| NOTICE OF |
| ADOPTION |

ADOPTION NOTICE 1
27 August 1991 for
NEMA TC 2-90
July 17, 1990
SUPERSEDING
NEMA TC 2-83
20 May 1985
USED INSTEAD OF
W-C-1094 (*in part)
3 July 1975

NEMA TC 2-90 was adopted on 27 August 1991 and is approved for use by the Department of Defense (DoD). National Electrical Manufacturers Association has furnished the clearance required by existing regulations. Copies of the document are stocked at the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, for issue to DoD activities only. All other requestors must obtain copies from:

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2101 L Street, N.W.
Washington, D.C. 20037

Title of Document: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

Date of Specific Issue Adopted: July 17, 1990

Releasing Non-Government Standards Body: National Electrical Manufacturers Association

* NOTE: NEMA Electrical Plastic Tubing (EPT) (Type I) will replace W-C-1094 Type I, Style A.

Custodians:
Navy - YD
Air Force - 85

Military Coordinating Activity:
Navy - YD
(Project 5975-1078)

Review Activities:
Army - 99
DLA - GS

FSC 5975

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NEMA STANDARDS PUBLICATION NO. TC 2

nema

Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)

NEMA

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

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TC 2

ELECTRICAL POLYVINYL CHLORIDE (PVC) TUBING (EPT) AND CONDUIT (EPC–40 AND EPC–80)

Published by:

National Electrical Manufacturers Association
2101 L Street, N.W., Suite 300
Washington, DC 20037

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Foreword

The purpose of this Standards Publication for electrical polyvinyl chloride (PVC) tubing (EPT) for above-ground and below-ground use is:

1. To list dimensions and other significant requirements.
2. To 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 and revision of these standards.

The Plastic Conduit, Duct, and Accessories Section of NEMA, through its members, has worked (and continues to work) closely with such organizations as the American Society for Testing and Materials, the Plastic Pipe Institute, appropriate government agencies, Underwriters Laboratories, Inc., and others in the periodic review and revision of these standards for any changes necessary to keep them up-to-date with advancing technology. Proposed or recommended revisions should be submitted to:

Vice President, Engineering
National Electrical Manufacturers Association
2101 L Street, N.W., Suite 300
Washington, DC 20037

Publication No. TC 2–1990 revises and supersedes the NEMA Standards Publication for *Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80),* Publication No. TC 2–1983. 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 2–1983 were reaffirmed.

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Scope

These standards cover the following types of electrical polyvinyl chloride (PVC) tubing (EPT) and conduit (EPC-40 and EPC-80). The designations "40" and "80" refer to Schedules 40 and 80, respectively, of iron pipe dimensions.

EPT-A-PVC – Electrical PVC tubing designed to be encased in concrete when installed; used in trenches or encased in buildings, walls, floors, or ceilings.

EPC-40-PVC – Electrical PVC conduit designed for normal-duty applications above ground; also used for all concrete encased applications or direct burial.

EPC-80-PVC – Electrical PVC conduit designed for heavy-duty applications above ground; also used for all concrete encased applications or direct burial.

NEMA Standard 3-5-1990.

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

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ELECTRICAL POLYVINYL CHLORIDE (PVC) TUBING (EPT) AND CONDUIT (EPC-40 AND EPC-80)

Section 1
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
1916 Race Street
Philadelphia, PA 19103

D 618–81 1961 (R1981)	*Conditioning Plastics and Electrical Insulating Materials for Testing, Standard Methods of*
D 883–1989	*Plastics, Definitions of Terms Relating to*
D 1600–1986a	*Plastics, Standard Abbreviations of Terms Relating to*
D 1784–1981	*Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, Specifications for*
D 2122–1988	*Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings*
D 2564–1988	*Solvent Cements for Poly (Vinyl Chloride), PVC Plastic Pipe and Fittings, Specifications for*
D 4396–1984	*Rigid Poly (Vinyl Chloride) (PVC) and Related Plastics Compounds for Non-Pressure Piping Products*
F 402–1988	*Recommended Practice for Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings*
F 412–1989	*Standard Definitions of Terms Relating to Plastic Piping Systems*
F 656–1989	*Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings*

