2
SIZES AND DIMENSIONS OF HDPE CONDUIT
U.S. CUSTOMARY UNITS

Trade Size	Metric Designator	Average Outside Diameter (inches)	Wall Thickness (inches)							
			EPEC-A-HDPE		EPEC-B-HDPE		EPEC-40-HDPE		EPEC-80-HDPE	
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1/2	16	0.840 ± 0.008	0.060	0.080	0.062	0.082	0.109	0.129	0.147	0.167
3/4	21	1.050 ± 0.012	0.060	0.080	0.078	0.098	0.113	0.133	0.154	0.174
1	27	1.315 ± 0.012	0.075	0.095	0.097	0.117	0.133	0.153	0.179	0.200
1 1/4	35	1.660 ± 0.012	0.100	0.120	0.123	0.143	0.140	0.160	0.191	0.214
1 1/2	41	1.900 ± 0.012	0.115	0.135	0.141	0.161	0.145	0.165	0.200	0.224
2	53	2.375 ± 0.012	0.145	0.165	0.176	0.197	0.154	0.174	0.218	0.244
2 1/2	63	2.875 ± 0.012	0.203	0.223	0.213	0.239	0.203	0.227	0.276	0.309
3	78	3.500 ± 0.012	0.216	0.236	0.259	0.290	0.216	0.242	0.300	0.336
4	103	4.500 ± 0.012	0.237	0.265	0.333	0.373	0.237	0.265	0.337	0.377
5	129	5.563 ± 0.012	0.258	0.289	0.412	0.461	0.258	0.289	0.375	0.420
6	155	6.625 ± 0.012	0.280	0.314	0.491	0.550	0.280	0.314	0.432	0.484

METRIC UNITS

Trade Size	Metric Designator	Average Outside Diameter (mm)	Wall Thickness (mm)							
			EPEC-A-HDPE		EPEC-B-HDPE		EPEC-40-HDPE		EPEC-80-HDPE	
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1/2	16	21.34 ± 0.20	1.52	2.03	1.57	2.08	2.77	3.28	3.73	4.24
3/4	21	26.67 ± 0.30	1.52	2.03	1.98	2.49	2.87	3.38	3.91	4.42
1	27	33.40 ± 0.30	1.91	2.41	2.46	2.97	3.38	3.89	4.55	5.08
1 1/4	35	42.16 ± 0.30	2.54	3.05	3.12	3.63	3.56	4.07	4.85	5.43
1 1/2	41	48.26 ± 0.30	2.92	3.43	3.58	4.09	3.68	4.19	5.08	5.69
2	53	60.33 ± 0.30	3.68	4.19	4.47	5.00	3.91	4.42	5.54	6.10
2 1/2	63	73.03 ± 0.30	5.16	5.66	5.41	6.07	5.16	5.77	7.01	7.85
3	78	88.90 ± 0.30	5.49	5.99	6.58	7.37	5.49	6.15	7.62	8.53
4	103	114.30 ± 0.30	6.02	6.73	8.46	9.48	6.02	6.73	8.56	9.58
5	129	141.30 ± 0.30	6.55	7.34	10.46	11.70	6.55	7.34	9.53	10.67
6	155	168.28 ± 0.30	7.11	7.98	12.47	13.97	7.11	7.97	10.97	12.29

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Section 4
PERFORMANCE REQUIREMENTS

4.1 QUALITY CONTROL TESTS

4.1.1 Conditioning

At the time of production, measurements and performance tests can be made at the temperature within the factory. In case of disagreement, specimens shall be conditioned per 5.1.1.

4.1.2 Dimensions

The conduit dimensions shall meet the requirements listed in Table 3-2 when measured in accordance with the methods listed in 5.2.

4.1.3 Ovality

When required by the customer, maximum allowable ovality of 3" and smaller conduit shall be less than 10% when conditioned in accordance with 5.1.1 and measured in accordance with 5.2.3.

Due to shipping and resultant coil limitations, ovality of 4" and larger conduit may exceed 10%. Contact the manufacturer for additional information.

4.1.4 Compression and Recovery

Specimens of HDPE conduit shall withstand, without splits or cracks, the minimum compression load given in Table 4-1 and recover to the minimum required when tested in accordance with 5.3.

4.1.5 Impact Test

The conduit does not meet the requirements of this standard if a crack or tear longer than 1/32 inch (0.8 mm) appears on the surface of more than three of ten specimens when tested in accordance with 5.4.

