

2017 NESC[®] Handbook

Premier Edition

A presentation of contributor commentary on the 2017 NESC, including a representation of the Code



Currently in preview, click buy full version

2017 NESC[®] Handbook

Premier Edition

*Contributor commentary on the 2017 NESC.
Includes representation of the Code.*

Trademarks and Disclaimers

The Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, New York, NY 10016-5997, USA

Copyright © 2016 by The Institute of Electrical and Electronics Engineers, Inc.

All rights reserved. Published 1 August 2016. Printed in the United States of America.

PDF: ISBN 978-1-5044-1996-3 STD20927

Print: ISBN 978-1-5044-1997-0 STDPT20927

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by The Institute of Electrical and Electronics Engineers, Incorporated.

IEEE Standards designations are trademarks of the IEEE (<http://www.ieee.org/>).

The NEC is published by the National Fire Protection Association (<http://www.nfpa.org/>). Copies are also available from The Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

The NESC is available from The Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

This Handbook is published by IEEE as a resource for NESC users and contains historical background information about the NESC as well as commentary and opinions on the standards. While the historical background information and commentary has been prepared and reviewed by individuals with experience and knowledge of the subject matter, the IEEE does not warrant the completeness or accuracy of the historical information or assert that the commentary and opinions are preferred interpretations of any standard. For interpretations of rules, see decisions of the NESC C2 representative Subcommittee on Interpretations at <http://standards.ieee.org/about/nesc/interps.html>.

IEEE Press/Standards Information Network publications are not consensus documents. Information contained in this and other works has been obtained from sources believed to be reliable and reviewed by credible members of IEEE Technical Societies, IEEE Standards Committees and/or Working Groups, and/or other relevant technical organizations. Neither the IEEE nor its contributors guarantee the accuracy or completeness of any information published herein, and neither the IEEE nor its contributors shall be responsible for any errors, omissions or damages arising out of the use of this information.

Likewise, while the contributors and publisher believe that the information and guidance given in this work serve as an enhancement to users, all parties must rely upon their own skill and judgment when making use of it. Neither the contributor nor the publisher assumes any liability to anyone for any loss or damage caused by any error or omission in the work, whether such error or omission is the result of negligence or any other cause. Any and all such liability is disclaimed.

The authoritative text of the National Electrical Safety Code® (NESC®) is contained in the NESC. If there are discrepancies in the representations of the Code text as represented in this Handbook and the NESC, the NESC shall be the governing document.

This work is published with the understanding that the IEEE and its contributors are supplying information through this publication, not attempting to render engineering or other professional services. If such services are required, the assistance of an appropriate professional should be sought. The IEEE is not responsible for the statements and opinions advanced in this publication.

Review Policy

The information contained in IEEE Press/Standards Information Network publications is reviewed and evaluated by peer reviewers from IEEE Technical Societies, IEEE Standards Committees and/or Working Groups, and/or other relevant technical organizations. The contributors addressed all of the peer reviewers' comments to the satisfaction of both the IEEE Standards Information Network and those who served as peer reviewers for this document.

The quality of the presentation of information contained in this publication reflects not only the obvious efforts of the contributors, but also the work of these peer reviewers. The IEEE Press acknowledges with appreciation their dedication and contribution of time and effort on behalf of the IEEE.

Acknowledgment

With thanks and appreciation to
Allen L. Clapp, P.E., P.L.S.
Editor, *NESC® Handbook*, First through Seventh Editions

For more than 50 years, Allen Clapp has been involved in the NESC in one manner or another. In 1964, Allen began using the NESC as a draftsman with a consulting engineering firm, while working his way through engineering school. He first participated on NESC Subcommittee 5 (covering strength and loading) as well as on NESC Subcommittee 4 (covering clearances) in 1971, pioneering early Code changes on building and water clearances.

Allen's role as editor of the NESC handbook has beginnings rooted in reviewing early interpretation requests for the NESC, as chair of the Interpretations Subcommittee. The concept of developing a handbook to better educate Code users about the NESC history is history itself, which includes decades of Allen's personal experience and dedication as the backbone to the handbook's evolution. Allen spent more than 3000 hours in compiling the first handbook edition using information transferred from the National Bureau of Standards to the IEEE when Secretariat for the NESC was transferred in 1972. He researched available papers and documents from the 1968 Code and earlier, passed down from retired subcommittee members, while acknowledging that some of the oldest data had been lost to antiquity. Thus, the need to keep the NESC handbook alive as a continuing resource to Code users increased in importance over time.

Allen has had the opportunity to serve more time on NESC subcommittees than any person in its history. Allen joined the NESC Main Committee in 1973, served as its chair from 1984 to 1993, and served on the Executive Subcommittee from the mid-1970s until the mid-1990s. He became secretary for Subcommittee 5 in the mid-1970s and served in that role for the better part of four decades. In addition to serving on Subcommittees 4 and 5, he also served as chair on Subcommittee 1 (covering coordination, scope, purpose, definitions, and references), and as chair of the Interpretations Subcommittee.

In Allen's own words, he expresses "pride in the accomplishments of the NESC subcommittee members over the past decades and belief in the NESC's capability to make the United States and other user countries a safer place for utility workers and the public alike, as the utility industries and the challenges that they face change in the future."

Any NESC subcommittee member can identify with Allen's thoughts that there have been "spirited discussions about issues, and good give-and-take from all. However, there can be no doubt about the fervor with which the NESC participants search for ways to make the NESC better."

Allen has expressed his personal hope "that the IEEE NESC Handbook can be expanded and continue to serve to help both code users and the future subcommittee members who must consider the appropriateness of future changes. The more explanations that are added to it over time—particularly about *why* changes are made—the better able it will be to serve our future."

Finally, with Allen's long tenure as its editor, he writes: "I have had the wise counsel of many subcommittee members in crafting language for inclusion in the Handbook. Many of these folks are not listed as a formal reviewer, but they have gladly donated their time and some have spent many hours helping to make this a better publication. Thank you all for your help and your many best wishes."

Thank you, Allen, for your dedication and service to the NESC and the industries that it serves. You are heartily wished all the best in your well-deserved retirement.

About the Premier Edition Handbook

Welcome to the Premier Edition of the 2017 NESC[®] Handbook.

The Premier Edition Handbook represents a next-generation tool for the professional who needs to understand the NESC. Contributor commentary gives users insight into what lies behind the NESC rules and how users might apply them. Unlike earlier handbooks, this new edition includes a representation of the Code*, with history and commentary** interspersed and coincident with the representative Code.

Discussed in the history and commentary are the development of the rules in the Code and the response to change proposals during the past 90 years. This commentary allows users to understand how questions they may encounter were dealt with in the past.

This Handbook includes input from contributors who are NESC committee members as well as the strong foundation developed by previous NESC handbook editor, Allen Clapp. The culmination of this effort is truly a collaborative effort, aimed at bringing to the NESC user the most comprehensive information regarding the evolution and content of the 2017 NESC.

How to Use the Premier Edition Handbook

Section 11

Rule 110A1

Section 11.
Protective arrangements for electric supply stations

(This section comprises rules that were moved from Section 10 in the 1971 Code; Section 11 of the 1941 Code and prior editions was renumbered to Section 12 in the 1971 Code.)

In Section 11, the 2017 Code's rewrite of Rule 110A1 made the rule more readable and included the following changes:

- (1) Safety signs for enclosures were clarified.
- (2) Notices or signs on structures shall be allowed to be connected to or located within 6 ft of an electric supply station enclosure without concurrence of the substation owner.
- (3) The term "barrier" was clarified to include other metallic barriers.

Changes affected Rule 110A2 and Figures 110-1 and 110-2. These revisions were limited only to clarity.

Table 110 was revised to reflect feet and inches instead of decimal feet. This change was made to be consistent with other tables in Part 1.

In Part 1, reference is made to the ANSI Z535 series of sign standards. The 2017 Code updated these references to reflect the most recent standards (2011).