National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, DC 20037

TC 3–1990	*PVC Fittings for Use with Rigid PVC Conduit and Tubing*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02669

NFPA 30–87	*Flammable and Combustible Liquid Code*
NFPA 70–1990*	*National Electrical Code*
NFPA 325M(1984)	*Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids*

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062

UL 514B–1982	*Fittings for Conduit and Outlet Boxes*
UL 514C–1988	*Non-Metallic Outlet Boxes, Flush-Device Boxes and Covers*
UL 651–1981	*Schedule 40 and 80 Rigid PVC Non-metallic Conduit*
UL 651A–1984	*Type EB and A Rigid PVC 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 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. The abbreviation for electrical polyvinyl chloride (PVC) tubing is "EPT" and for electrical plastic conduit is "EPC."

NEMA Standard 3-5-1990.

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Section 3
GENERAL REQUIREMENTS

3.1 MATERIALS

3.1.1 Electrical Conduit and Tubing

Electrical plastic conduit and tubing shall be made from poly(vinyl chloride) (PVC) plastic compound which meets the minimum cell classification of PVC 11321 as defined in ASTM D 4396 or of cell class 12233C as defined in ASTM D 1784.

NEMA Standard 3-5-1990.

Other compounds that have a different cell classification because one or more properties are superior to those of the compounds specified above may also be used.

Clean, reworked material, conforming to the cell class requirements of this standard, may be used, providing that the conduit produced meets the requirements of this standard.

Authorized Engineering Information 3-5-1990.

3.1.2 Solvent Cements

PVC solvent cements shall be in accordance with ASTM D 2564 or as specified by the manufacturer. PVC primers shall be in accordance with ASTM F 656 or as specified by the manufacturer. ASTM F 402 is referenced as recommended practice for safe handling of solvent cements.

3.2 COLOR

EPT-A-PVC, EPC-40-PVC, and EPC-80-PVC shall be gray in color.

3.3 DIMENSIONS AND LENGTHS

Dimensions of EPC and EPT shall meet the requirements of Table 3-1 when determined in accordance with 5.2. Lengths shall be in accordance with 3.3.4.

3.3.1 Average Outside Diameter

The average diameter of the conduit shall be determined by use of a vernier circumferential wrap tape as defined in ASTM D 2122.

3.3.2 Out-of-Roundness

Out-of-roundness of the conduit shall be measured with out-of-roundness gauges specified in Table 3-2.

Out-of-roundness tolerance shall apply only at the time of manufacture, not to conduit that has been packaged and placed in yard storage.

3.3.3 Wall Thickness

The minimum and maximum wall thickness shall be measured at one end of the conduit with a micrometer as defined in ASTM D 2122.

NEMA Standard 3-5-1990.

3.3.4 Conduit Length

The overall length, including the integral bell or coupling, is commonly 10 ft. ±¾ inch (3.05 m ±0.02 m) or 20 ft. ±1 inch (6.10 m ±0.03 m). A tape measure accurate to ±1/16 inch (±1 mm) shall be permitted to be used to measure the length. Other lengths are acceptable if agreed to by the parties involved.

NEMA Standard 3-5-1990.

3.4 JOINTS

3.4.1 EPC-40-PVC couplings may be supplied with conduit.

Note—EPC-40-PVC couplings may be used to join EPC-80-PVC.

Authorized Engineering Information 3-5-1990.

3.4.2 Plastic conduit may have belled ends. The wall thickness of an integral bell shall be considered satisfactory if formed from conduit meeting the requirements of this standard. The integral bell shall be considered satisfactory if it accepts the go/no-go gauges as specified in Table 3-3.

Authorized Engineering Information 3-5-1990.

The length of the bell shall be measured with an instrument accurate to ±1/16 inch (±1 mm). A tape measure or steel rule is adequate.

