NEMA STANDARDS PUBLICATION NO. TC 15

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Corrugated Polyvinyl Chloride (PVC) Fiber Optic Innerduct

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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NEMA Standards Publication No. TC 15-1993

CORRUGATED POLYVINYL CHLORIDE (PVC) FIBER OPTIC INNERDUCT

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FOREWORD

These standards for corrugated PVC fiber optic innerduct are intended to:

a. List dimensions and other significant requirements.
b. Set forth some of the properties of these products and to assist in selecting and obtaining the proper product for a particular need.

User needs have been considered throughout the development of these standards.

The Polymer Raceway Products Section of NEMA, through its members, has worked (and continues to work) closely with such organizations as ASTM, the Plastic Pipe Institute, appropriate government agencies, testing laboratories and others in the periodic review and revision of these standards for any changes necessary to remain current. Proposed or recommended revisions should be submitted to:

Vice President, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

Publication No. TC 15-1993 revises and supersedes the NEMA Standards Publication "Corrugated Polyvinyl Chloride (PVC) Fiber Optic Innerduct", Publication No. TC 15-1986. Prior to publication, the NEMA Standards, Suggested Standards for Future Design, and Authorized Engineering Information which appear in this publication unchanged since their appearance in TC 15-1986 were reaffirmed.

SCOPE

These standards cover corrugated PVC innerduct designed to be used as protection for fiber optic cable, and other conductors within larger raceways, cable trays, or similar enclosures.

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Section 1
REFERENCED STANDARDS AND DEFINITIONS

1.1 REFERENCED STANDARDS

In this publication, reference is made to the following publications. Copies are available from the sources indicated.

American Society for Testing and Materials
1916 Race Street
Philadelphia, PA 19103

D 618-61 (1990)	*Conditioning Plastics and Electrical Insulating Materials for Testing*
D 883-91	*Definition of Terms Relating to Plastics*
D 1600-91	*Abbreviations of Terms Relating to Plastics*
D 1784-90	*Specifications for Rigid Polyvinyl Chloride Compounds and Chlorinated Polyvinyl Chloride Compounds*
D 2122-90	*Determining Dimensions of Thermoplastic Pipe and Fittings*
D 2444-84	*Standard Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*
D 4396-1984 (R1990)	*Specifications for Rigid Poly (Vinyl Chloride) (PVC) and Related Plastic Compounds for Non-Pressure Piping Products*
F 412-91	*Definitions of Terms Relating to Plastic Piping Systems*

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

ANSI/UL 651-1989	*Schedule 40 and 80 Rigid PVC Conduit*

1.2 DEFINITIONS AND ABBREVIATIONS

Definitions of terms shall be in accordance with ASTM D-883 or ASTM F-412. Abbreviations shall be in accordance with ASTM D-1600 unless otherwise indicated. The values stated in U.S. customary units are to be regarded as the standard.

1.2.1 Corrugated PVC Fiber Optic Innerduct

A rigid polyvinyl chloride (PVC) corrugated raceway of circular cross-section intended for the installation of optic fiber cable within a larger conduit system.

1.2.2 Qualification Test

A qualification test is a non-repetitive evaluation conducted on an existing, altered, or new product to determine acceptability.

1.2.3 Quality Control Test

A quality control test is an in-plant test that is conducted on a given test frequency to determine whether a product is in accordance with the specification requirements.

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Section 2
GENERAL REQUIREMENTS

2.1 APPLICATIONS

Corrugated PVC fiber optic innerduct is designed to provide individual raceways within a conduit system designed to contain several fiber optic cables. Individual raceways allow maximum utilization of the larger conduit while preventing damage to new or existing cable(s) during cable installation or removal activities. Corrugated PVC fiber optic innerduct can also be used above ground providing it is not subject to, or is given protection from, physical damage. Corrugated PVC fiber optic innerduct should not be used in the following circumstances.

a. For support of fixtures or other equipment
b. Where subject to physical damage

2.2 MATERIALS

Corrugated PVC fiber optic innerduct shall be made from polyvinyl chloride (PVC) compounds which meet the cell classification PVC 12233 A, B or C as defined in ASTM D-1784 or cell classification PVC 11232 A, B or C as defined in ASTM D 4396. Other homopolymer PVC compounds that have different cell classification, because one or more properties are superior to those compounds specified above, shall also be permitted.

