ANSI/NEMA GR 1-2007

Grounding Rod Electrodes and Grounding Rod Electrode Couplings

Approved as an American National Standard
ANSI Approval Date: July 17, 2007

NEMA Standards Publication GR 1-2007

Grounding Rod Electrodes and Grounding Rod Electrode Couplings

Published by:

National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209

www.nema.org

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The National Electrical Manufacturers Association (NEMA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety–related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

CONTENTS

Tables

Figures

Foreword

This Standards Publication provides practical information concerning construction, test, performance, and manufacture of ground rod electrodes and ground rod electrode couplings. This standard is intended for use by the electrical industry to provide guidelines for the manufacture and proper application of these products, and to promote the benefits of repetitive manufacture and widespread product availability.

One of the primary purposes of this Standards Publication is to encourage the manufacture and utilization of products, which, in themselves, function in accordance with these standards. While some sections of this publication are intended to eliminate misunderstandings between manufacturers and users, all sections, when applied properly, contribute to safety in one way or another.

The proper manufacture of ground rod electrodes and ground rod electrode couplings is, however, only one consideration in promoting the safe utilization of electricity. Other safety considerations, including environmental conditions, system design, equipment selection and application, installation, operating practices and maintenance, involve the joint efforts of the system designer, the various equipment manufacturers, the installer, and the user. Information is provided herein to assist in proper selection and use.

This Standards Publication covers design and performance requirements for ground rod electrodes and ground rod electrode couplings, and provides recommendations for their selection and use under normal or certain specific conditions. These standards have been promulgated with a view of promoting safety to persons and property when products conforming to them are selected, installed, and maintained in accordance with the *National Electrical Code*® and/or the *National Electrical Safety Code*.

NEMA Standards Publications are periodically reviewed to meet changing conditions and technical progress, and the latest edition should be utilized. Purchasers will be notified as to when revisions take place and will be provided an opportunity to acquire these when available.

Comments from users of this standards publication are welcome. They should be sent to:

Vice President, Technical Services
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209

This Standards Publication was developed by the Electrical Connector Section of the National Electrical Manufacturers Association.

Section 1
GENERAL

1.1 SCOPE

This Standards Publication applies to ground rod electrodes and ground rod electrode couplings that function in accordance with the *National Electrical Code®* (NFPA 70-2005) and/or the *National Electrical Safety Code* (ANSI C2-2002). Included are materials, construction, and performance of copper bonded ground rod electrodes, zinc-coated ground rod electrodes, and stainless steel clad ground rod electrodes. This standards publication also includes information for electrode products that have been successfully used for many years but are not defined within the *National Electrical Code* or the *National Electrical Safety Code*. The items described in this Standards Publication are defined in Section 1.

1.2 NORMATIVE REFERENCES

This NEMA Standards Publication represents the results of research and investigation by the members of NEMA, its Sections and Committees. It has been developed through consultation among manufacturers, users, and national engineering societies. This publication references the following standards (all referenced documents use the latest document date):

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

ASTM A123/A123M-01	*Standard Specification for Zinc (Hot Dip Galvanized) Coatings of Iron and Steel Products*
ASTM A153/A153M-01	*Standard Specification for Zinc Coatings (Hot-Dip) on Iron and Steel Hardware*
ASTM A276-05a	*Standard Specification for Stainless Bars and Shapes*
ASTM A370-97a	*Standard Test Methods and Definitions for Mechanical Testing of Steel Products*
ASTM E376-96	*Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods*

Institute of Electrical and Electronic Engineers
445 Hoes Lane
Piscataway, NJ 08854

ANSI/IEEE C2-2002	*National Electrical Safety Code*

National Fire Protection Association, Inc.
One Batterymarch Park
Quincy, MA 02169

ANSI/NFPA 70-2005	*National Electrical Code®*

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062

ANSI/UL 467-1993	*Standard for Grounding and Bonding Equipment*

1.3 UNITS OF MEASUREMENT

The primary units of measure in this Standards Publication are based on the metric dimensions with conventional inch-pound system in parentheses, which is commonly accepted and used by the electrical construction industry.

1.4 DEFINITIONS

adhesion: The physical bond between the applied metal and the core metal.

copper bond: The physical bond between the copper and the core metal.

coupling: A connecting device for mechanically and electrically joining two ground rod electrodes in series.

ground rod electrode: A rod type device that establishes an electrical connection to the earth and is capable of being driven.

zinc coating: The layer of zinc around the core metal.