3.5 INSPECTIONS

The manufacturer shall inspect the conduit at time of manufacture for compliance to dimensional and performance requirements and for freedom from defects as defined in 4.4.

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Table 3-1
SIZES AND DIMENSIONS OF PVC CONDUIT AND TUBING

U.S. Customary Units

Nominal Size, Inches	Outside Diameter, In. Average	Wall Thickness, Inches						Minimum Cross-Sectional Area, Square Inches, of EPC-80-PVC*	Bell Insertion Depth, Inches
		EPT-A-PVC		EPC-40-PVC		EPC-80-PVC			
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum		
½	0.840±0.004	0.080	0.060	0.129	0.109	0.167	0.147	0.22	1 1/16–1½
¾	1.050±0.004	0.080	0.060	0.133	0.113	0.174	0.154	0.41	¾–1½
1	1.315±0.005	0.080	0.060	0.153	0.133	0.200	0.179	0.69	⅞–1⅞
1 ¼	1.660±0.005	0.090	0.070	0.160	0.140	0.214	0.191	1.24	15/16–2
1 ½	1.900±0.006	0.100	0.080	0.165	0.145	0.224	0.200	1.71	1 1/16–2
2	2.375±0.006	0.120	0.100	0.174	0.154	0.244	0.218	2.87	1⅛–2
2 ½	2.875±0.007	0.130	0.110	0.227	0.203	0.309	0.276	4.12	1½–3
3	3.500±0.008	0.145	0.125	0.242	0.216	0.336	0.300	6.43	1⅝–3⅛
3 ½	4.000±0.008	0.165	0.145	0.253	0.226	0.356	0.318	8.65	1 11/16–3 ¼
4	4.500±0.009	0.170	0.150	0.265	0.237	0.377	0.377	11.2	1 ¾–3 ⅜
5	5.563±0.010	...	...	0.289	0.258	0.420	0.375	17.8	1 15/16–3 5⅛
6	6.625±0.011	...	...	0.314	0.280	0.484	0.432	25.8	2 ⅛–3 ¾

Metric Units

Nominal Size, Inches	Outside Diameter, mm Average	Wall Thickness, Millimeters						Minimum Cross-Sectional Area, mm^2, of EPC-80-PVC*	Bell Insertion Depth, mm
		EPT-A-PVC		EPC-40-PVC		EPC-80-PVC			
		Maximum	Minimum	Maximum	Minimum	Maximum	Minimum		
½	21.34±0.10	2.03	1.52	3.28	2.77	4.24	3.73	1.4	17.5–38.1
¾	26.67±0.10	2.03	1.52	3.28	2.87	4.42	3.91	2.4	19.1–38.1
1	33.40±0.13	2.03	1.52	3.89	3.38	5.08	4.55	4.4	22.2–47.6
1 ¼	42.15±0.13	2.29	1.78	4.06	3.56	5.43	4.85	8.0	23.8–50.8
1 ½	48.26±0.15	2.54	2.03	4.19	3.68	5.69	5.08	11.0	27.0–50.8
2	60.32±0.15	3.05	2.54	4.42	3.91	6.30	5.54	18.5	28.6–50.8
2 ½	73.02±0.18	3.30	2.79	5.77	5.16	7.85	7.01	26.6	38.1–76.2
3	88.90±0.20	3.68	3.18	6.15	5.49	8.53	7.62	41.5	41.3–79.4
3 ½	101.60±0.20	4.19	3.68	6.43	5.74	9.04	8.08	55.8	42.9–82.6
4	114.30±0.23	4.32	3.81	6.73	6.02	9.58	8.56	72.3	44.5–85.7
5	141.30±0.25	...	...	7.34	6.55	10.67	9.52	114.8	49.2–92.1
6	168.28±0.28	...	...	7.98	7.11	12.29	10.97	166.5	54.0–95.3

NEMA Standard 3-5-1990.