Use of rework material shall be permitted provided the innerducts produced meet all the requirements of these standards.

2.3 DIMENSIONS

The dimensions of corrugated PVC fiber optic innerduct shall meet the requirements of Table 3-1 when determined in accordance with 4.2.

2.4 WORKMANSHIP

Corrugated PVC fiber optic innerduct shall be homogeneous throughout, free from visible cracks, holes, foreign inclusions, and other defects.

Table 2-1
Dimensions

Nominal Size Inches	Outside Dia. Avg. in. (mm)	Out of Roundness Max. in. (mm)	Out of Roundness Min. in. (mm)	Inside Dia. Min. in. (mm)
1	1.315 ± .008 (33.4 ± .20)	1.325 (33.66)	1.305 (33.15)	1.00 (25.4)
1-1/4	1.660 ± .008 (42.16 ± .20)	1.672 (42.47)	1.648 (41.86)	1.33 (33.8)
1-1/2	1.900 ± .008 (48.26 ± .20)	1.912 (48.56)	1.888 (47.96)	1.56 (39.6)
2	2.375 ± .008 (60.32 ± .20)	2.387 (60.63)	2.363 (60.02)	2.02 (51.31)

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Section 3
PERFORMANCE REQUIREMENTS

3.1 QUALIFICATION TEST

3.1.1 Flammability

The corrugated PVC fiber optic innerduct shall meet the following requirement when tested in accordance with 4.7.

The corrugated PVC fiber optic innerduct shall have no flaming or glowing particle drop or fall from the specimen. Tubing shall not continue to flame longer than five seconds after removal of flame. The tubing shall not be completely consumed during or after the application of flame.

3.2 QUALITY CONTROL TESTS

3.2.1 Flattening

There shall be no evidence of splitting, cracking, or breaking when corrugated PVC fiber optic innerduct is tested in accordance with 4.3.

If one specimen fails the original test, two additional sets of three specimens shall be tested. Both sets tested on retest must meet the requirements of this standard.

3.2.2 Impact Resistance

No crack or tear longer than 1/32 inch (.79 mm) shall appear in seven out of ten specimens of corrugated PVC fiber optic innerduct when tested in accordance with 4.4 using the values given in Table 3-1.

If initial test fails, two additional sets of specimens shall be tested. Both sets tested on retest must meet the requirements of this standard.

3.2.3 Resistance to Mechanical Abuse

There shall be no evidence of cracking or opening of any kind when corrugated PVC fiber optic innerduct is tested according to both Method 1 and Method 2 of 4.5.

If initial test fails, two additional sets of specimens shall be tested. Both sets tested on retest must meet the requirements of this standard.

3.2.4 Tension Test

The corrugated PVC fiber optic innerduct shall withstand application of the tension force given in Table 3-2 when tested in accordance with 4.6.

If initial test fails, two additional sets of specimens shall be tested. Both sets tested on retest must meet the requirements of this standard.

Table 3-1
DROP HEIGHT FOR IMPACT RESISTANCE

Nominal Size Inches	Height of the Space Between the Bottom of the Weight and the Top of the Specimen Before the Weight Is Released lbf (N)
1	2 (8.8)
1-1/4	2.5 (11.12)
1-1/2	3.0 (13.34)

Table 3-2
TENSION FORCE REQUIREMENTS

Nominal Size, Inches	Tension Force Lbs (N) Minimum
1	550 (2447)
1-1/4	630 (2802)
1-1/2	680 (3025)
2	800 (3559)

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Section 4
TEST METHODS

4.1 CONDITIONING, TEST CONDITIONS, AND SAMPLING

4.1.1 Conditioning Test Specimens

When conditioning is required, the test specimen shall be conditioned in accordance with Procedure A in ASTM D-618 at 73.4 ±3.6°F (23 ±2°C) and 50 ±2 percent relative humidity for not less than 40 hours prior to the test unless otherwise specified.

4.1.2 Test Conditions

Tests shall be conducted at 73.4 ±3.6°F (23 ±2°C) and 50 ±2 percent relative humidity unless otherwise specified.

4.1.3 Sampling

Samples shall be selected at random.