Rule 114 was deleted in the 2017 Code after much discussion. It was recognized that after other attempts to clarify the rule, questions remained about its intent. References to more information are listed elsewhere in this Premier Edition Handbook for interested readers. Most utility workers carry fire extinguishers with them when working in unattended stations, and such common practice makes this rule obsolete.

110. General requirements

Rule 110. (Rule 102 of the 1941 Code and prior editions was moved here in the 1971 Code; previous Rule 110 became Rule 120.)

A. Enclosure of equipment

1. Types of enclosures

Rooms and spaces in which electric supply conductors or equipment are installed shall be so arranged with barriers, such as fences, screens, partitions, or walls, to form an enclosure as to limit the likelihood of entrance of unauthorized persons or interference by them with equipment inside. Entrances not under observation of an authorized attendant shall be kept locked. An installed barrier may be satisfied with any one of the following:

- a. Fence fabric, not less than 2.13 m (7 ft) in height.
- b. A combination of 1.8 m (6 ft) or more of fence fabric and an extension utilizing three or more strands of barbed wire to achieve an overall height of the fence of not less than 2.13 m (7 ft).
- c. Other types of construction, not less than 2.13 m (7 ft), that present equivalent barriers to climbing or other unauthorized entry.

A safety sign shall be displayed on or beside the door or gate at each entrance. For fenced or walled electric supply stations without roofs, a safety sign shall be displayed on each exterior side of the fence or wall enclosure. Where the station is entirely enclosed by walls and roof, a safety sign is required only at ground level entrances. Where entrance is gained through sequential doors, the safety sign should be located at the inner door position.

NOTE: ANSI Z535.1-2011, ANSI Z535.2-2011, ANSI Z535.3-2011, ANSI Z535.4-2011, and ANSI Z535.5-2011 contain information regarding safety signs.

Metal fences or other metallic barriers, when used to enclose electric supply stations having energized electric conductors or equipment, shall be grounded in accordance with Section 9.

88
Copyright © 2016 IEEE. All rights reserved.

* The Premier Edition Handbook provides a representation of the NESC text; however, the definitive text is found in the Code itself, the *National Electrical Safety Code[®], 2017 Edition*.

** Commentary from contributors provides a historical perspective on the development of the Code but is not text from the Code. Commentary does not constitute an interpretation of the Code and does not replace the NESC process for obtaining formal interpretations of the Code. (For information on that process, see <http://standards.ieee.org/about/nesc/interps.html>.) The combination of Code and commentary is provided for user convenience only.

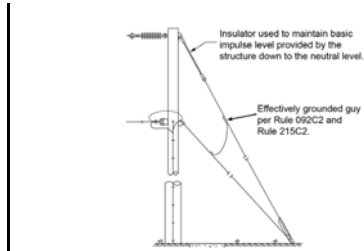


Figure 279-1—insulator used for BIL insulation

Rule 279A2. (This rule was added as Rule 279A3 [Corrosion protection] in the 1977 Code and was revised and renumbered to Rule 279A2 in the 2007 Code.)

Insulators placed in a guy solely to prevent electrolysis are not required to meet the requirements for guy insulators, but they may not reduce the strength of the guy. See Rule 217A (Rule 280A of the 1987 Code and prior editions).

In 2007, insulators used for BIL insulation purposes were specifically added to the rule, along with a reference to new Rule 215C7. The 2017 Code revised Rule 279A2(b) to further address this issue. In essence, by insulating the pole end of guys, the pole ground wire that otherwise would have run up the pole in the area of the energized phases can be removed, and the BIL level of the top of the pole can be increased on wood or FRP poles. Quite often the desire is to create a ground-free work zone in the area of the phase conductors. If the guys were grounded in that area, Rule 441A3 would require them to be covered with insulation while work was performed; thus guys are increasingly insulated on the pole end—particularly for the 25 kV and 35 kV distribution class voltages. Even though the insulation may be primarily for work efficiency in this case, it still increases the BIL capability of the top of the pole. Neither insulators used to limit galvanic corrosion nor insulators used for BIL insulation are required to meet the electrical strength requirements for guy insulators, but both are required to meet the mechanical strength requirements (see Rule 279A1c).

279A2. Use of guy insulators (2002 Code and prior editions) (Rule 279A2 of the 2002 Code was moved to Rule 215C; see Rules 215C2, 215C3, and 215C5.)

279A3. Corrosion protection (This rule was added in the 1977 Code and was revised and renumbered to Rule 279A2 in the 2007 Code.)

New or Revised Diagrams and Photos within the Representative Code Text

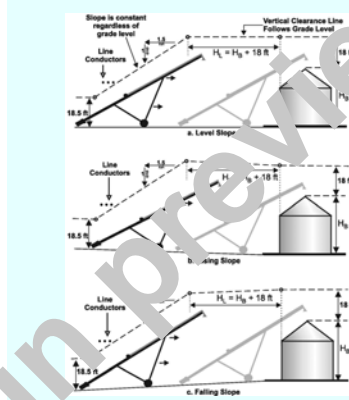


Figure H234-4(b)
Vertical clearance above flat or sloping ground near grain bin filled with portable augers

G. Additional clearances for voltages exceeding 22 kV for wires, conductors, cables, and unguarded rigid live parts of equipment

Greater clearances than specified in Rules 234B, 234C, 234D, 234E, 234F, and 234J shall be provided where required as follows:

- For voltages between 22 and 470 kV, the clearance specified in Rules 234B, 234C, 234D, 234E, 234F, and 234J shall be increased at the rate of 10 mm (0.4 in) per kV in excess of 22 kV. For voltages exceeding 470 kV, the clearance shall be determined by the method given in Rule 234H. All clearances for lines over 50 kV shall be based on the maximum operating voltage.

EXCEPTION: For voltages exceeding 98 kV ac to ground or 139 kV dc to ground, clearances less than those required above are permitted for systems with known maximum switching-surge factor. (See Rule 234H.)

Diagrams and Photos from Handbook Contributors

About the Contributors and Reviewers

IMPORTANT NOTICE: No part of the commentary is intended to represent the view of any company with which a contributor or reviewer is or has been affiliated. Any opinions expressed are the personal opinions of the contributors. No particular section of the commentary necessarily represents the view of any individual contributor or reviewer. The commentary does not represent the official position of the IEEE or any NESC Technical Committee.

Nelson G. Bingel III

Member, NESC Main Committee
Member, NESC Executive Subcommittee
Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Chair, NESC Subcommittee 5, Overhead Lines—Strength and Loading

Charles C. Bleakley

Chair, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Member, NESC Subcommittee 4, Overhead Lines—Clearances
Chair, NESC Subcommittee 7, Underground Lines
Member, NESC Interpretations Subcommittee

Allen L. Clapp, P.E., P.L.S.

Member, NESC Interpretations Subcommittee

John B. Dagenhart, P.E.

Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Chair, NESC Subcommittee 2, Grounding Methods
Member, NESC Interpretations Subcommittee

Mark A. Konz, P.E.

Member, NESC Subcommittee 3, Electric Supply Stations

Lauren E. Gaunt, P.E.

Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Member, NESC Subcommittee 2, Grounding Methods
Secretary, NESC Subcommittee 7, Underground Lines

Mickey B. Gunter

Secretary, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Secretary, NESC Subcommittee 4, Overhead Lines—Clearances
Member, NESC Subcommittee 7, Underground Lines
Member, NESC Interpretations Subcommittee

Mark F. Jurgemeyer

Member, NESC Subcommittee 5, Overhead Lines—Strength and Loading

Ernest H. Neubauer, P.E.

Member, NESC Subcommittee 4, Overhead Lines—Clearances

Ewell T. Robinson, P.E.

Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Secretary, NESC Subcommittee 2, Grounding Methods
Member, NESC Interpretations Subcommittee

Charles A. Shaw, P.E.

Member, NESC Subcommittee 8, Work Rules

Samuel Stonerock

Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Secretary, NESC Subcommittee 8, Work Rules

Greg Wolven, P.E.