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Table 3-2
OUT-OF-ROUNDNESS GAUGES

A rigid plate, about 1/4" thick, bored with a circular hole to the maximum permitted diameter allowed for out-of-roundness, accurate to ±0.002 inches.

Inches		
Normal Size	Circular Hole Dimension	Reference Dimension For Gauge
1/2	0.848	0.840±0.008
3/4	1.060	1.050±0.010
1	1.325	1.315±0.010
1 1/4	1.672	1.660±0.012
1 1/2	1.912	1.900±0.012
2	2.387	2.375±0.012
2 1/2	2.890	2.875±0.015
3	3.515	3.500±0.015
3 1/2	4.050	4.000±0.050
4	4.550	4.500±0.050
5	5.613	5.563±0.050
6	6.675	6.625±0.050

Table 3-3
GO/NO-GO GAUGES
Tolerance ±0.002 Inches

Inches				
Normal Size	Socket Entrance		Socket Bottom	
	Go Gage	No-Go Gage	Go Gage	No-Go Gage
1/2	0.848	0.857	0.832	0.841
3/4	1.060	1.069	1.042	1.051
1	1.325	1.336	1.305	1.316
1 1/4	1.672	1.683	1.650	1.661
1 1/2	1.912	1.925	1.888	1.901
2	2.387	2.400	2.363	2.376
2 1/2	2.883	2.898	2.861	2.876
3	3.507	3.524	3.484	3.501
3 1/2	4.007	4.024	3.984	4.001
4	4.506	4.525	4.482	4.501
5	5.583	5.604	5.543	5.564
6	6.647	6.670	6.603	6.626

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Section 4
PERFORMANCE REQUIREMENTS

4.1 QUALIFICATION TESTS

4.1.1 Definition

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

4.1.2 Deflection Resistance

Specimens of PVC tubing and conduit shall not deflect more than specified below under the load given in Table 4-1 when tested in accordance with 5.3. After loading, the minor axis measured inside of each loaded specimen shall not be less than 70 percent of the inside diameter of the specimen measured before loading. Since this value is a function of material modulus, it need only be run when a compound formulation change has been made.

NEMA Standard 3-5-1990.

4.1.3 Leakage at Joints

Joints between conduit or tubing and their respective fittings made by methods recommended by the product manufacturer should not leak when tested in accordance with 5.4. Note that this is a qualification requirement and not a quality control test.

Authorized Engineering Information 3-9-1967.

4.2 QUALITY CONTROL TESTS

4.2.1 Definition

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.

4.2.2 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.

4.2.3 Flattening

There shall be no evidence of splitting, cracking, or breaking when PVC conduit or tubing is tested in accordance with 5.5.

NEMA Standard 3-5-1990.

4.2.4 Workmanship

Conduit and tubing shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other defects.

NEMA Standard 9-25-1975.

4.2.5 Impact Resistance

No crack or tear penetrating the conduit shall appear in seven out of ten specimens of conduit and tubing when tested in accordance with 5.6 using the values given in Table 4-2.

NEMA Standard 5-15-1978.

Impact resistance tests are quality control tests intended to verify that the conduit has been properly extruded. The tests are not intended to represent field conditions.

The test criteria, when applied to the conduit within 48 hours of manufacture, have been found by experience to be adequate for handling, transport, and installation. The actual impact resistance strength is generally higher, but varies because it is dependent on specific formulation, specific extruder, and specific extrusion procedures. Changes in formulation to obtain maximum impact resistance may result in lesser values in other parameters such as deflection resistance.

Exposure of PVC conduit to ultraviolet (UV) radiation will result in a measurable decrease in impact resistance. Therefore, impact resistance values are applicable only at time of manufacture and are not applicable for yard-aged conduit. However, initial impact values set by the standard are higher than necessary for normal handling.

Authorized Engineering Information 3-5-1990.