Section 2
COPPER BONDED GROUND ROD ELECTRODES

2.1 STEEL CORE PROPERTIES

Upon inspection of the steel core, there shall be minimal signs of pitting and erosion. There shall be no gashes or cracks that protrude slivers from the surface of the electrode. The steel core, when tested in accordance with ASTM A370, shall have a tensile strength of not less than 552 MPa (80,000 lb per square-inch) and a Rockwell hardness of no less than B80.

2.2 COPPER THICKNESS

The copper thickness shall not be less than 0.25 mm (0.010 in.) for ground rod electrodes 12.7 mm (0.50 in.) or greater in diameter. The copper thickness shall be measured with a properly calibrated eddy-current (electromagnetic) device. The device shall be used in accordance with the manufacturer's instructions, and by following the standard practice for measuring coating thickness described in ASTM E376.

2.3 LENGTH

Ground rod electrodes shall have a minimum total length of 2.44 m (8 ft). They shall have a length as specified with a –0 tolerance.

2.4 GROUND ROD ELECTRODE DIAMETERS

Finished ground rod electrodes for the trade sizes listed in Table 2-1 shall be cold drawn and fall within the specified finished diameter ranges.

Table 2-1
FINISHED DIAMETER RANGES FOR COPPER BONDED GROUND ROD ELECTRODES

	Finished Diameter Range							
	Threaded				Threadless			
Trade Size	Minimum		Maximum		Minimum		Maximum	
Inches	mm	(in.)	mm	(in.)	mm	(in.)	mm	(in.)
1/2*	12.70	0.500	12.90	0.507	12.70	0.500	12.90	0.507
5/8	14.10	0.555	14.35	0.565	14.10	0.555	14.35	0.565
3/4	17.09	0.673	17.35	0.683	17.09	0.673	17.35	0.683
1	23.04	0.907	23.29	0.917	23.04	0.907	23.29	0.917

*An L or ★ is typically used to indicate minimum 12.70 mm (0.500 in.) diameter.

2.5 THREADS

Threads on copper bonded, sectional type ground rod electrodes shall be rolled onto both ends after copper bonding, and shall conform to the specifications in Figure 2-1 and Table 2-2.

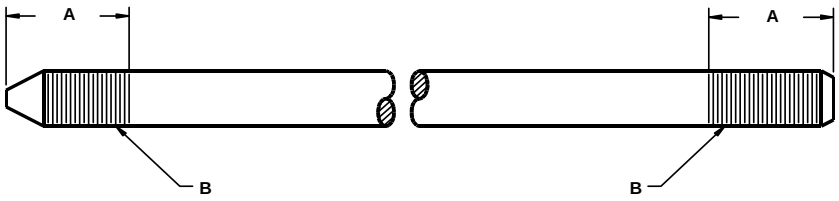


Figure 2-1
THREAD SPECIFICATION

Table 2-2
THREAD SPECIFICATIONS

Trade Size Inches	Dimension A		Thread B Profile
	mm (+3.2, -1.6)	in. (+1/8, -1/16)	UNC
1/2*	26.99	1-1/16	9/16-12
5/8	30.16	1-3/16	5/8-11
3/4	31.75	1-1/4	3/4-10
1	42.86	1-11/16	1-8

*An L or ★ is typically used to indicate minimum 12.70 mm (0.500 in.) diameter.

2.6 END CONFIGURATIONS

The end configurations of a copper bonded ground rod electrode shall be in accordance with Figure 2-2. The diameter of the penetrating (pointed) end of a copper bonded ground rod electrode shall be as specified per Dimension A, of Table 2-3, for each trade size. The length of the chamfer on the driving (blunt) end shall be as specified per Dimension B of Table 2-3.

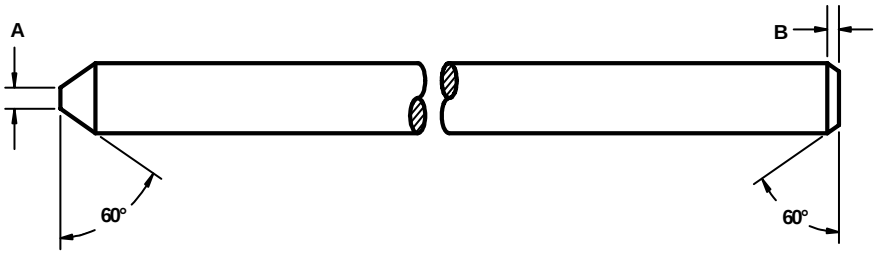


Figure 2-2
END CONFIGURATION

Table 2-3
END POINT CONFIGURATIONS

Trade Size Inches	Dimension A (Maximum)		Dimension B (Minimum)	
	mm	(in.)	mm	(in.)
1/2*	4.76	3/16	2.38	3/32
5/8	4.76	3/16	3.18	1/8
3/4	6.35	1/4	3.18	1/8
1	9.53	3/8	5.56	7/32

*An L or ★ is typically used to indicate minimum 12.70 mm (0.500 in.) diameter.