Member, NESC Subcommittee 1, Coordination, Scope, Purpose, Definitions, and References
Secretary, NESC Subcommittee 3, Electric Supply Stations

Nelson G. Bingel III, *Contributor*, has worked for 30 years at Osmose Utilities Services, where he is responsible for engineering and other technical aspects of wood, steel, concrete, and fiberglass utility poles and structures. This responsibility covers a wide range of activities such as inspection, maintenance, restoration, and repair along with mitigation of deterioration and corrosion. Nelson designed unique software used during structure inspections and developed the O-Calc pole loading program used by companies nationwide for calculating comprehensive pole loading analysis. In addition, he has been granted three U.S. patents for unique designs of pole restoration systems.



Nelson has been active with the NESC for more than 25 years and currently serves as chair of NESC Subcommittee 5 (Overhead Lines—Strength and Loading) and member of NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References), the NESC Executive Subcommittee, and the NESC Main Committee. He also chairs the American Standards Committee O5 (Specifications and Dimensions for Wood Poles), which develops the standards for new wood poles and crossarms.

Nelson earned a bachelor's degree in mechanical engineering from Purdue University.

Charles C. (Charlie) Bleakley, *Contributor and Reviewer*, retired from Georgia Power Company with more than 34 years of service. His last position was distribution manager of Construction Distribution Services where he was directly responsible for the planning, testing, designing, and publishing the company's *Distribution Specification Book*. Other responsibilities included developing and field testing new specifications and training engineers and line crews to use the specifications. Charlie also has engineering and managerial experience with distribution system engineering and operation, line crew and engineer staff supervision, and power delivery system management. Since retirement, he works as a consultant for Georgia Power Company to participate in NESC subcommittee work and keep the company up-to-date on the Code.



Charlie's NESC activities include serving as member (since 1981) and chair (since 1997) of Subcommittee 7 (Underground Lines); member (1984–1993 Code) of Subcommittee 5 (Overhead Lines—General and Insulation); member (since 1994) of Subcommittee 4 (Overhead Lines—Clearances); and member (since 1997), secretary (2002–2012), and chair (since 2013) of Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References). He has also served as a member of the NESC Interpretations Subcommittee since 1987.

Allen L. Clapp, *Contributor and Reviewer*, is a Professional Engineer and Professional Land Surveyor who has been involved in the design and evaluation of electric supply and communication facilities for more than 50 years. Allen has provided consulting services for more than 500 utilities and industries. At least 28,000 people have attended Allen's seminars on the NESC, pole line design, and utility accident investigation. Allen has investigated more than 1,000 accidents and testified before courts and commissions many times over the past 45 years.



Allen has served continuously on NESC technical subcommittees since 1971: member (1973–2006) and chair (1984–1993) of the NESC Main Committee; member (1976–1993) of the Executive Committee; member (1978–2011), secretary (1981–1984), and chair (1993–2011) of Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References); member (1972–2015) and acting secretary (more than 20 times) of Subcommittee 4 (Overhead Lines—Clearances); and member (1971–2015) and secretary (1978–2010) of Subcommittee 5 (Overhead Lines—Strengths and Loadings). Allen has also been a member of the NESC Interpretations Subcommittee since 1976 and served as its chair for 10 years (1980–1990).

Allen was the principal editor for the previous editions of the *NESC Handbook* and is a contributor to the *Standard Handbook for Electrical Engineers* published by McGraw-Hill. He has also served as IEEE representative on the ANSI Z535 Safety Signs and Colors Committee (1994–2013) and as chair of the Z535.2 Subcommittee on Environmental and Facility Safety Signs (1995–2013).

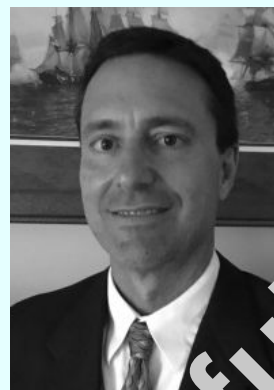
John B. (Johnny) Dagenhart, *Contributor*, has more than 38 years of experience in the electrical engineering industry. John is President of Dagenhart Consulting Services, PC, in Durham, North Carolina. In 2015 he purchased sole ownership of Clapp Research Associates, PC, where he had worked for more than 27 years. At the end of 2015, he merged Clapp Research Associates, PC with Dagenhart Consulting Services. Prior to working with Clapp Research, Johnny worked as a distribution engineer for Duke Energy.



Johnny has been involved on various NESC subcommittees since 1990. He currently serves as chair of NESC Subcommittee 2 (Grounding Methods), member of NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References), and member of the NESC Interpretations Subcommittee.

Johnny provided research and served as a reviewer for the previous editions of the *NESC Handbook*, is a contributor to the *Standard Handbook for Electrical Engineers* published by McGraw-Hill, and has authored articles on electrical power quality issues and on both the NESC and the National Electrical Code® (NEC®).

Mark A. Konz, *Contributor*, is a Professional Engineer who has worked 25 years with Gulf Power Company in Pensacola, FL. Mark's experience includes designing electrical distribution systems, operating electrical distribution systems in the Distribution Control Center, and specifying the materials and construction standards for all engineers. He gained electric substation experience working as system protection engineer. Mark is currently the Customer Service Organization training supervisor and has taught numerous NESC classes for the company.



Since 2001, Mark has served on the Southeastern Electric Exchange (SEE) section on the NESC where he participates in revising all parts of the Code. For almost as long, he has been representing SEE as a principal member of NESC Subcommittee 3 (Electric Supply Stations) and has participated in three Code revision cycles.

Mark earned a bachelor's degree in electrical engineering from Florida State University and a master's degree in management from Troy State University in Alabama. He is a registered continuing education provider in Florida. He also serves on the advisory boards for the electrical and computer engineering programs at both the University of West Florida and the Florida State University College of Engineering.

Lauren E. Gaunt, *Contributor*, has more than 35 years of experience in the planning, engineering, construction, and operation of electric power distribution, transmission, and substation systems. Lauren has been employed within the Eversource Energy System in Connecticut since 1987 and currently serves as a principal engineer and the company's primary technical communicator with Connecticut's Public Utilities Regulatory Authority.



For more than 25 years, Lauren has participated nationally in developing electric power system safety standards for the NESC. He currently serves as member of NESC Subcommittee 2 (Grounding Methods), secretary of NESC Subcommittee 7 (Underground Lines), and alternate member of NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References). Lauren is also a long-time member of the national committee responsible for ANSI C84.1-2011 [American National Standard for Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)].

Lauren has taught electrical engineering courses at the University of New Haven since 1984. He is a senior member of the IEEE, a registered Professional Engineer in Connecticut, and a member of several industrial advisory boards promoting electrical and other technology education. Lauren earned a bachelor's degree in electrical engineering from the University of Michigan in 1980 and a master's degree in electric power engineering from Rensselaer Polytechnic Institute in New York in 1987. He also holds an extra class amateur radio license from the Federal Communications Commission.

Mickey B. Gunter, *Contributor and Reviewer*, has more than 38 years of experience in distribution engineering design, standards, and training and spent the majority of his career with Georgia Power Company.

Mickey has been active with the NESC since 1993 and participated in six Code revision cycles. He presently serves on four NESC subcommittees: secretary of Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References), secretary of Subcommittee 4 (Overhead Lines—Clearances), member of Subcommittee 7 (Underground Lines), and member of the NESC Interpretations Subcommittee. He also serves as chair of the Southeastern Electric Exchange (SEE) section on the NESC and as chair of the Edison Electric Institute (EEI) NESC Subcommittee 4.

Mickey earned a bachelor’s degree in industrial engineering from Georgia Institute of Technology in 1966.