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Table 4-1
LOAD FOR COMPRESSION AND RECOVERY TEST

Trade Size	Metric Designator	EPEC-A-HDPE		EPEC-B-HDPE		EPEC-40-HDPE		EPEC-80-HDPE	
		lbf	N	lbf	N	lbf	N	lbf	N
1/2	16	150	667	275	1223	950	4226	1600	7117
3/4	21	150	667	250	1112	750	3336	1500	6672
1	27	175	778	250	1112	650	2891	1300	5783
1 1/4	35	188	836	350	1557	500	2224	1000	4448
1 1/2	41	238	1059	450	2002	400	1779	900	4003
2	53	300	1334	450	2002	400	1779	900	4003
2 1/2	63	350	1557	500	2224	400	1779	800	3559
3	78	350	1557	500	2224	400	1779	800	3559
4	103	350	1557	600	2669	350	1557	800	3559
5	129	300	1334	800	3559	300	1334	800	3559
6	155	250	1112	800	3559	250	1112	800	3559

Table 4-2
DROP HEIGHT FOR IMPACT TEST

Trade Size	Metric Designator	Height	
		feet	meters
1/2	16	2.5	0.76
3/4	21	4	1.22
1	27	5	1.52
1 1/4	35	6	1.83
1 1/2	41	7.5	2.29
2	53	9.5	2.90
2 1/2	63	10.5	3.20
3	78	11	3.35
4	103	11	3.35
5	129	11	3.35
6	155	11	3.35

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Section 5
TEST METHODS

5.1 CONDITIONING, TEST CONDITIONS, AND SAMPLING

5.1.1 Conditioning Test Specimens

Unless otherwise indicated, all test specimens shall be conditioned in accordance with Procedure A in ASTM D 618 at 73.4° ± 3.6°F (23° ± 2.0° C). Shorter time periods shall be permitted for quality control testing if it can be shown that specimens have reached equilibrium.

5.1.2 Sampling

Samples shall be selected at random.

5.2 DIMENSIONS

5.2.1 Outside Diameter (Average)

The average outside diameter of the conduit shall be determined by use of a vernier circumferential wrap tape, a dial type caliper, or other instruments, as defined in ASTM D 2122.

5.2.2 Wall Thickness

The wall thickness shall be measured by a ball anvil micrometer or equivalent means at one end of the conduit to the nearest ± 0.001 inches as defined in ASTM D 2122.

5.2.3 Ovality

The ovality shall be measured as defined in ASTM D 2122 and calculated as follows:

$$\% \text{ Ovality} = \frac{\text{Maximum OD - Minimum OD}}{\text{Average OD}} \times 100$$

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5.3 COMPRESSION AND RECOVERY

Three specimens 6 inches (150 mm) in length shall be cut from lengths of the appropriate EPEC. The inside diameter of each specimen shall be calculated using the following formula:

$$ID = OD - 2t$$

Where: ID = Calculated Inside Diameter, in (mm)
OD = Measured Outside Diameter, in (mm)
t = Average Wall Thickness, in (mm)

Each specimen shall then be placed between a pair of 6-inch (150 mm) or longer rigid flat steel plates held parallel and in contact with the specimen OD. One plate shall be moved toward the other at the rate of 0.5 inch (13 mm) per minute until the distance between the parallel plates has been decreased by 50 percent of the original calculated inside diameter of the specimen. When the load is removed, the specimens shall recover to at least 85 percent of their original calculated inside diameter within 10 minutes. There shall be no evidence of splitting or cracking of any of the specimens.

5.4 IMPACT TEST

Ten 6-inch (150 mm) specimens on the surfaces of which there are no cracks, tears, or other imperfections shall be cut from lengths of appropriate EPEC. The specimens shall be tested separately while resting on a solid flat steel plate that is at least 0.5 inch (13 mm) thick and that is firmly anchored with its upper surface horizontally. It is recommended that a protective cage surround the plates and specimens to prevent injury. A 20-lb (9 kg) steel type B tup, per ASTM D 2444 (2-inch (50.8 mm) right-circular cylinder with rounded edges) shall be allowed to fall freely through a vertical guide from the heights shown in Table 4-2. The flat face of the weight shall strike the center of the specimen**.** Care should be taken to avoid double strikes due to rebound of tup.

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Section 6
MARKINGS

6.1 MARKING REQUIREMENTS

The markings on the conduit shall be legible and spaced at intervals of not more than 5 ft (1.5 m). The following marks are required:

a. manufacturer's name or trademark
b. trade size
c. wall thickness, schedule, or dimension ratio (DR)
d. date code or month and year of manufacture
e. "HDPE"
f. "NEMA TC 7"

6.2 OPTIONAL MARKINGS

Optional markings are acceptable if they do not conflict with and cannot be confused with the marking requirements in 6.1.

a. Markings such as a lightning bolt symbol may be used to indicate this conduit is a carrier of electrical conductors.
b. Sequential length numbering
c. Type of polyethylene conduit (i.e. EPEC-A)
d. Colored co-extruded layer or stripes
e. Other markings as agreed upon between manufacturer and customer

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Appendix A
RECOMMENDED MINIMUM DRUM DIAMETERS

Trade Sizes	Metric Designators	Drum Diameter	
		inches	cm
1/2	16	18	48
3/4	21	18	48
1	27	24	61
1 1/4	35	30	76
1 1/2	41	30	76
2	53	36	92
2 1/2	63	42	107
3	78	48	122
4	103	68	173
5	129	84	214
6	155	84	214

NOTE—Smaller drum diameters may be utilized as agreed upon between the customer and manufacturer.

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