2.7 ADHESION

2.7.1 Test Method

An 18 in. length of ground rod electrode with one end cut to a 45 degree point shall be driven between two steel clamping plates or the jaws of a vise set 0.04 in. less than the diameter of the ground rod electrode, so as to shear off sufficient metal to expose the bond between the copper and the ground rod electrode.

2.7.2 Evaluation

There shall be no evidence of separation of the copper and the steel core.

2.8 DUCTILITY

2.8.1 Test Method

At room temperature (25º±5ºC), a length of ground rod electrode shall be rigidly held in a clamp or vise and the free end bent by applying a force normal to the ground rod electrode at a distance from the clamping device equal to 40 times the ground rod electrode diameter. The magnitude of the force and the direction of application shall be such that the ground rod electrode is permanently bent through a 30-degree angle.

2.8.2 Evaluation

Upon visual inspection with no magnification, there shall be no evidence of cracking of the copper.

2.9 FINISH

The surface of a ground rod electrode shall be smooth and free from blisters, slivers, and other types of projections.

2.10 STRAIGHTNESS

The deviation from straight for any ground rod electrode shall be determined and evaluated in accordance with the following:

2.10.1 Test Method

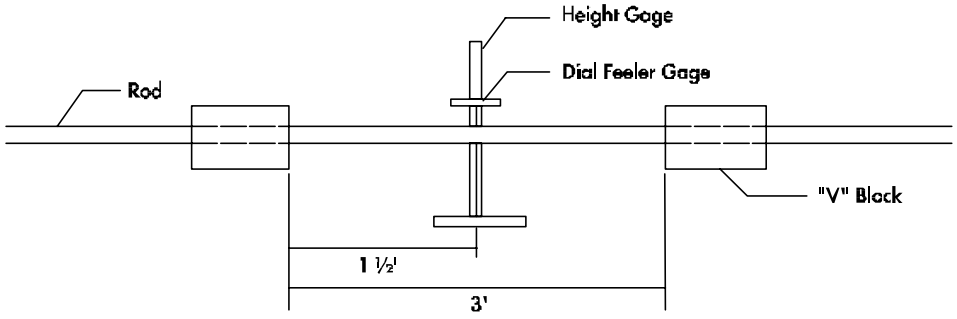
The selected ground rod electrode shall be supported by two "V" blocks, with a dial feeler gage located at the mid-point of the "V" blocks in accordance with Figure 2-3. While rotating the ground rod electrode by hand, the maximum and minimum readings shall be recorded. The readings are then subtracted for the total deviation. The average deviation from straight for the length of the ground rod electrode located between the "V" blocks is determined by the following formula:

$$AverageDeviation = \frac{Maximum\ Deviation\ (inches) - Minimum\ Deviation\ (inches)}{2\ x\ 3\ ft}$$

2.10.2 Evaluation

Straightness of the ground rod electrode shall not vary more than 6.4 mm (0.25 in.) in 1.5 m (5 ft).

Figure 2-3
APPARATUS FOR STRAIGHTNESS TEST



2.11 MARKINGS

A ground rod electrode shall be permanently and legibly marked with the manufacturer's identification and the catalog or equivalent designation, within 305 mm (12 in.) of the driving end of the ground rod electrode.

Section 3
ZINC COATED GROUND ROD ELECTRODES

3.1 STEEL CORE PROPERTIES

Upon inspection of the steel core, there shall be minimal signs of pitting and erosion. There shall be no gashes or cracks that protrude slivers from the surface of the ground rod electrode. The steel core, when tested in accordance with ASTM A370, shall have a tensile strength of not less than 552 MPa (80,000 PSI) and a Rockwell hardness of no less than B80.

3.2 ZINC COATING

3.2.1 Coating Method

All ground rod electrodes manufactured in accordance with this section shall be coated utilizing a method in accordance with applicable ASTM standards. Hot dip galvanized ground rod electrodes shall be manufactured in accordance with ASTM A123 or ASTM A153.