Mark F. Jurgemeyer, *Reviewer*, has experience in project management, design, and construction administration for distribution transmission systems for utilities worldwide. Mark is the engineering manager for Intermountain Rural Electric Association. His previous experience includes working for Stanley Consultants, Inc.; Morrison Knudsen/Washington Group International; Behrent Engineering Co.; and GEA Integrated Cooling Technologies, Inc. He presented “Transmission Line Design” and “Substation Physical Design” at T&D World University in 2007 and 2008 in Dallas, TX.

Mark has been a principal member of NESC Subcommittee 5 (Overhead Lines—Strength and Loading) since 2009. He has also been involved in the development of several standards as part of the IEEE Power and Energy Society’s Towers, Poles, and Conductors Subcommittee since 2007. He is also a member of the American Society of Civil Engineers (ASCE).

Mark earned a bachelor’s degree in civil engineering from University of Colorado in 1995.



Ernest H. (Ernie) Neubauer, *Reviewer*, is a registered Professional Engineer in three states. Ernie began his career in 1972 with Alabama Power Company as a distribution engineer. In 1976 he switched to the electric cooperative world and since then has worked for four electric cooperatives in Ohio, Florida, and Georgia.

Ernie has been representing the National Rural Electric Cooperative Association (NRECA) as a member of NESC Subcommittee 4 (Overhead Lines—Clearances) since the 2002 Code revision cycle.

Ernie earned a bachelor’s degree in electrical engineering, specializing in the power area, from the University of Tennessee in 1972 and a master’s in business administration from Wright State University in Ohio in 1997.



Ewell T. (Tim) Robeson, *Reviewer*, is a registered Professional Engineer in North Carolina, South Carolina, and Florida with 46 years of experience in electrical distribution line design. As a contractor for Duke Energy, Tim works on overhead and underground distribution teams to integrate design, construction, and material standards among the legacy companies that compose Duke Energy.

In 1970, Tim started as a field engineer with Carolina Power and Light Company before spending most of his career developing design and construction standards for underground distribution systems. He also worked as a lead engineer for distribution design and materials for the Carolinas and Florida before retiring in 2012 from Progress Energy.

Tim serves as secretary and Edison Electric Institute (EEI) representative on NESC Subcommittee 2 (Grounding Methods) and is a member of NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References) and the NESC Interpretations Subcommittee. He is also a past member of the NESC Executive Subcommittee, past EEI representative on the NESC Main Committee, past principal member and IEEE representative on NESC Subcommittee 7 (Underground Lines), and past chair of the EEI NESC Utilities Representative Coordinating Task Force.

Tim is also a senior member of the IEEE. He earned a bachelor's degree in electrical engineering from North Carolina State University.



Charles A. (Charlie) Shaw, *Reviewer*, is a registered Professional Engineer with 35 years of experience in the electric utility industry working in a variety of roles in engineering, operations, and safety.

Charlie is actively involved in several industry groups and serves as a principal member on NESC Subcommittee 8 (Work Rules) representing the Southeastern Electric Exchange.

Charlie earned a bachelor's degree in electrical engineering from Auburn University.



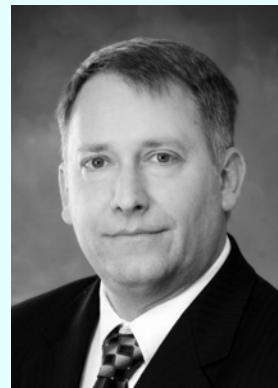
Samuel Stonerock, *Contributor*, is a 30-year employee of Southern California Edison (SCE) and a senior project manager in the Transmission and Distribution (T&D) Department. He is a member of NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References) and the secretary of NESC Subcommittee 8 (Work Rules) representing the Edison Electric Institute.



Samuel also represents SCE while serving as member and first vice chair of ASTM International's Committee F18 and represents ASTM International as a member of the National Fire Protection Association's Committee 70-E. He is also a member of IEEE's Power and Energy Society, the ESMOL Subcommittee, and the Industry Applications Society.

With his experience in distribution field construction and maintenance, compliance inspections, and joint-use contract administration, Samuel serves as member and chair of California's General Order 95/128 Rules Committee and as an internal technical advisor on regulatory, legal, and legislative matters related to T&D policies, practices, procedures, and safety standards.

Greg Wolven, *Reviewer*, is a licensed Professional Engineer in both Indiana and Virginia with more than 35 years of experience working for rural electric cooperatives. Greg has worked for two electric cooperatives in Virginia and is currently director of engineering for WIN Energy REMC in Vincennes, IN. He is in charge of staking, mapping, system planning, advanced metering infrastructure (AMI), information technology, and telecommunications.



Greg is a member of the IEEE, the National Society of Professional Engineers (NSPE), the National Rural Electric Cooperative Association (NRECA) Substation Design Subcommittee, and NESC Subcommittee 1 (Coordination, Scope, Purpose, Definitions, and References); secretary of NESC Subcommittee 3 (Electric Supply Stations); and chair of NRECA's Software Integration Initiative task force.

Greg earned a bachelor's degree in electrical engineering from the Virginia Military Institute in 1981. In his spare time he enjoys reading, working on old homes, and martial arts. He is a third degree black belt and a volunteer assistant instructor in Tae Kwon Do.

Contents

Section 1. Introduction to the National Electrical Safety Code®	1
010. Purpose	4
011. Scope	6
A. Covered	6
B. Not covered	7
C. Types of requirements	8
012. General rules	10
013. Application	11
A. New installations and extensions	11
B. Existing installations	11
C. Inspection and work rules	14
014. Waiver for emergency and temporary installations	14
A. Emergency installations	14
B. Temporary overhead installations	15
015. Intent	15
016. Effective date	16
017. Units of measure	17
018. Method of calculation	18
Section 2. Definitions of special terms	19
Section 3. References	35
Section 9. Grounding methods for electric supply and communications facilities	38
090. Purpose	38
091. Scope	38
092. Point of connection of grounding conductor	39
A. Direct-current systems that are required to be grounded	39
1. 750 V and below	39
2. Over 750 V	39
B. Alternating current systems that are required to be grounded	40
1. 750 V and below	40
2. Over 750 V	40
3. Separate grounding conductor	40
C. Messenger wires and guys	42
1. Messenger wires	42
2. Guys	43
3. Common grounding of messengers and guys on the same supporting structure	43
D. Current in grounding conductor	45
E. Fences	47
093. Grounding conductor and means of connection	48
A. Composition of grounding conductors	48
B. Connection of grounding conductors	49
C. Ampacity and strength	50
1. System grounding conductors for single-grounded systems	50
2. System grounding conductors for multi-grounded alternating current systems	50
3. Grounding conductors for instrument transformers	50
4. Grounding conductors for primary surge arresters	50
5. Grounding conductors for equipment, messenger wires, and guys	50
6. Fences	51
7. Bonding of equipment frames and enclosures	51

8.	Ampacity limit	51
9.	Strength	51
D.	Guarding and protection	52
E.	Underground	53
F.	Common grounding conductor for circuits, metal raceways, and equipment	54
094.	Grounding electrodes	55
A.	Existing electrodes	55
1.	Metallic water piping system	55
2.	Local systems	55
3.	Steel reinforcing bars in concrete foundations and footings	55
B.	Made electrodes	56
1.	General	56
2.	Driven rods, buried wire, strips, or plates	56
3.	Pole-butt plates and wire wraps	57
4.	Concentric neutral cable	58
5.	Concrete-encased electrodes	58
6.	Directly embedded metal poles	62
095.	Method of connection to electrode	63
A.	Ground connections	63
B.	Point of connection to piping systems	64
C.	Contact surfaces	65
096.	Ground resistance requirements.....	65
A.	General	65
B.	Supply stations	65
C.	Multi-grounded systems	65
D.	Single-grounded (unigrounded or delta) systems	66
097.	Separation of grounding conductors	71
098.	Number 098 not used in this edition.....	80
099.	Additional requirements for grounding and bonding of communication apparatus	81
A.	Electrode	81
B.	Electrode connection	81
C.	Bonding of electrodes	81
Part 1. Safety Rules for the Installation and Maintenance of Electric Supply Stations and Equipment		84
Section 10. Purpose and scope of rules.....		85
100.	Purpose.....	85
101.	Scope.....	85
102.	Application of rules	86
103.	Referenced sections	87
Section 11. Protective arrangements in electric supply stations.....		88
110.	General requirements	88
A.	Enclosure of equipment	88
1.	Types of enclosures	88
2.	Safety clearance zone	89
B.	Rooms and spaces	100
1.	Construction	100
2.	Use	100
3.	Ventilation	101
4.	Moisture and weather	101
C.	Electric equipment	102