4.2 DIMENSIONS

4.2.1 Outside Diameter (Out-of-Roundness)

The outside diameter of corrugated PVC fiber optic innerduct shall be measured in accordance with Section 9 of ASTM D-2122. Out-of-roundness tolerance shall apply only at the point of manufacture.

4.2.2 Outside Diameter (Average)

The average outside diameter at any cross section on the length of corrugated PVC fiber optic innerduct shall be determined in accordance with Section 9 of ASTM D-2122.

4.3 FLATTENING

Three 2-inch (50.8 mm) long specimens shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the product. The rate of loading shall be uniform and such that the compression is completed within 2 to 5 minutes. On removal of the load, the specimen shall be examined for evidence of splitting, cracking, or breaking.

4.4 IMPACT RESISTANCE

Ten 6-inch (152 mm) long specimens, on the surface of which there are no cracks, tears, or other imperfections shall be cut from each nominal size of corrugated PVC fiber optic innerduct. The specimens shall be tested separately while resting on a solid flat steel plate which is at least 1/2 inch (13 mm) thick and which is firmly anchored with its upper surface horizontal. A 20 lb. (9.07 kg) "B" Tup, as described in ASTM D-2444, shall be allowed to fall freely though a vertical guide from the height indicated in Table 3-1. The force of the weight shall strike the center of the specimen once; provision shall be made to prevent the weight from striking the specimen more than once. The conditioning time for impact specimens shall be a minimum of 1 hour at 73.4 ±3.6°F (23° ±2°C). The specimen shall be examined for breaks or splits.

4.5 RESISTANCE TO MECHANICAL ABUSE

This test is conducted to determine the resistance of corrugated PVC fiber optic innerduct to abnormal conditions of excessive bending which might possibly occur in use. The ability of corrugated PVC fiber optic innerduct to be bent around a mandrel without cracking at any point shall be evaluated in accordance with 4.5.1 and 4.5.2.

4.5.1 Test Method 1

After conditioning 1 hour at 73.4° ±3.6°F (23° ±2°C), three samples of each nominal size of corrugated PVC fiber optic innerduct shall be bent around a mandrel 360 degrees at a room ambient temperature 73.4° ± 3.6°F (23° ± 2°C). The radius of the mandrel around which the samples shall be bent is as shown in Table 4-1.

Table 4-1
MANDREL RADIUS

Nominal Size Inches	Radius of Mandrel Inches (mm)
1	5.0 (127)
1-1/4	7.0 (178)
1-1/2	8.0 (203)
2	10.0 (254)

Tension shall be applied at a uniform rate to the specimen under test as necessary to cause the corrugated PVC fiber optic innerduct to conform closely to the curved surface. While in this position, each specimen shall be examined carefully for any breaks.

4.5.2 Test Method 2

Three samples of each nominal size of corrugated PVC fiber optic innerduct shall be conditioned at a temperature 32°F (0°C) for a period of 5 hours. The specimens shall be removed from the cold chamber one at a time and immediately bent halfway (180 degrees) around the mandrel used for Method 1. Tension shall be applied at a uniform rate to each specimen as necessary to cause the corrugated PVC fiber optic innerduct to conform closely to the curved surface. While in this position, the specimen shall be examined carefully for evidence of cracking.

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4.6 TENSION TEST

Six specimens 21 inches (533 mm) long shall be cut from sample lengths. The ends of each specimen are to be smooth and perpendicular to the longitudinal axis of the tubing. A grip shall be fitted to each end of the specimen. If needed to support the tubing, a smooth plug shall be placed inside the tubing under the grip and up to 1 inch beyond the grip. The specimens are than connected and the load smoothly applied and maintained for 1 minute without the tubing breaking. Alternatively, a tensile machine may be used to test the specimen using a speed of 1/2 inch ± 0.05 in per minute.

4.7 FLAMMABILITY

Three samples of each size of corrugated PVC fiber optic innerduct shall be subjected to and shall meet the requirements of the flammability test in UL 651.

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NEMA STANDARDIZATION BACKGROUND

The purpose of NEMA standards, their classification, and status are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for their particular needs. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process, or procedure with reference to one or more of the following: nomenclature, composition, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the Standards Publication may be capable of otherwise equivalent performance.

(Standardization Policies and Procedures, p. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp. 5)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design, which standard has received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, pp. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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