ADOPTION NOTICE 1
October 31, 1991 for
NEMA TC 6-1990
1990*
SUPERSEDING
NEMA TC 6-1983
May 6, 1985

Notice of Adoption

NEMA TC 6-1990 was adopted on October 31, 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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9050 Junction Drive, Suite 2
Jessup, Maryland 20701

Title of Document: PVC and ABS Plastic Utilities Duct for Underground Installation

Date of Specific Issue Adopted: 1990* (No specific date of issue)

Releasing Non-Government Standards Body: National Electrical Manufacturers Association

Custodians:
Army - ER
Navy - YD
Air Force - 85

Military Coordinating Activity:
Navy - YD

(Project 5975-1097)

Review Activities:
Air Force - 99
DLA - GS

FSC 5975

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NEMA STANDARDS PUBLICATION NO. TC 6

nema

PVC and ABS Plastic Utilities Duct for Underground Installation

NEMA

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

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TC 6

PVC AND ABS PLASTIC UTILITIES DUCT FOR UNDERGROUND INSTALLATION

Published by:

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

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Foreword

The purpose of these standards for PVC and ABS plastic utilities duct for underground installation is:

1. to list dimensions and other significant requirements, and
2. to set forth some of the properties of this product 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. Test methods and performance values have been related as closely as possible to end-use applications.

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, and others in the periodic review and revisions 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.
Washington, DC 20037

Publication No. TC 6-1990 revises and supersedes No. TC 6-1983. 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 6-1978 were reaffirmed.

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Scope

These standards cover the following types of PVC and ABS plastic utilities duct for underground installation for communication and electrical wire and cable:

Type EB – designed for encased burial in concrete when installed in trenches underground, and

Type DB – designed for direct burial in trenches underground without a requirement for encasement in concrete.

Fittings designed for use with duct covered by this specification are described in NEMA Standards Publication No. TC 9, *Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.*

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

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PVC AND ABS PLASTIC UTILITIES DUCT FOR UNDERGROUND INSTALLATION

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 543-1987	*Test for Resistance of Plastics to Chemical Reagent*
D 618-1961 (R1981)	*Conditioning Plastics and Electrical Insulating Materials for Testing*
D 648-1982 (R1988)	*Test for Deflection Temperature of Plastics Under Flexural Load*
D 883-1989	*Definitions of Terms Relating to Plastics*
D 1600-1986a	*Abbreviations of Terms Relating to Plastics*
D 1788-1981	*Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Plastics*
D 2122-1988	*Determining Dimensions of Thermoplastic Pipe and Fittings*
D 2235-1989	*Specifications for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings*
D 2412-1987	*Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading*
D 2444-1984	*Test for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*
D 2564-1988	*Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings*
D 2672-1989	*Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement*
D 3138-1989	*Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components*
D 4396-1984	*Specification for Rigid Poly (Vinyl Chloride)(PVC) and Related Plastic Compounds for NonPressure Piping Products*
F 402-1988	*Recommended Practice for Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings*
F 412-1989	*Definitions of Terms Relating to Plastic Piping Systems*

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TC 2-1990	*Electrical Poly(Vinyl Chloride) Tubing (EPT) and Conduit (EPC-40 and EPC-80)*
TC 9-1990	*Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation*

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Section 2
GENERAL REQUIREMENTS

2.1 DEFINITIONS AND ABBREVIATIONS

Definitions for plastic utilities duct shall be in accordance with ASTM D 883 or ASTM F 412, or both, and abbreviations shall be in accordance with ASTM D 1600, unless otherwise specified.

NEMA Standard 9-20-1978.

2.2 MATERIALS

2.2.1 Ducts

Plastic utilities ducts shall be made from:

1. Poly (vinyl chloride) (PVC) plastic compound that meets the minimum cell classification of PVC 11232 A, B, or C, as defined in ASTM D 4396, or
2. Acrylonitrile-Butadiene-Styrene (ABS) plastic compound which meets the minimum cell classification of ABS 1-2-3 as defined in ASTM D 1788.

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

Reworked material shall be permitted to be used provided that the duct produced meets all of the requirements of these standards.

NEMA Standard 1-12-1984.

2.2.2 Solvent Cements

PVC solvent cements shall be in accordance with ASTM D 2564. ABS solvent cements shall be in accordance with ASTM D 2235. Combination solvent cements for use in joining PVC and ABS ducts shall be in accordance with ASTM D 3138. ASTM F 402 is referenced as a recommended practice for safe handling of solvent cements.