111.	Illumination	102
	A. Under normal conditions	102
	B. Emergency lighting	105
	C. Fixtures	105
	D. Attachment plugs and receptacles for general use	106
	E. Receptacles in damp or wet locations	106
112.	Floors, floor openings, passageways, and stairs	106
	A. Floors	106
	B. Passageways	107
	C. Railings	107
	D. Stair guards	108
	E. Top rails	108
113.	Exits	109
	A. Clear exits	109
	B. Double exits	109
	C. Exit doors	109
	Section 12. Installation and maintenance of equipment	113
120.	General requirements	113
121.	Inspections	113
	A. In-service equipment	113
	B. Idle equipment	114
	C. Emergency equipment	114
	D. New equipment	114
122.	Guarding shaft ends, pulleys, belts, and suddenly moving parts	115
	A. Mechanical transmission machinery	115
	B. Suddenly moving parts	115
123.	Protective grounding	115
	A. Protective grounding or physical isolation of non-current-carrying metal parts	115
	B. Grounding method	116
	C. Provision for grounding equipment during maintenance	116
	D. Grounding methods for direct-current systems over 750 V	117
124.	Guarding live parts	117
	A. Where required	117
	B. Strength of guards	120
	C. Types of guards	121
	1. Location or physical isolation	121
	2. Shields or enclosures	122
	3. Supplemental barriers or guards within electric supply stations	123
	4. Mats	125
	5. Live parts below supporting surfaces for persons	125
	6. Insulating covering on conductors or parts	126
	D. Taut-string distances	126
125.	Working space about electric equipment	136
	A. Working space (600 V or less)	136
	1. Clear spaces	136
	2. Access and entrance to working space	136
	3. Working space	136
	4. Headroom working space	136
	5. Front working space	136
	B. Working space over 600 V	137
126.	Equipment for work on energized parts	138
127.	Classified locations	139
	A. Coal-handling areas	139

B. Flammable and combustible liquids	139
C. Flammable liquid storage area	140
D. Loading and unloading facilities for flammable and combustible liquids	140
E. Gasoline-dispensing stations	140
F. Boilers	140
G. Gaseous hydrogen systems for supply equipment	140
H. Liquid hydrogen systems	140
I. Sulfur	141
J. Oxygen	141
K. Liquefied petroleum gas (LPG)	141
L. Natural gas (methane)	141
128. Identification	142
129. Mobile hydrogen equipment	143
Section 13. Rotating equipment	144
130. Speed control and stopping devices	144
A. Automatic overspeed trip device for prime movers	144
B. Manual stopping devices	144
C. Speed limit for motors	145
D. Number 130D not used in this edition.	145
E. Adjustable-speed motors	145
F. Protection of control circuits	145
131. Motor control	146
132. Number 132 not used in this edition.	146
133. Short-circuit protection	147
Section 14. Storage batteries	148
140. General	148
141. Location	148
142. Ventilation	148
143. Racks	149
144. Floors in battery areas	149
145. Illumination for battery areas	150
146. Service facilities	150
Section 15. Transformers and regulators	151
150. Current-transformer secondary circuits protection when exceeding 600 V	151
151. Grounding secondary circuits of instrument transformers	151
152. Location and arrangement of power transformers and regulators	152
A. Outdoor installations	152
B. Indoor installations	152
153. Short-circuit protection of power transformers	153
Section 16. Conductors	155
160. Application	155
161. Electrical protection	155
A. Overcurrent protection required	155
B. Grounded conductors	155
C. Insulated power cables	155
162. Mechanical protection and support	157
163. Isolation	158
164. Conductor terminations	159
A. Insulation	159
B. Metal-sheathed or shielded cable	159

Section 17. Circuit breakers, reclosers, switches, and fuses	160
170. Arrangement	160
171. Application.....	160
172. Circuit breakers, reclosers, and switches containing oil	161
173. Switches and disconnecting devices	161
A. Capacity	161
B. Provisions for disconnecting	162
174. Disconnection of fuses.....	163
Section 18. Switchgear and metal-enclosed bus	164
180. Switchgear assemblies	164
A. General requirements for all switchgear	164
B. Metal-enclosed power switchgear	165
C. Dead-front power switchboards	166
D. Motor control centers	167
E. Control switchboards	167
181. Metal-enclosed bus	167
A. General requirements for all types of bus	167
B. Isolated-phase bus	167
Section 19. Surge arresters.....	169
190. General requirements	169
191. Indoor locations	170
192. Grounding conductors.....	170
193. Installation	171
Part 2. Safety Rules for the Installation and Maintenance of Overhead Electric Supply and Communication Lines	172
Section 20. Purpose, scope, and application of rules.....	175
200. Purpose.....	175
201. Scope.....	175
202. Application of rules	176
Section 21. General requirements.....	177
210. Referenced sections	177
211. Number 211 not used in this edition.....	177
212. Induced voltages	177
213. Accessibility.....	178
214. Inspection and tests of lines and equipment	178
A. When in service	178
1. Initial compliance with rules	178
2. Inspection	178
3. Tests	179
4. Inspection records	179
5. Corrections	179
B. When out of service	180
1. Lines infrequently used	180
2. Lines temporarily out of service	180
3. Lines permanently abandoned	180
215. Grounding of circuits, supporting structures, and equipment.....	180
A. Methods	180

B.	Circuits	180
1.	Common neutral	180
2.	Other neutrals	181
3.	Other conductors	181
4.	Surge arresters	181
5.	Use of earth as part of circuit	181
C.	Non-current-carrying parts	182
1.	General	182
2.	Guys	182
3.	Span wires	183
4.	Insulators used to limit galvanic corrosion	183
5.	Multiple messengers on the same structure	183
216.	Arrangement of switches	187
A.	Accessibility	187
B.	Indicating open or closed position	187
C.	Locking	187
D.	Uniform position	187
E.	Remotely controlled, automatic transmission, or distribution overhead line switching devices	187
217.	General	188
A.	Supporting structures	188
1.	Protection of structures	188
2.	Readily climbable supporting structures	188
3.	Identification	189
4.	Attachments, decorations, and obstructions	189
B.	Unusual conductor supports	192
C.	Protection and marking of guys	193
218.	Vegetation management	194
A.	General	194
B.	At line crossings, railroad crossings, limited-access highway crossings, or navigable waterways requiring crossing permits	194
Section 22. Relations between various classes of lines and equipment.....		196
220.	Relative levels.....	196
A.	Standardization of levels	196
B.	Relative levels: supply and communication conductors and equipment	196
1.	Preferred levels	196
2.	Special construction for railroad supply circuits of 600 V or less and carrying power not in excess of 5 kW	197
C.	Relative levels: Supply lines of different voltage classifications (0 to 750 V, over 750 V to 8.7 kV, over 8.7 kV to 22 kV, over 22 kV to 50 kV, and over 50 kV)	198
1.	At crossings or conflicts	198
2.	On structures used only by supply conductors	199
D.	Identification of overhead conductors and cables	199
E.	Identification of equipment on supporting structures	200
221.	Avoidance of conflict.....	200
222.	Joint use of structures	202
223.	Communications protective requirements	203
A.	Where required	203
B.	Means of protection	204
224.	Communication circuits located within the supply space and supply circuits located within the communication space.....	204
A.	Communication circuits located in the supply space	204