3.2.2 Thickness

The zinc deposit thickness shall not be less than 0.099 mm (0.0039 in.) for an ASTM A123 ground rod electrode or 0.086 mm (0.0034 in.) for an ASTM A153 ground rod electrode.

3.2.3 Measurement

The measurement for zinc thickness shall be made with a properly calibrated eddy-current (electromagnetic) device. The device shall be used in accordance with the manufacturer's instructions, and by following the standard practice for measuring coating thickness described in ASTM E376.

3.3 LENGTH

Ground rod electrodes shall have a minimum total length of 2.44 m (8 ft). They shall have a length as specified with a –0 tolerance.

3.4 GROUND ROD ELECTRODE DIAMETERS

Finished ground rod electrodes for the trade sizes listed in Table 3-1 shall fall within the specified diameter ranges.

Table 3-1
FINISHED DIAMETER RANGES FOR ZINC COATED GROUND ROD ELECTRODES

Trade Size Inches	Finished Diameter Ranges			
	Minimum		Maximum	
	mm	(in.)	mm	(in.)
5/8	15.88	0.625	16.26	0.640
3/4	19.05	0.750	19.43	0.765
1	25.40	1.000	25.78	1.015

Exception: The above dimensions may be different if the ground rod is certified to a U.S. nationally recognized standard.

3.5 ADHESION

The zinc coating shall withstand handling consistent with the nature and thickness of the coating and the normal use of the ground rod electrode without peeling or flaking.

3.5.1 Test Method

Proper adhesion of the zinc coating to the base metal surface shall be determined by cutting or prying the coating with the point of a stout knife, applied with a pressure sufficient to remove a portion of the coating.

3.5.2 Evaluation

Adhesion shall be considered inadequate if flaking occurs, exposing the base metal in advance of the knife point. Adhesion shall not be evaluated at edges or corners.

3.6 FINISH

The surface of ground rod electrodes shall be uniform in appearance, clean, and free of visible coating defects, such as blisters, flux, inclusions, pits, roughness, slivers, sharp spikes, nodules, bare spots, burning, cracks, or unplated areas, and other defects that may affect function of the coating. The coating shall not be stained or discolored. However, superficial staining that results from rinsing or slight discoloration resulting from any drying or baking operation to relieve hydrogen embrittlement shall be acceptable.

3.7 STRAIGHTNESS

The deviation from straight for any ground rod electrode shall be determined and evaluated as follows:

3.7.1 Test Method

Ground rod electrodes shall be prepared for straightness testing in accordance with 2.10.1.

3.7.2 Evaluation

Straightness of the ground rod electrode shall not vary more than 6.4 mm (0.25 in.) in 1.5 m (5 ft) for any 1.5 m (5 ft) section of rod.

3.8 END CONFIGURATIONS

End configurations of a zinc coated ground rod electrode shall be in accordance with Figure 3-1. A four-sided nail type point with the same 60° angle on each side of the point shall be acceptable. The diameter of the penetrating (pointed) end of the zinc coated ground rod electrode shall be as specified per Dimension A of Table 3-2 for each trade size. The length of the optional chamfer, Figure 3-1, on the driving (blunt) end shall be as specified per Dimension B of Table 3-2. Alternative end configurations as illustrated in Figure 3-2 shall also be acceptable.

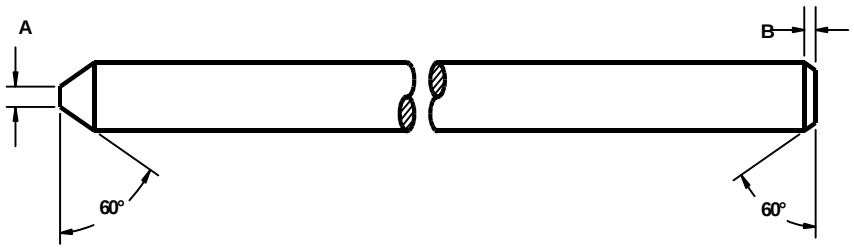


Figure 3-1
END CONFIGURATION

Table 3-2
END POINT CONFIGURATIONS

Trade Size Inches	Diameter of End Points			
	Dimension A Maximum		Dimension B Minimum	
	mm	(in.)	mm	(in.)
5/8	4.76	3/16	3.18	1/8
3/4	6.35	1/4	3.18	1/8
1	9.53	3/8	5.56	7/32