2.2.3 Compound Heat Distortion

The minimum heat distortion temperature shall be 179.6°F (82°C) for ABS and 158°F (70°C) for PVC when tested in accordance with ASTM D 648.

NEMA Standard 1-23-1990.

2.3 NOMINAL SIZES

The nominal sizes of duct shall be 2,3, 3½, 4, 5, and 6 inches.

NEMA Standard 1-17-1974.

2.4 DIMENSIONS

The dimensions of each size of duct shall be in accordance with Table 2-1.

2.4.1 Average Outside Diameter

The average diameter at any cross section on the length of duct shall be determined by the use of a vernier circumferential wrap tape in accordance with Section 8 of ASTM D 2122.

2.4.2 Out-of-Roundness

Out-of-roundness of the duct shall be measured in accordance with Section 9 of ASTM D 2122. Out-of-roundness shall conform to Table 2-1. Out-of-roundness tolerance shall apply only at the point of manufacture.

2.4.3 Duct Length

The overall length including the integral bell or coupling, shall be 20 ft. + 1 in. –0 in. (609.6 cm + 25.4 mm –0 mm), unless otherwise specified.

NEMA Standard 9-20-1978.

2.5 BELLED ENDS

Plastic ducts shall be permitted to have belled ends.

Belled ends shall be in accordance with the dimensions listed in Table 2-2 or as specified in ASTM D 2672. The wall thickness of an integral bell shall be considered satisfactory if formed from duct that meets the requirements of this standard.

Out-of-roundness tolerance of belled ends shall be in accordance with Table 2-2.

Belled ends shall be centered to provide a visible shoulder around the entire circumference of the duct.

NEMA Standard 9-20-1978.

2.6 WORKMANSHIP

Plastic ducts shall be homogeneous throughout and free from visible cracks, holes, burrs, foreign inclusions, or other defects that could damage conductors or cables.

NEMA Standard 1-17-1974.

2.7 INSPECTION

Plastic ducts shall be inspected at the point of manufacture for compliance with the dimensional and performance requirements of these standards and for freedom from defects as defined in 2.6.

NEMA Standard 9-20-1978.

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Table 2-1
DIMENSIONS OF UNDERGROUND UTILITIES DUCT

A. Inches

Nominal Duct Size, Inches	Outside Diameter			Minimum Wall Thickness*				Minimum Inside Diameter
		Out of Roundness		Type EB		Type DB		
	Average Tolerance	Minimum	Maximum	ABS	PVC	ABS	PVC	
2	2.375±0.006	2.345	2.405	0.060	0.060	0.067	0.060	2.000
3	3.500±0.008	3.470	3.530	0.069	0.061	0.103	0.092	3.000
3½	4.000±0.008	3.950	4.050	0.081	0.072	0.120	0.107	3.500
4	4.500±0.009	4.450	4.550	0.092	0.082	0.136	0.121	4.000
5	5.563±0.010	5.513	5.613	0.116	0.103	0.169	0.152	5.000
6	6.625±0.011	6.575	6.675	0.140	0.125	0.201	0.182	6.000

B. Millimeters

Nominal Duct Size, Inches	Outside Diameter			Minimum Wall Thickness*				Minimum Inside Diameter
		Out of Roundness		Type EB		Type DB		
	Average Tolerance	Minimum	Maximum	ABS	PVC	ABS	PVC	
2	60.32±0.15	59.56	61.09	1.52	1.52	1.70	1.52	50.80
3	88.90±0.20	88.14	89.66	1.75	1.55	2.62	2.34	76.20
3½	101.60±0.20	100.33	102.87	2.06	1.83	3.05	2.72	88.90
4	114.30±0.23	113.03	115.57	2.34	2.08	3.45	3.07	101.60
5	141.30±0.25	140.03	142.57	2.95	2.62	4.29	3.86	127.00
6	168.28±0.28	167.00	169.54	3.56	3.18	5.11	4.62	152.40

*The relationship between these minimum wall thicknesses and performance is based on compounds having a modulus of elasticity of 360,000 psi (2482.11 MPa) for ABS and 500,000 psi (3447.38 MPa) for PVC. Some compounds might require greater wall thicknesses to meet the performance requirements of these standards. (This note is approved as Authorized Engineering Information.)