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Table 4-1
LOAD FOR DEFLECTION RESISTANCE

Nominal Size, Inches	EPT-A-PVC Load	EPC-40-PVC Load	EPC-80-PVC Load
	lb. (kg)	lb. (kg)	lb. (kg)
½	300 (136)	1000 (454)	2000 (907)
¾	300 (136)	1000 (454)	2000 (907)
1	300 (136)	1000 (454)	2000 (907)
1 ¼	300 (136)	1000 (454)	2000 (907)
1 ½	350 (159)	750 (340)	2000 (907)
2	450 (204)	700 (318)	2000 (907)
2 ½	425 (193)	1000 (454)	2000 (907)
3	450 (204)	1000 (454)	2000 (907)
3 ½	550 (249)	1000 (454)	2000 (907)
4	525 (238)	900 (408)	2000 (907)
5	...	850 (386)	2000 (907)
6	...	850 (386)	2000 (907)

Table 4-2
LOAD 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		
	EPT-A-PVC	EPC-40-PVC	EPC-80-PVC
	ft. (m)	ft. (m)	ft. (m)
½	1 ½ (0.46)	2 ½ (0.77)	1 ¼ (0.38)
¾	2 (0.61)	4 (1.22)	1 ¼ (0.38)
1	4 (1.22)	5 (1.53)	2 (0.61)
1 ¼	6 (1.83)	6 (1.83)	2 ¼ (0.69)
1 ½	7 ½ (2.29)	7 ½ (2.29)	2 ½ (0.77)
2	9 ½ (2.90)	9 ½ (2.90)	4 (1.22)
2 ½	10 ½ (3.20)	10 ½ (3.20)	5 ½ (1.68)
3–6	11 (3.35)	11 (3.35)	7 (2.14)

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Section 5
TEST METHODS

5.1 CONDITIONING, TEST CONDITIONS, AND SAMPLING

5.1.1 Conditioning Test Specimens

When conditioning is required, the test specimens shall be conditioned in accordance with Procedure A in ASTM D 618 at 73.4°±3.6°F (23°±2°C). Shorter time periods shall be permitted for quality control testing if it can be shown that specimens have reached equilibrium.

5.1.2 Test Conditions

Tests shall be conducted at 73.4°±3.6°F (23°±2°C) unless otherwise specified.

5.1.3 Sampling

Samples shall be selected at random.

NEMA Standard 3-5-1990.

5.2 DIMENSIONS

5.2.1 Maximum and Minimum Outside Diameter (Out-of-Roundness)

The outside diameter of conduit and tubing shall be measured in accordance with Section 9 of ASTM D 2122. Out-of-roundness tolerances shall apply only at the point of manufacture. Out-of-roundness is not a requirement applicable for conduit that has been packaged and placed in yard storage.

5.2.2 Outside Diameter (Average)

The average outside diameter at any cross section on the length of conduit or tubing shall be as measured by the use of a vernier circumferential tape in accordance with Section 9 of ASTM D 2122.

5.2.3 Wall Thickness

The maximum and minimum wall thickness shall be measured with a micrometer at an end of conduit and tubing to the nearest 0.001 inch (0.02 mm) in accordance with Section 6 of ASTM D 2122.

NEMA Standard 3-5-1990.

5.3 DEFLECTION RESISTANCE

Three 6-inch (152-mm) long specimens shall be cut from lengths of each size of EPC and EPT. The inside diameter of each specimen shall be measured. Each specimen shall then be placed between a pair of 6-inch (152-mm) or longer rigid flat steel plates that are horizontal and parallel to one another. One plate shall be moved toward the other at the rate of ½ inch (13 mm) per minute until the load specified in Table 4-1 is applied to the specimen.

NEMA Standard 5-15-1978.

5.4 LEAKAGE OF JOINTS

Two pieces of EPC or EPT shall be joined together by a method recommended by the manufacturer. Solvent cemented joints shall be allowed to stand for 24 hours at room temperature prior to testing. The specimen shall be subjected to an internal or external pressure of 25 psi (172.4 kPa), using water as the medium, for one hour.