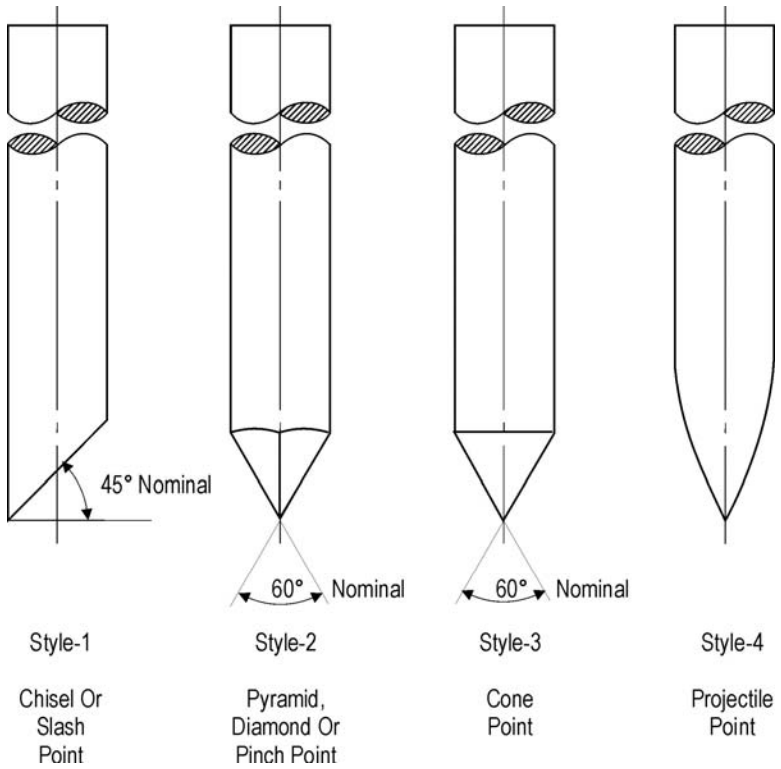


Table 3-2
ALTERNATIVE END CONFIGURATIONS

3.9 MARKINGS

Ground rod electrodes shall be permanently and legibly marked with the manufacturer's identification, and the catalog or equivalent designation within 305 mm (12 in.) of the driving end of the ground rod electrode.

Section 4
STAINLESS STEEL GROUND ROD ELECTRODES

4.1 STEEL PROPERTIES

Grade 304 solid stainless steel rods to ASTM A276.

The stainless steel rod, when tested in accordance with ASTM A370, shall have a tensile strength of no less than 795 MPa (115,305 PSI).

4.2 LENGTH

Ground rod electrodes shall have a minimum total length of 2.44 m (8 ft). They shall have a length as specified with a –0 tolerance.

4.3 GROUND ROD ELECTRODE DIAMETERS

Finished ground rod electrodes for the trade sizes listed in Table 4-1 shall fall within the specified diameter ranges.

Table 4-1
FINISHED DIAMETER RANGES FOR SOLID STAINLESS STEEL GROUND ROD ELECTRODES

Trade Size Inches	Finished Diameter Ranges			
	Minimum		Maximum	
	mm	(in.)	mm	(in.)
5/8	15.88	0.625	16.13	0.635
3/4	19.05	0.750	19.43	0.765

4.4 FINISH

The surface of ground rod electrodes shall be uniform in appearance, clean, and free of visible defects. The coating shall not be stained or discolored. However, superficial staining shall be acceptable.

4.5 STRAIGHTNESS

The deviation from straight for any ground rod electrode shall be determined and evaluated as follows:

4.5.1 Test Method

Ground rod electrodes shall be prepared for straightness testing in accordance with 2.10.1.

4.5.2 Evaluation

Straightness of the ground rod electrode shall not vary more than 6.4 mm (0.25 in.) in 1.5 m (5 ft) for any 1.5 m (5 ft) section of rod.

The diameter of the penetrating (pointed) end of the stainless steel coated ground rod electrode shall be as specified per Dimension A, of Figure 4-1 and Table 4-2 for each trade size. The length of the optional chamfer, Figure 4-1, on the driving (blunt) end shall be as specified per Dimension B of Table 4-2.