Table 2-2
BELLED ENDS DIMENSIONS (DUCT)

A. Inches

Nominal Duct Size, Inches	A			B			C		
	Socket Entrance Inside Diameter			Socket Bottom Inside Diameter			Socket Depth		
		Out of Roundness			Out of Roundness				
	Average Tolerance	Minimum	Maximum	Average Tolerance	Minimum	Maximum	Average	Minimum	Maximum
2	2.400±0.006	2.370	2.430	2.381±0.006	2.351	2.411	1.875	1.750	2.000
3	3.538±0.008	3.508	3.568	3.508±0.008	3.478	3.538	3.000	2.875	3.125
3½	4.041±0.008	3.991	4.091	4.008±0.008	3.958	4.058	3.250	3.125	3.375
4	4.544±0.009	4.494	4.594	4.509±0.009	4.459	4.559	3.500	3.375	3.625
5	5.614±0.010	5.564	5.664	5.573±0.010	5.523	5.623	4.125	4.000	4.250
6	6.687±0.011	6.637	6.737	6.636±0.011	6.586	6.686	5.125	5.000	5.250

B. Millimeters

Nominal Duct Size, Inches	A			B			C		
	Socket Entrance Inside Diameter			Socket Bottom Inside Diameter			Socket Depth		
		Out of Roundness			Out of Roundness				
	Average Tolerance	Minimum	Maximum	Average Tolerance	Minimum	Maximum	Average	Minimum	Maximum
2	60.96±0.15	60.20	61.72	60.48±0.15	59.72	61.24	47.63	44.45	50.80
3	89.87±0.20	89.10	90.63	89.10±0.20	88.34	89.87	76.20	73.02	79.38
3½	102.64±0.20	101.37	103.91	101.80±0.20	100.53	103.07	82.55	79.38	85.72
4	115.42±0.23	114.15	116.69	114.53±0.23	113.26	115.80	88.90	85.73	92.08
5	142.60±0.25	141.33	143.87	141.55±0.25	140.28	142.82	104.78	101.60	107.95
6	169.85±0.28	168.58	171.12	168.55±0.28	166.83	169.82	130.18	127.00	133.35

NOTE—Metal Circular Go No-Go plug gages machined to the minimum and maximum inside diameters shown in Appendix B may be used to check dimensions A and B. (This note is approved as Authorized Engineering Information.)

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Section 3
REQUIREMENTS AND TEST METHODS

3.1 CONDITIONING TEST SPECIMENS AND TEST CONDITIONS

3.1.1 Referee Test

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±5 percent relative humidity for not less than 40 hours prior to test. The 32°F (0°C) drop weight specimen and the surrounding conditioning medium are to be in thermal equilibrium with one another at a temperature of 32° to 35°F (0° to 1.6°C).

Tests shall be conducted at 73.4°±3.6°F (23°±2°C) and 50± 5 percent relative humidity unless otherwise specified.

3.1.2 Quality Control

Specimens shall be conditioned for a minimum of 3 hours in air, or 1 hour in liquid, at 73.4°±3.6°F (23°± 2°C). The 32°F (0°C) drop weight impact specimens shall be conditioned at 32° to 35°F (0° to 1.6°C) for at least ½ hour in liquid or other suitable means to obtain thermal equilibrium.

Specimens shall be tested at 73.4°± 3.6°F (23° ± 2°C) with no regard for relative humidity. The low temperature impact test equipment may be at 73.4°± 3.6°F (23° ± 2°C) with no regard for relative humidity.

NEMA Standard 9-20-1978.

3.2 LEAKAGE AT JOINTS

Joints between conduit and tubing and their respective fittings made by methods recommended by the product manufacturer shall not leak when tested in accordance with 5.6 of TC 2.

NEMA Standard 1-23-1990.

NOTE: This is a qualification requirement and not a quality control test.

NOTE: If water tight joints are needed, see Appendix A.1.3.4 of TC 2.

Authorized Engineering Information 1-23-1990.

3.3 HYDROCARBON RESISTANCE

The hydrocarbon resistance of ABS ducts shall be considered adequate if the duct meets the load deflection requirements specified in 3.5 after being immersed for 48 hours in heptane in accordance with ASTM D 543.

NEMA Standard 1-17-1974.

3.4 IMPACT RESISTANCE

The minimum impact resistance values for duct shall be as shown in Table 3-1 when tested as follows:

After conditioning in accordance with 3.1, five specimens, each 6± ⅛ in. (152.4 ±3 mm) long shall be tested in accordance with Section 10 of ASTM D 2444, using a 20-lb. (9 kg) Tup B and flat plate holder B. All specimens shall pass. If one fails, another five specimens shall be tested. If 9 out of 10 specimens pass the test, the duct shall be considered to have met the requirements of this standard. No more than 15 seconds shall elapse from the time of removal of the specimen from conditioning medium until completion of that test.