NEMA Standard 5-15-1978.

5.5 FLATTENING

A specimen, with a 2-inch minimum length, 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 before 2 minutes. On removal of the load, the specimen shall be examined for evidence of splitting or breaking. Failure is defined as breakage of the specimen or as a tear that penetrates through the conduit wall.

Authorized Engineering Information 3-5-1990.

Note—At the manufacturer's option, the manufacturer may use a longer sample or flatten the sample more than specified, as this would provide a more severe test.

NEMA Standard 5-15-1978.

5.6 IMPACT RESISTANCE

Impact specimens shall be 6±⅛ inches in length. Impact specimens shall be tested separately while resting on a solid flat steel plate with a shallow positioning groove (approximately ⅛ inch in depth with the edges rounded to a radius of approximately 1/16 inch).

NEMA Standard 3-5-1990.

Note—A flat plate with no groove may be used.

Authorized Engineering Information 3-5-1990.

For EPT and EPC-40 conduit, a 2-inch radius nose, Tup B as defined in ASTM D 2444 shall be used. The weight of the tup shall be 20 pounds±4 ounces. The tup shall strike the center of the specimen. For EPC-80, a tup in the form of a solid right-circular cylinder having a diameter of 6 inches shall be used. The weight of the tup shall be 75 pounds±12 ounces. The minimum impact resistance values are given in Table 4-2.

NEMA Standard 3-5-1990.

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Section 6
MARKINGS

6.1 GENERAL

Each of the markings required in the following paragraphs shall be clearly legible and shall comply with the following location and other requirements:

6.1.1 Long Elbows and Other Bends

For long elbows and other bends ("Long" is defined here as more than 24 inch or 610 mm in overall axial length) and for all straight lengths of conduit, the markings shall be on the product and shall comply with the permanence requirements in paragraphs 18.1–18.7 of UL 651.

6.1.2 Short Elbows and Other Bends

For short elbows and other bends ("Short" is defined here as not more than 24 inch or 610 mm in overall axial length), the markings need not be on the product but shall appear on the smallest unit packaging used for the product. In the absence of any packaging, the markings shall appear on a permanent adhesive label affixed to each piece.

6.1.3 Additional Markings

Additional markings are acceptable if they do not conflict with and cannot be confused with the markings covered in the following.

6.2 REQUIREMENTS FOR MARKINGS

The product, package, or label marking shall include (1) "rigid PVC conduit," (2) the trade size of the conduit product, and (3) the name or trademark of the manufacturer of these conduit products. If the organization that is responsible for the conduit product is different from the actual manufacturer, both the responsible organization and the actual manufacturer shall be identified by name or by acceptable coding, such as by trade name or trademark. A private labeler may also be identified. These markings shall be repeated at uniform intervals and shall appear at least every 10 feet or 3 meters, but not less than once, on each straight length of PVC conduit.

The markings of a product that is intended for use with 90°C (194°F) wiring shall include the designation "maximum 90°C wire" or "max 90°C wire."

If the manufacturer produces conduit or elbows and other bends at more than one factory, markings shall include a distinctive designation—which may be in code—by means of which the conduit or fitting can be identified as the product of a particular factory.

The marking of Schedule 80 conduit products shall be in a color contrasting with the color background of the conduit, package, or label and different from the color of other markings: "Schedule 80 PVC." Use NEC for wire fill capacity: "Area ... square inches." The blank shall be filled in with the applicable interior cross-sectional area from Table 3-1.

The marking in the previous paragraph shall be in letters at least ¼ inch or 6 mm high for conduit products of the ½- through 1½-inch trade sizes and shall be in letters at least ½ inch or 13 mm high for conduit products of the 2- through 6-inch trade sizes.

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AUTHORIZED ENGINEERING INFORMATION

APPENDIX A
SUGGESTED JOINING METHODS

A.1.1 SOLVENT CEMENT JOINING OF PVC CONDUIT

A.1.1.1 Scope

These procedures cover the joining of PVC conduit and fittings by means of solvent cements, sometimes called solvent welding. The procedures generally apply to any PVC conduit and fitting products. Manufacturers should supply special instructions for their own products, if and when it is deemed necessary.