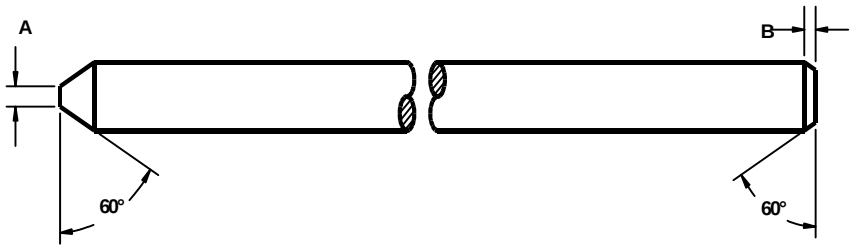


Figure 4-1
END CONFIGURATION

Table 4-2
END POINT CONFIGURATIONS

Trade Size Inches	Diameter of End Points			
	Dimension A		Dimension B	
	Maximum		Minimum	
	mm	(in.)	mm	(in.)
5/8	4.76	3/16	3.18	1/8
3/4	6.35	1/4	3.18	1/8

4.6 MARKINGS

A ground rod electrode shall be permanently and legibly marked with the manufacturer's identification, and the catalog or equivalent designation within 305 mm (12 in) of the driving end of the ground rod electrode.

Section 5
COUPLINGS FOR COPPER BONDED GROUND ROD ELECTRODES

5.1 PHYSICAL PROPERTIES

5.1.1 Surface Condition

The surface of the coupling shall be smooth and free of cracks, burrs, or sharp corners.

5.1.2 Material

Coupling material shall be copper or a copper alloy containing not less than 80% copper, and shall be suitable for burial in earth.

5.2 CONSTRUCTION

5.2.1 Length

The length of threaded couplings shall be sufficient to cover the threaded portion of two coupled ground rod electrodes. In addition, the lengths of both threaded and threadless couplings shall be sufficient to meet the performance requirements of section 5.3 of this standard.

5.2.2 Application Diameter

5.2.2.1 Threaded Ground Rod Electrode Couplings

A threaded coupling shall be symmetrical and shall accept threaded ground rod electrodes of the trade sizes in Table 5-1.

Table 5-1
COUPLING THREAD SIZES FOR THREADED
COPPER BONDED GROUND ROD ELECTRODES

Trade Size Inches	Thread Profile
1/2	9/16-12
5/8	5/8-11
3/4	3/4-10
1	1-8

5.2.2.2 Threadless Ground Rod Electrode Couplings

A threadless ground rod electrode coupling shall be symmetrical and shall accept threadless ground rod electrodes of the trade sizes in Table 5-2.

Table 5-2
APPLICATION DIAMETERS FOR THREADLESS COUPLINGS FOR THREADLESS COPPER BONDED GROUND ROD ELECTRODES

Trade Size Inches	Application Diameter	
	mm	(in.)
1/2*	12.70 - 12.95	0.500 - 0.510
5/8	14.10 - 14.35	0.555 - 0.565
3/4	17.09 – 17.35	0.673 - 0.683
1	23.04 – 23.29	0.907 - 0.917

*An L or ★ is typically used to indicate minimum 12.70 mm (0.500 in.) diameter.

5.3 PERFORMANCE

5.3.1 Conductivity

When used to join two copper bonded ground rod electrodes of the minimum diameters specified in Table 2-1, couplings shall provide to joined ground rod electrodes, no less than 95% of the conductivity of an unspliced copper bonded ground rod electrode of equal length.

5.3.2 Impact

5.3.2.1 Test Method

Two 460 mm (18 in.) copper bonded ground rod electrodes of the diameters specified in Table 2-1, shall be coupled and held vertically in a tubular fixture that is at least 0.25 mm (0.010 in.) greater than the copper bonded ground rod electrode diameter. The penetrating end of the bottom ground rod electrode shall be rested on a fixed plate of a weight sufficient to withstand the test impact, and located in a hole at least 100 mm (4 in.) in depth. The coupling shall not rest on or be contained within the tubular fixture or the fixed plate. The top ground rod electrode shall be subjected to an impact energy of 54 J (40 ft-lb) imparted by a dropped mass.

5.3.2.2 Evaluation

After 25 impacts, there shall be no evidence of breakage, splitting, or damage that impairs the performance of the coupling.

5.3.3 Pullout

When used to join two copper bonded ground rod electrodes of the minimum diameters specified in Table 2-1, the joining coupling and copper bonded ground rod electrodes must withstand a pullout force of no less than 6.7 kN (1500 lbf) before separation.