B.	Supply circuits used exclusively in the operation of communication circuits	205
225.	Electric railway construction	206
A.	Trolley-contact conductor fastenings	206
B.	High-voltage contact conductors	207
C.	Third rails	207
D.	Prevention of loss of contact at railroad crossings at grade	208
E.	Guards under bridges	209
Section 23.	Clearances	210
230.	General	210
A.	Application	210
1.	Permanent and temporary installations	211
2.	Emergency installations	211
3.	Measurement of clearance and spacing	212
4.	Rounding of calculation results	213
B.	Ice and wind loading for clearances	215
C.	Supply cables	218
D.	Covered conductors	221
E.	Neutral conductors	222
F.	Fiber-optic cable	223
1.	Fiber-optic—supply cable	223
2.	Fiber-optic—communication cable	223
G.	Alternating- and direct-current circuits	224
H.	Constant-current circuits	224
I.	Maintenance of clearances and spacings	224
231.	Clearances of supporting structures from other objects	225
A.	From fire hydrants	226
B.	From streets, roads, and highways	227
C.	From railroad tracks	231
232.	Vertical clearances of wires, conductors, cables, and equipment above ground, roadway, rail, or water surfaces	233
A.	Application	236
B.	Clearance of wires, conductors, cables, equipment, and support arms mounted on supporting structures	238
1.	Clearance to wires, conductors, and cables	238
2.	Clearance to unguarded rigid live parts of equipment	244
3.	Clearance to support arms, switch handles, and equipment cases	246
4.	Street and area lighting	246
C.	Additional clearances for wires, conductors, cables, and unguarded rigid live parts of equipment	247
1.	Voltages exceeding 22 kV	247
D.	Alternate clearances for voltages exceeding 98 kV ac to ground or 139 kV dc to ground	248
1.	Sag conditions of line conductors	249
2.	Reference heights	249
3.	Electrical component of clearance	249
4.	Limit	249
233.	Clearances between wires, conductors, and cables carried on different supporting structures	290
A.	General	290
1.	Conductor movement envelope	291
2.	Clearance envelope	294
B.	Horizontal clearance	294
1.	Clearance requirements	294

2.	For voltages exceeding 50 kV, the additional clearance specified in Rule 233B1 shall be increased 3% for each 300 m (1000 ft) in excess of 1000 m (3300 ft) above mean sea level	294
3.	Alternate clearances between conductors of different circuits where one or both circuits exceed 98 kV ac to ground or 139 kV dc to ground	294
C.	Vertical clearance	295
1.	Clearance requirements	295
2.	Voltages between the wires, conductors, or cables exceeding 22 kV	295
3.	Alternate clearances for voltage exceeding 98 kV ac to ground or 139 kV dc to ground	295
234.	Clearance of wires, conductors, cables, and equipment from buildings, bridges, rail cars, swimming pools, and other installations.....	315
A.	Application	315
1.	Vertical and horizontal clearances (no wind displacement)	315
2.	Horizontal clearances (with wind displacement)	315
3.	Transition between horizontal and vertical clearances	316
B.	Clearances of wires, conductors, and cables from other supporting structures	322
1.	Horizontal clearances	322
2.	Vertical clearances	322
C.	Clearances of wires, conductors, cables, and rigid live parts from buildings, signs, billboards, chimneys, radio and television antennas, tanks, flagpoles and flags, banners, and other installations except bridges	324
1.	Vertical and horizontal clearances	324
2.	Guarding of supply conductors and rigid live parts	325
3.	Supply conductors attached to buildings or other installations	325
4.	Communication conductors attached to buildings or other installations	327
5.	Ladder space	327
D.	Clearance of wires, conductors, cables, and unguarded rigid live parts from bridges	341
1.	Vertical and horizontal clearances	341
2.	Guarding trolley-contact conductors located under bridges	342
E.	Clearance of wires, conductors, cables, or unguarded rigid live parts installed over or near swimming areas with no wind displacement	343
1.	Swimming pools	343
2.	Beaches and waterways restricted to swimming	344
3.	Waterways subject to water skiing	344
F.	Clearances of wires, conductors, cables, and rigid live parts from grain bins	347
1.	Grain bins loaded by permanently installed augers, conveyors, or elevator systems	347
2.	Grain bins loaded by portable augers, conveyors, or elevators (with no wind displacement)	347
G.	Additional clearances for voltages exceeding 22 kV for wires, conductors, cables, and unguarded rigid live parts of equipment	351
H.	Alternate clearances for voltages exceeding 98 kV ac to ground or 139 kV dc to ground	352
1.	Sag conditions of line conductors	352
2.	Reference distances	352
3.	Electrical component of clearance	352
4.	Limit	353
I.	Clearance of wires, conductors, and cables to rail cars	353
J.	Clearance of equipment mounted on supporting structures	354
1.	Clearance to unguarded rigid live parts of equipment	354
2.	Clearance to equipment cases	355
235.	Clearance for wires, conductors, or cables carried on the same supporting structure	372
A.	Application of rule	373
1.	Multiconductor wires or cables	373

2.	Conductors supported by messengers or span wires	373
3.	Line conductors of different circuits	373
B.	Horizontal clearance between line conductors	374
1.	Fixed supports	374
2.	Suspension insulators	375
3.	Alternate clearances for different circuits where one or both circuits exceed 98 kV ac to ground or 139 kV dc to ground	376
C.	Vertical clearance at the support for line conductors and service drops	378
1.	Basic clearance for line wires, conductors, cables, and service drops of same or different circuits	378
2.	Additional clearances	378
3.	Alternate clearances for different circuits where one or both exceed 98 kV ac, or 139 kV dc to ground	381
4.	Communication worker safety zone	381
D.	Diagonal clearance between line wires, conductors, and cables located at different levels on the same supporting structure	387
E.	Clearances in any direction at or near a support from line conductors to supports, and to vertical or lateral conductors, service drops, and span or guy wires, attached to the same support	388
1.	Fixed supports	388
2.	Suspension insulators	388
3.	Alternate clearances for voltages exceeding 98 kV ac to ground or 139 kV dc to ground	388
F.	Clearances between circuits located in the supply space on the same support arm	390
G.	Conductor spacing: vertical racks or separate brackets	392
H.	Clearance and spacing between communication conductors, cables, and equipment	394
I.	Communication antenna clearances in any direction from supply and communication lines attached to the same supporting structure	394
1.	General	394
2.	Communication antenna clearances	394
3.	Equipment case that supports or is adjacent to a communication antenna	394
4.	Vertical or lateral communication conductors and cables attached to a communication antenna	394
236.	Climbing space	411
A.	Location and dimensions	411
B.	Portions of supporting structures in climbing space	411
C.	Support arm location relative to climbing space	411
D.	Location of equipment relative to climbing space	412
E.	Climbing space between conductors	413
F.	Climbing space on buckarm construction	414
G.	Climbing space past longitudinal runs not on support arms	414
H.	Climbing space past vertical conductors	416
I.	Climbing space near ridge-pin conductors	416
237.	Working space	418
A.	Location of working spaces	420
B.	Dimensions of working spaces	420
1.	Along the support arm	420
2.	At right angles to the support arm	420
3.	Vertically	421
C.	Location of vertical and lateral conductors relative to working spaces	421
D.	Location of buckarms relative to working spaces	421
1.	Standard height of working space	421
2.	Reduced height of working space	421
E.	Guarding of energized equipment	422