The procedures described herein can be used to produce strong, reliable joints in PVC conduit systems either in shop operations or in the field. In cases where watertight joints are required, see A.1.3.4. However, skill and knowledge on the part of the mechanic are required to produce such joints. This skill and knowledge can be obtained by making joints under the guidance of skilled mechanics and testing the joints until good quality joints are obtained. It is the responsibility of the contractor to ensure that his mechanics can properly perform their work.

A.1.2 MATERIALS

A.1.2.1 Conduit

The conduit should meet the requirements of this standard.

A.1.2.2 Fittings

The fittings should meet the requirements of NEMA Publication No. TC 3.

A.1.2.3 Cement

The solvent cement should meet the requirements of ASTM D2564 or it shall be in accordance with the manufacturer's recommendations.

A.1.2.3.1 Selection of Solvent Cement

Solvent cements are available in two general viscosity ranges. Light-bodied cements are generally recommended for use with conduit up through 2 inches (50.8 mm) in size and having relatively close fitting joints. Heavy-bodied cements are generally recommended for use with conduit 2 inches (2" = 51 mm) and larger and for noninterference joints. The heavy-bodied cements may also be used with the smaller conduit sizes.

A.1.2.3.2 Storage of Cement

PVC solvent cements should be stored in a cool place except when actually in use at the job site.

These cements have a limited shelf life when not stored in hermetically sealed containers. The cement manufacturer should be consulted for specific recommendations on storage conditions and shelf life.

A.1.2.3.3 Precautions

Solvent cements may be toxic, flammable, or otherwise hazardous. The precautionary recommendations of the cement manufacturer should be followed.

A.1.2.3.4 Brush or Applicator Size

The cement should be applied with a natural bristle or nylon brush, using a ½ inch (13 mm) wide brush for conduit ½ inch (13 mm) and less in size, and a 1 inch (25 mm) wide brush for conduit ¾ to 2 inches (19 mm to 51 mm), inclusive, in size. For sizes larger than 2-inch (51 mm), the width of the brush should be equal to at least ½ of the conduit size, except that a 2½ inch (64 mm) wide brush is adequate for conduits 6 inch (152 mm) and larger. Dauber-Type applicators as supplied with cement will generally cover the entire size range.

A.1.3 JOINT PREPARATIONS

Before applying cement, the surfaces to be joined should be wiped clean and free of dirt, oil, grease, or moisture.

A.1.4 APPLICATION OF CEMENT

PVC solvent cement is fast drying and, therefore, should be applied as quickly as possible, consistent with good workmanship. It may be necessary for two workers to perform this operation for larger sizes of conduit. Under conditions of high atmospheric humidity, quick application is important to minimize the condensation of moisture from the air on the cement surface. Use of a slower drying cement will minimize moisture condensation.

A thin, uniform coating of cement should be applied to the inside surface of the fitting socket lightly enough to prevent the formation of a bead of cement at the interior shoulder of the fitting. Next a full, uniform coating of cement should be applied to the outside surface of the conduit to the depth of the fitting socket.

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A.1.5 ASSEMBLY OF JOINT

Immediately after applying the coat of cement to the conduit, insert the conduit into the fitting socket until it bottoms at the fitting shoulder. Turn the conduit 90° turn during insertion to distribute the cement evenly. Hold the conduit in place for about 1 minute to prevent backing out in the case of tight interference fit joints. Wipe any excess cement away from the outside of the joint.

A.1.6 APPEARANCE OF JOINT

A well-made joint will show a full bead of cement around its entire perimeter. Gaps in the bead may indicate a defective joint due to lack of an adequate quantity of cement.