5.3.4 Bend

5.3.4.1 Test Method

Two copper bonded ground rod electrodes coupled together shall be subjected to the same bending requirements as an individual ground rod electrode. The test specimen shall be gripped in a suitable rigid clamp or vise and the ground rod electrode bent by applying a force normal to the ground rod electrode, at a distance of 40 times the ground rod electrode diameter from the clamping device. The coupling shall be located midway between the clamping device and the point of applied force. The force shall be applied until the ground rod electrode is permanently bent through an angle of 30°.

5.3.4.2 Evaluation

The coupling shall not exhibit any signs of cracking or separation from the ground rod electrode.

5.3.5 Mechanical Strength

Couplings shall provide sufficient mechanical strength to permit driving under normal conditions and not exhibit deformation or splitting under such conditions. This is demonstrated by successful compliance to sections 5.3.2 through 5.3.4.

5.4 MARKINGS

Each coupling shall be marked with the manufacturer’s name or trademark and trade size. Each container, packaged as required by the end user, shall be marked with the manufacturer's name or trademark, and trade size.

Section 6
COUPLINGS FOR ZINC-COATED GROUND ROD ELECTRODES

6.1 PHYSICAL PROPERTIES

6.1.1 Surface Condition

The surface of the coupling shall be smooth and free of cracks, burrs, or sharp corners.

6.1.2 Material

Coupling material shall be of zinc coating or stainless steel.

Material characteristics shall include the following:

Tensile Strength: 483 MPa Minimum (70,000 PSI)
Yield strength: 380 MPa Minimum (55,000 PSI)
% Elongation 2 in.: 10%

6.2 CONSTRUCTION

6.2.1 Length

The length of the threadless coupling shall be a minimum of 69.85 mm (2-3/4 in.). In addition, the lengths of threadless couplings shall be sufficient to meet the performance requirements of section 5.3 of this standard.

6.2.2 Threadless Ground Rod Electrode Couplings

A threadless zinc-coated ground rod electrode coupling shall be symmetrical and shall accept a plain threadless zinc-coated ground rod electrode of the trade sizes in Table 6-1.

Table 6-1
APPLICATION DIAMETERS FOR THREADLESS COUPLINGS FOR THREADLESS ZINC-COATED GROUND ROD ELECTRODES

Trade Size Inches	Application Diameter	
	mm	(in.)
5/8	15.87 – 16.25	0.625 – 0.640
¾	19.05 – 19.43	0.750 – 0.765
1	25.40 – 25.78	1.000 – 1.015

6.3 PERFORMANCE

The coupling used to join two zinc coated ground rod electrodes shall pass the bend test and withstand a pullout force of no less than 6.67 kN (1500 lbf) before separation.

6.3.1 Conductivity

When used to join two zinc-coated ground rod electrodes of the minimum diameters specified in Table 2-1, couplings shall provide to joined ground rod electrodes, no less than 95% of the conductivity of an unspliced zinc-coated ground rod electrode of equal length.

6.3.2 Impact

6.3.2.1 Test Method

Two 450 mm (18 in.) zinc-coated ground rod electrodes of the diameters specified in Table 2-1, shall be coupled and held vertically in a tubular fixture that is at least 0.010 in. greater than the zinc-coated ground rod electrode diameter. The penetrating end of the bottom ground rod electrode shall be rested on a fixed plate of a weight sufficient to withstand the test impact, and located in a hole at least 100 mm (4 in.) in depth. The coupling shall not rest on or be contained within the tubular fixture or the fixed plate. The top ground rod electrode shall be subjected to an impact energy of 54 J (40 ft-lb).

6.3.2.2 Evaluation

After 25 impacts, there shall be no evidence of breakage, splitting, or damage that impairs the performance of the coupling.

6.3.3 Bend

6.3.3.1 Test Method

Two zinc-coated ground rod electrodes coupled together shall be subjected to the same bending requirements as an individual ground rod electrode. The test specimen shall be gripped in a suitable rigid clamp or vise and the ground rod electrode bent by applying a force normal to the ground rod electrode, at a distance of 40 times the ground rod electrode diameter from the clamping device. The coupling shall be located midway between the clamping device and the point of applied force. The force shall be applied until the ground rod electrode is permanently bent through an angle of 30°.

6.3.3.2 Evaluation

The coupling shall not exhibit any signs of cracking or separation from the ground rod electrode.

6.3.4 Mechanical Strength

Couplings shall provide sufficient mechanical strength to permit driving under normal conditions, and not exhibit deformation or splitting under such conditions. This is demonstrated by successful compliance to sections 6.3.2 and 6.3.3.