F.	Working clearances from energized equipment	422
238.	Vertical clearance between specified communications and supply facilities located on the same structure	422
A.	Equipment	427
B.	Clearances in general	427
C.	Clearances for span wires or brackets	428
D.	Clearance of drip loops associated with luminaires and traffic signals	428
E.	Communication worker safety zone	428
239.	Clearance of vertical and lateral facilities from other facilities and surfaces on the same supporting structure	429
A.	General	430
B.	Location of vertical or lateral conductors relative to climbing spaces, working spaces, and pole steps	431
C.	Conductors not in conduit	431
D.	Guarding and protection near ground	431
E.	Requirements for vertical and lateral supply conductors on supply line structures or within supply space on jointly used structures	433
1.	General clearances	433
2.	Special cases	433
F.	Requirements for vertical and lateral communication conductors on communication line structures or within the communication space on jointly used structures	435
1.	Clearances from communication conductors	435
2.	Clearances from supply conductors	435
G.	Requirements for vertical supply conductors and cables passing through communication space on jointly used line structures	435
1.	Guarding—General	435
2.	Cables and conductors in conduit or covering	435
3.	Protection near trolley, ungrounded traffic signal, or ungrounded luminaire attachments	436
4.	Service drops	436
5.	Clearance from through bolts and other metal objects	436
H.	Requirements for vertical communication conductors passing through supply space on jointly used structures	437
1.	Metal-sheathed communication cables	437
2.	Communication conductors	437
3.	Communication grounding conductors	438
4.	Clearance from through bolts and other metal objects	438
I.	Operating rods	438
J.	Additional rules for standoff brackets	439
Section 24.	Grades of construction	442
240.	General	442
241.	Application of grades of construction to different situations	443
A.	Supply cables	443
B.	Order of grades	443
C.	At crossings	444
1.	Wires, conductors, or other cables of one line	444
2.	Grade of upper line	444
3.	Grade of lower line	444
4.	Multiple crossings	444
D.	Structure conflicts	444
242.	Grades of construction for conductors	445
A.	Constant-current circuit conductors	446
B.	Railway feeder and trolley-contact circuit conductors	447

C. Communication circuit conductors and cables	447
D. Fire-alarm circuit conductors	447
E. Neutral conductors of supply circuits	448
F. Surge-protection wires	448
243. Grades of construction for line supports	451
A. Structures	451
B. Crossarms and support arms	451
C. Pins, armless construction brackets, insulators, and conductor fastenings	451
Section 25. Loadings for Grades B and C	453
250. General loading requirements and maps	453
A. General	455
B. Combined ice and wind district loading	456
C. Extreme wind loading	457
1. Velocity pressure exposure coefficient, k_z	458
2. Gust response factor, GRF	459
D. Extreme ice with concurrent wind loading	460
251. Conductor loading	477
A. General	477
B. Load components	478
1. Vertical load component	478
2. Horizontal load component	478
3. Total load	478
252. Loads on line supports	479
A. Assumed vertical loads	479
B. Assumed transverse loads	480
1. Transverse loads from conductors and messengers	480
2. Wind loads on structures	480
3. At angles	480
4. Wind span	481
C. Assumed longitudinal loading	482
1. Change in grade of construction	482
2. Jointly used poles at crossings over railroads, communication lines, or limited access highways	482
3. Deadends	483
4. Unequal spans and unequal vertical loads	483
5. Stringing loads	483
6. Communication conductors on unguyed supports at railroad and limited access highway crossings	483
D. Simultaneous application of loads	484
253. Load factors for structures, crossarms, support hardware, guys, foundations, and anchors	486
Section 26. Strength requirements	488
260. General (see also Section 20)	490
A. Preliminary assumptions	490
B. Application of strength factors	490
261. Grades B and C construction	492
A. Supporting structures	492
1. Metal, prestressed-, and reinforced-concrete structures	493
2. Wood structures	494
3. Fiber-reinforced polymer structures	499
4. Transverse strength requirements for structures where side guying is required, but can be installed only at a distance	500

5.	Longitudinal strength requirements for sections of higher grade in lines of a lower grade construction	500
B.	Strength of foundations, settings, and guy anchors	501
C.	Strength of guys and guy insulators	503
1.	Metal and prestressed-concrete structures	503
2.	Wood and reinforced-concrete structures	503
3.	Fiber-reinforced polymer structures	503
D.	Crossarms and braces	504
1.	Concrete and metal crossarms and braces	504
2.	Wood crossarms and braces	504
3.	Fiber-reinforced polymer crossarms and braces	504
4.	Crossarms and braces of other materials	504
5.	Additional requirements	504
E.	Insulators	507
F.	Strength of pin-type or similar construction and conductor fastenings	507
1.	Longitudinal strength	507
2.	Double pins and conductor fastenings	507
3.	Single supports used in lieu of double wood pins	508
G.	Armless construction	508
1.	General	508
2.	Insulating material	508
3.	Other components	508
H.	Open supply conductors and overhead shield wires	508
1.	Tensions	508
2.	Splices, taps, dead-end fittings, and associated attachment hardware	511
3.	Trolley-contact conductors	511
I.	Supply cable messengers	511
J.	Open-wire communication conductors	512
K.	Communication cables and messengers	512
1.	Communication cables	512
2.	Messenger	512
L.	Paired metallic communication conductors	513
1.	Paired conductors supported on messenger	513
2.	Paired conductors not supported on messenger	513
M.	Support and attachment hardware	513
N.	Climbing and working steps and their attachments to the structure	514
262.	Number 262 not used in this edition	516
263.	Grade N construction	518
A.	Poles	518
B.	Guys	518
C.	Crossarm strength	518
D.	Supply line conductors	518
1.	Size	518
E.	Service drops	519
1.	Size of open-wire service drops	519
2.	Tension of open-wire service drops	519
3.	Cabled service drops	519
F.	Trolley-contact conductors	520
G.	Communication conductors	521
H.	Street and area lighting equipment	521
I.	Insulators	521
264.	Guying and bracing	521
A.	Where used	521
B.	Strength	522

C. Point of attachment	523
D. Guy fastenings	523
E. Electrolysis	523
F. Anchor rods	524
Section 27. Line insulation	525
270. Application of rule	525
271. Material and marking	525
272. Ratio of flashover to puncture voltage	525
273. Insulation level	526
274. Factory tests	527
275. Special insulator applications	527
A. Insulators for constant-current circuits	527
B. Insulators for single-phase circuits directly connected to three-phase circuits	527
276. Number 276 not used in this edition	528
277. Mechanical strength of insulators	528
278. Aerial cable systems	531
A. Electrical requirements	531
B. Mechanical requirements	531
279. Guy and span insulators	531
A. Insulators	531
1. Properties of guy insulators	531
2. Galvanic corrosion and BIL insulation	532
B. Properties of span-wire insulators	534
1. Material	534
2. Insulation level	534
3. Mechanical strength	534
Section number 28 not used in this edition	535
Section number 29 not used in this edition	536
Part 3. Safety Rules for the Installation and Maintenance of Underground Electric Supply and Communication Lines	537
Section 30. Purpose, scope, and application of rules	541
300. Purpose	541
301. Scope	541
302. Application of rules	541
Section 31. General requirements applying to underground lines	542
310. Referenced sections	542
311. Installation and maintenance	542
312. Accessibility	542
313. Inspection and tests of lines and equipment	543
A. When in service	543
1. Initial compliance with safety rules	543
2. Inspection	543
3. Tests	543
4. Inspection records	543
5. Corrections	543
B. When out of service	543
1. Lines infrequently used	543

2.	Lines temporarily out of service	543
3.	Lines permanently abandoned	543
314.	Grounding of circuits and equipment	543
A.	Methods	543
B.	Conductive parts to be grounded	543
C.	Circuits	544
1.	Neutrals	544
2.	Other conductors	544
3.	Surge arresters	544
4.	Use of earth as part of circuit	544
315.	Communications protective requirements	544
A.	Where required	544
B.	Means of protection	545
316.	Induced voltage.....	545
Section 32. Underground conduit systems		546
320.	Location	546
A.	Routing	546
1.	General	546
2.	Natural hazards	546
3.	Highways and streets	547
4.	Bridges and tunnels	547
5.	Railroad tracks	547
6.	Water	547
B.	Separation from other underground installations	548
1.	General	548
2.	Separations between supply and communication conduit systems	548
3.	Sewers, sanitary and storm	548
4.	Water lines	548
5.	Gas and other lines that transport flammable material	548
6.	Steam or cryogenic lines	548
321.	Excavation and backfill	549
A.	Trench	549
B.	Quality of backfill	549
322.	Conduit, ducts, and joints	549
A.	General	549
B.	Installation	550
1.	Restraint	550
2.	Joints	550
3.	Externally coated pipe	550
4.	Building walls, floors, or roofs	550
5.	Bridges	550
6.	In vicinity of manholes	550
323.	Manholes, handholes, and vaults	551
A.	Strength	551
B.	Dimensions	553
C.	Manhole access	554
D.	Covers	554
E.	Vault and utility tunnel access	555
F.	Ladder requirements	555
G.	Drainage	556
H.	Ventilation	556
I.	Mechanical protection	556
J.	Identification	556