A.1.7 APPLICATION OF CEMENT AND ASSEMBLY FOR SEVERE SERVICE CONDITIONS WHERE MAXIMUM STRENGTH AND LEAKTIGHT JOINTS ARE ESSENTIAL

A.1.8 ADDITIONAL MATERIALS

A.1.8.1 Chemical Cleaners

1. Methyl ethyl ketone (MEK)
2. Methyl isobutyl ketone (MIBK)
3. Tetrahydrofurane (THF)
4. Commercial cleaner as recommended by the cement manufacturer.

Care should be taken in the handling and disposal of these materials, and recommendations of the cleaner manufacturer should be followed.

For your information, suggested hazard identification ratings of the recommended chemical cleaners follow.

Cleaner	Hazard Identification		
	Health	Flammability	Reactivity
Methyl Ethyl Ketone (MEK)	1	3	0
Methyl Isobutyl Ketone (MIBK)	2	3	0
Tetrahydrofurane (THF)	2	3	1

For more specific information, refer to NFPA 325M, *Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids* and ASTM F402, *Recommended Safe Handling of Solvent Cements Used for Joining.*

A.1.8.1.1 MECHANICAL CLEANERS

1. Fine abrasive paper or cloth (100 grit or finer).
2. Clean, oil-free steel wool.

A.1.9 JOINT PREPARATION

The surfaces to be joined should be wiped clean and free of dirt, oil, grease, and moisture. The gloss from the mating surfaces should be removed with a chemical or mechanical cleaner listed in A.1.8.1.1. If a mechanical deglossing procedure is used, wipe all abrasive or plastic particles from the surfaces so treated.

A.1.10 APPLICATION OF CEMENT

PVC solvent cement is fast drying and, therefore, should be applied as quickly as possible, consistent with good workmanship. It may be necessary for two workers to perform this operation for larger sizes of conduit. Under conditions of high atmospheric humidity, quick application is important to minimize the condensation of moisture from the air on the cement surface.

First, applying a full even coating of cement to the surface of the conduit to the depth of the fitting socket. Next apply a thin uniform coating of cement to the interior of the fitting socket. Then apply a second full coating of cement to the outside of the conduit.

A.1.11 ASSEMBLY OF THE JOINT

Assemble immediately, observing the precautions given in A.1.5.

A.1.12 SET TIME

Handle newly assembled joints carefully until the cement has gone through the set period. The recommended set periods are related to temperatures as follows:

60°–100°F – 30 minutes
40°– 60°F – 1 hour
20°– 40°F – 2 hours
0°– 20°F – 4 hours

Authorized Engineering Information 3-5-1990.

A.1.12.1 Table A-1 titled "Expansions Characteristics of Rigid PVC Nonmetallic Conduit" shows the change in length, per 100 feet of conduit for a given temperature change.

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Table A-1
EXPANSION CHARACTERISTICS OF PVC RIGID NONMETALLIC CONDUIT
COEFFICIENT OF THERMAL EXPANSION = 3.38×10^{-5} IN-IN/°F

Temperature Change in °F	Length Change in inches per 100 ft. of PVC Conduit
5	0.2
10	0.4
15	0.6
20	0.8
25	1.0
30	1.2
35	1.4
40	1.6
45	1.8
50	2.0
55	2.2
60	2.4
65	2.6
70	2.8
75	3.0
80	3.2
85	3.4
90	3.6
95	3.8
100	4.1
105	4.2
110	4.5
115	4.7
120	4.9
125	5.1
130	5.3
135	5.5
140	5.7
145	5.9
150	6.1
155	6.3
160	6.5
165	6.7
170	6.9
175	7.1
180	7.3
185	7.5
190	7.7
195	7.9
200	8.1

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NEMA STANDARDIZATION

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 purchasers 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. *(Standardization Policies and Procedures, p. 1)*

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, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 2)

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.8)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
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, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.
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. 7 & 16)

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 been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.

(Standardization Policies and Procedures, pp. 7 & 16)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment, and/or approval, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.

(Standardization Policies and Procedures, pp. 7 & 16)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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