NEMA Standard 9-20-1978.

Table 3-1
MINIMUM IMPACT RESISTANCE VALUES FOR DUCT

Nominal Size, Inches	Minimum Impact Resistance at 32°F (0°C), Foot-pounds Force (Joules)			
	Type EB		Type DB	
	ABS	PVC	ABS	PVC
2	20 (27)	20 (27)	20 (27)	20 (27)
3	20 (27)	20 (27)	35 (47)	40 (54)
3½	20 (27)	20 (27)	40 (54)	50 (68)
4	25 (34)	25 (34)	60 (81)	60 (81)
5	40 (54)	30 (41)	85 (115)	85 (115)
6	70 (95)	40 (54)	120 (163)	120 (163)

3.5 DUCT STIFFNESS

The minimum duct stiffness values for Types EB and DB underground duct shall be as shown in Table 3-2 when tested as follows:

The duct stiffness (F/ΔY) shall be determined at 5 percent inside diameter deflection in accordance with ASTM D 2412. Each specimen shall be placed so that the minimum wall thickness is uppermost (adjacent to the top bearing plate). The vertical inside diameter shall be measured before compressing the specimen.

Three specimens, each 6±⅛ in. (152.4±3 mm) long, shall be cut from each sample. The specimens shall be compressed at the rate of ½ in. (13mm) per minute and the load recorded at the vertical deflection equivalent to 5 percent of the original inside diameter of the specimen.

The duct stiffness at 5 percent vertical deflection shall be determined as follows:

Duct Stiffness = F/ΔY, Pounds/Inch/Inch (Kilopascals)

Where:

F = Load in pounds per inch of specimen length recorded at 5 percent vertical deflection of sample inside diameter in inches.

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ΔY = Vertical deflection of inside diameter in inches.

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Table 3-2
MINIMUM DUCT STIFFNESS FOR TYPES EB AND DB UNDERGROUND DUCT

	Type EB		Type DB	
Nominal Size	$F/\Delta Y$ lb/in/in	(kPa)	$F/\Delta Y$ lb/in/in	(kPa)
All	20	138	60	414

3.6 MARKINGS

All required markings shall be legible and so applied as to remain legible under normal handling and installation practices.

Duct shall be marked with the following:

1. Manufacturer's name or trademark;
2. Nominal size;
3. Material: ABS or PVC;
4. NEMA TC 6;
5. Type: EB or DB; and
6. Any additional marking deemed necessary by the manufacturer.

NEMA Standard 9-20-1978.

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Appendix A
SOCKET BOTTOM AND SOCKET ENTRANCE GO/ NO-GO GAGE FOR BELLED END DIMENSIONS SHOWN IN TABLE 2-2

A.1 SOCKET BOTTOM GO/ NO-GO GAGE

The socket bottom Go/No-Go gage may be machined from ¼ inch (6 mm) thickness steel into a full circle gage according to the following dimensions:

Table A-1

A. Inches

Total Length of Connector	Nominal Duct Size, Inches	Go Gage		No-Go Gage	
		Diameter	Marking	Diameter	Marking
4	2	2.374–2.375	2.375	2.388–2.389	2.388
4½	3	3.499–3.500	3.500	3.517–3.518	3.517
5	3 ½	3.999–4.000	4.000	4.017–4.018	4.017
5	4	4.499–4.500	4.500	4.519–4.520	4.519
6	5	5.562–5.563	5.563	5.584–5.585	5.584
6½	6	6.624–6.625	6.625	6.648–6.649	6.648

B. Millimeters

Total Length of Connector	Nominal Duct Size, Inches	Go Gage		No-Go Gage	
		Diameter	Marking	Diameter	Marking
102	2	60.30– 60.32	60.32	60.66–60.68	60.66
114	3	88.87–88.90	88.90	89.33–89.36	89.33
127	3½	101.57–101.60	101.60	102.03–102.06	102.03
127	4	114.27– 114.30	114.30	114.78–114.81	114.78
152	5	141.27–141.30	141.30	141.83–141.86	141.83
165	6	168.25–168.28	168.28	168.86–168.88	168.86

The gage may be used on line by the operator to continually check the dimension at the bell end bottom. The Go end should go to the bottom of the socket. The No-Go end should not go to the bottom of the socket.

The Go end may be identified by green paint. The No-Go end may be identified by red paint.