6.4 MARKINGS

Each coupling shall be marked with the manufacturer's name or trademark and trade size. Each container, packaged as required by the end user, shall be marked with the manufacturer's name or trademark, and trade size.

Section 7
COUPLINGS FOR STAINLESS STEEL GROUND ROD ELECTRODES

7.1 PHYSICAL PROPERTIES

7.1.1 Surface Condition

The surface of the coupling shall be smooth and free of cracks, burrs, or sharp corners.

7.1.2 Material

Coupling material shall be of Grade 304 stainless steel.

7.2 CONSTRUCTION

7.2.1 Length

The length of the stainless steel coupling shall be a minimum of 69.85 mm (2-3/4 in.). In addition, the lengths of stainless steel couplings shall be sufficient to meet the performance requirements of section 7.3.

7.2.2 Application Diameter

7.2.2.1 Threaded Ground Rod Electrode Couplings

A threaded stainless steel coupling shall be symmetrical and shall accept threaded stainless steel ground rod electrodes threads of the trade sizes in Table 7-1.

Table 7-1
COUPLING THREAD SIZES FOR THREADED
STAINLESS STEEL GROUND ROD ELECTRODES

Trade Size Inches	Thread Profile
1/2	9/16-12
5/8	5/8-11
3/4	3/4-10
1	1-8

7.2.2 Threadless Ground Rod Electrode Couplings

A threadless stainless steel ground rod electrode coupling shall be symmetrical and shall accept a plain threadless stainless steel ground rod electrode of the trade sizes in Table 7-2.

Table 7-2
APPLICATION DIAMETERS FOR THREADLESS COUPLINGS FOR THREADLESS STAINLESS STEEL GROUND ROD ELECTRODES

Trade Size Inches	Application Diameter	
	mm	(in.)
5/8	15.87 – 16.25	0.625 – 0.640
3/4	19.05 – 19.43	0.750 – 0.765
1	25.40 – 25.78	1.000 – 1.015

7.3 PERFORMANCE

The threadless coupler for a stainless steel ground rod must be able to seat on the rod with minimal impacting force, be able to withstand such impacting forces so as not to break or split, and have sufficient opening to allow for variation in rod size due to manufacturing process or some deforming as a result of driving ground rods.

7.3.1 Conductivity

When used to join two stainless steel ground rod electrodes of the minimum diameters specified in Table 7-1, couplings shall provide to joined ground rod electrodes, no less than 95% of the conductivity of an unspliced stainless steel ground rod electrode of equal length.

7.3.2 Impact

7.3.2.1 Test Method

Two 450 mm (18 in.) stainless steel ground rod electrodes of the diameters specified in Table 7-1, shall be coupled and held vertically in a tubular fixture that is at least 0.25 mm (0.010 in.) greater than the galvanized ground rod electrode diameter. The penetrating end of the bottom ground rod electrode shall be rested on a fixed plate of a weight sufficient to withstand the test impact, and located in a hole at least 100 mm (4 in.) in depth. The coupling shall not rest on or be contained within the tubular fixture or the fixed plate. The top ground rod electrode shall be subjected to an impact energy of 54 J (40 ft-lb).

7.3.2.2 Evaluation

After 25 impacts, there shall be no evidence of breakage, splitting, or damage that impairs the performance of the coupling.

7.3.3 Bend

7.3.3.1 Test Method

Two stainless steel ground rod electrodes coupled together shall be subjected to the same bending requirements as an individual ground rod electrode. The test specimen shall be gripped in a suitable rigid clamp or vise and the ground rod electrode bent by applying a force normal to the ground rod electrode, at a distance of 40 times the ground rod electrode diameter from the clamping device. The coupling shall be located midway between the clamping device and the point of applied force. The force shall be applied until the ground rod electrode is permanently bent through an angle of 30°.

7.3.3.2 Evaluation

The coupling shall not exhibit any signs of cracking or separation from the ground rod electrode.

7.3.4 Mechanical Strength

Couplings shall provide sufficient mechanical strength to permit driving under normal conditions, and not exhibit deformation or splitting under such conditions. This is demonstrated by successful compliance to sections 7.3.2 and 7.3.3.

7.4 MARKINGS

Each coupling shall be marked with the manufacturer's name or trademark and trade size. Each container, packaged as required by the end user, shall be marked with the manufacturer's name or trademark, and trade size.

§