The dimensions of each gage may be marked on the gage.

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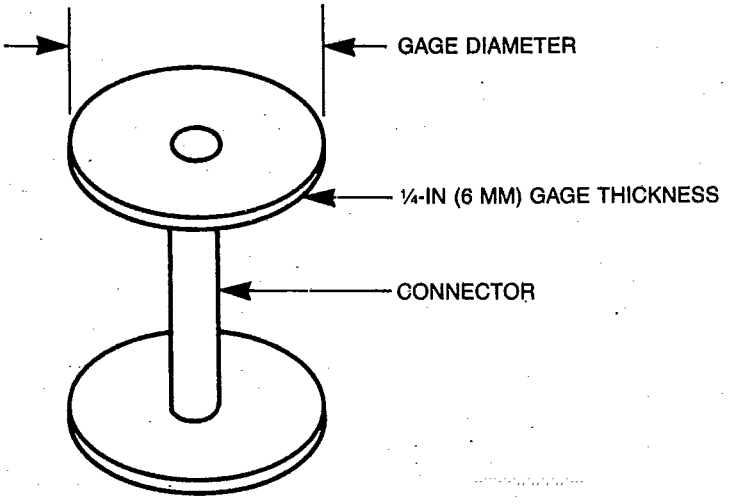

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A.2 SOCKET ENTRANCE GO/ NO-GO GAGE

The socket entrance Go/No-Go gage may be machined from ¼ inch (6 mm) thickness steel into a full circle gage according to the following dimensions:

Table A-2

A. Inches

Total Length of Connector	Nominal Duct Size, Inches	Go Gage		No-Go Gage	
		Diameter	Marking	Diameter	Marking
4	2	2.393–2.394	2.394	2.407–2.408	2.407
4½	3	3.529–3.530	3.530	3.547–3.548	3.547
5	3½	4.032–4.033	4.033	4.050–4.051	4.050
5	4	4.534–4.535	4.535	4.554–4.555	4.554
6	5	5.603–5.604	5.604	5.625–5.626	5.625
6½	6	6.675–6.676	6.676	6.699–6.700	6.699

B. Millimeters

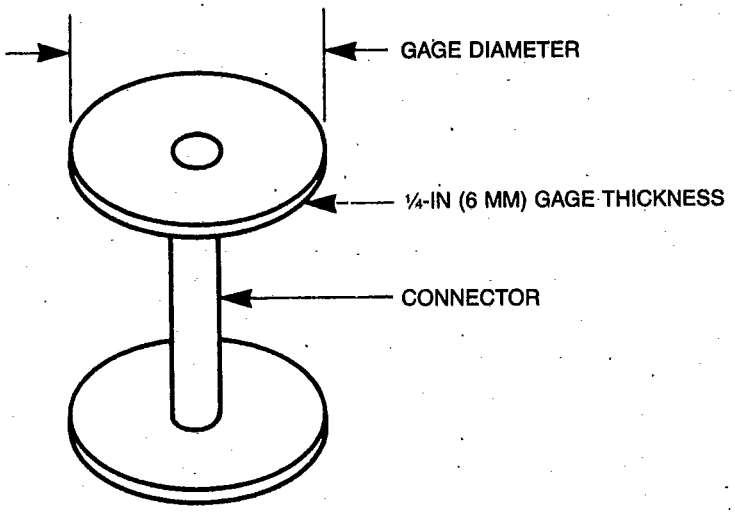
Total Length of Connector	Nominal Duct Size, Inches	Go Gage		No-Go Gage	
		Diameter	Marking	Diameter	Marking
102	2	60.78–60.81	60.81	61.14–61.16	61.14
114	3	89.64–89.66	89.66	90.09–90.12	90.09
127	3½	102.41–102.44	102.44	102.87–102.89	102.87
127	4	115.16–115.19	115.19	115.67–115.70	115.67
150	5	142.32–142.34	142.34	142.88–142.90	142.88
162	6	169.54–169.57	169.57	170.15–170.18	170.15

The gage may be used on line by the operator to continually check the dimensions of the socket entrance inside diameter. The Go end should enter the socket entrance of the bell. The No-Go end should not enter the socket entrance of the bell.

The Go end may be identified with green paint. The No-Go end may be identified with red paint.

The dimension of each gage may be marked on the gage.

Authorized Engineering Information 9-20-1978.



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Appendix B
INSTALLATION PRACTICES

It is recommended that the products described by these standards be installed in accordance with manufacturer's recommendations.

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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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