Section 33. Supply cable.....	557
330. General.....	557
331. Sheaths and jackets.....	557
332. Shielding.....	557
A. General.....	557
B. Material.....	558
333. Cable accessories and joints.....	558
Section 34. Cable in underground structures.....	559
340. General.....	559
341. Installation.....	559
A. General.....	559
B. Cable in manholes and vaults.....	559
1. Supports.....	559
2. Clearance.....	560
3. Identification.....	560
342. Grounding and bonding.....	562
343. Number 343 not used in this edition.....	562
344. Communication cables containing special supply circuits.....	562
Section 35. Direct-buried cable and cable in duct not part of a conduit system.....	563
350. General.....	563
351. Location and routing.....	565
A. General.....	565
B. Natural hazards.....	565
C. Other conditions.....	565
1. Swimming pools (in-ground).....	565
2. Buildings and other structures.....	565
3. Railroad tracks.....	565
4. Highways and streets.....	566
5. Water.....	566
6. Bridges.....	566
352. Installation.....	566
A. Trenching.....	566
B. Plowing.....	567
C. Boring.....	567
D. Depth of burial.....	567
E. Supply cables shall not be installed in the same duct with communication cables unless all of the cables are operated and maintained by the same utility.....	567
F. Communication cables may be installed together in the same duct provided all utilities involved are in agreement.....	567
353. Deliberate separations—Equal to or greater than 300 mm (12 in) from underground structures or other cables.....	568
A. General.....	568
B. Crossings.....	569
C. Parallel facilities.....	569
D. Steam or cryogenic lines.....	569
354. Random separation—Separation less than 300 mm (12 in) from underground structures or other cables.....	569
A. General.....	569
B. Supply cables or conductors.....	570
C. Communication cables or conductors.....	570
D. Supply and communication cables or conductors.....	570
1. General.....	570

2.	Grounded bare or semiconducting jacketed neutral supply cables	571
3.	Insulating jacketed effectively grounded neutral supply cables	571
4.	Insulating jacketed grounded neutral supply cables in nonmetallic duct	571
E.	Supply and communication cables or conductors and non-metallic water and sewer lines	571
355.	Additional rules for duct not part of a conduit system	576
Section 36. Risers		577
360.	General	577
361.	Installation	577
362.	Pole risers—Additional requirements	577
363.	Pad-mounted installations	577
Section 37. Supply cable terminations		578
370.	General	578
371.	Support at terminations	578
372.	Identification	578
373.	Clearances in enclosures or vaults	579
374.	Grounding	579
Section 38. Equipment		580
380.	General	580
381.	Design	580
382.	Location in underground structures	582
383.	Installation	582
384.	Grounding and bonding	583
385.	Identification	584
Section 39. Installation in tunnels		585
390.	General	585
391.	Environment	585
Part 4. Work Rules for the Operation of Electric Supply and Communications Lines and Equipment		587
Section 40. Purpose and scope		589
400.	Purpose	589
401.	Scope	589
402.	Referenced sections	590
Section 41. Supply and communications systems—Rules for employers		591
410.	General requirements	591
A.	General	591
B.	Emergency and first aid procedures	592
C.	Responsibility	592
411.	Protective methods and devices	598
A.	Methods	598
B.	Devices and equipment	598
C.	Inspection and testing of protective devices and equipment	599
D.	Signs and tags for employee safety	599
E.	Identification and location	599
F.	Fall protection	599

Section 42. General rules for employees	601
420. General	601
A. Rules and emergency methods	601
B. Qualifications of employees	601
C. Safeguarding oneself and others	602
D. Energized or unknown conditions	603
E. Ungrounded metal parts	603
F. Arcing conditions	603
G. Liquid-cell batteries	604
H. Tools and protective equipment	604
I. Clothing	604
J. Ladders and supports	605
K. Fall protection	605
L. Fire extinguishers	607
M. Machines or moving parts	607
N. Fuses	607
O. Cable reels	607
P. Street and area lighting	607
Q. Antennas	608
421. General operating routines	609
A. Duties of a first-level supervisor or person in charge	609
B. Area protection	609
1. Areas accessible to vehicular and pedestrian traffic	609
2. Areas accessible to employees only	609
3. Locations with crossed or fallen wires	609
C. Escort	609
422. Overhead line operating procedures	610
A. Setting, moving, or removing poles in or in the vicinity of energized electric supply lines	610
B. Checking structures before climbing	610
C. Installing and removing wires or cables	610
423. Underground line operating procedures	611
A. Guarding manhole and street openings	611
B. Testing for gas in manholes and unventilated vaults	611
C. Flames	611
D. Excavation	612
E. Identification	612
F. Operation of power-driven equipment	612
 Section 43. Additional rules for communications employees	 614
430. General	614
431. Approach to energized conductors or parts	614
432. Joint-use structures	617
433. Attendant on surface at joint-use manhole	617
434. Sheath continuity	618
 Section 44. Additional rules for supply employees	 619
440. General	619
441. Energized conductors or parts	619
A. Minimum approach distance to energized lines or parts	619
1. General	619
2. Precautions for approach—Voltages from 51 V to 300 V	620
3. Precautions for approach—Voltages from 301 V to 72.5 kV	620
4. Precautions for approach—Voltages above 72.5 kV	621

5.	Temporary (transient) overvoltage control device (TTOCD)	621
6.	Altitude correction	621
B.	Additional approach requirements	625
C.	Live-line tool clear insulation length	627
1.	Clear live-line tool length	627
2.	Live-line conductor support tool length	627
442.	Switching control procedures	637
A.	Designated person	637
B.	Specific work	637
C.	Operations at stations	637
D.	Re-energizing after work	637
E.	Tagging electric supply circuits associated with work activities	638
F.	Restoration of service after automatic trip	638
G.	Repeating oral messages	638
443.	Work on energized lines and equipment	639
A.	General requirements	639
B.	Requirement for assisting employee	640
C.	Opening and closing switches	640
D.	Working position	640
E.	Protecting employees by switches and disconnectors	640
F.	Making connections	640
G.	Switchgear	640
H.	Current transformer secondaries	640
I.	Capacitors	641
J.	Gas-insulated equipment	641
K.	Attendant on surface	641
L.	Unintentional grounds on delta circuits	641
444.	De-energizing equipment or lines to protect employees	642
A.	Application of rule	642
B.	Employee's request	643
C.	Operating switches, disconnectors, open points, and tagging	643
D.	Employee's protective grounds	643
E.	Proceeding with work	644
F.	Reporting clear—Transferring responsibility	644
G.	Removal of tags	644
H.	Sequence of re-energizing	644
445.	Protective grounds	645
A.	Installing grounds	645
1.	Current-carrying capacity of grounds	645
2.	Initial connections	645
3.	Test for voltage	645
4.	Completing grounds	646
B.	Removing grounds	646
446.	Live work	647
447.	Protection against arcing and other damage while installing and maintaining insulators and conductors	648
NESC Appendix A—Uniform system of clearances adopted in the 1990 Code		649
NESC Appendix B—Uniform clearance calculations for conductors under ice and wind conditions adopted in the 2007 Code		655
NESC Appendix C—Example applications for Rule 250C Tables 250-2 and 250-3		658

NESC Appendix D—Determining maximum anticipated per-unit overvoltage factor (T) at the worksite.....	672
NESC Appendix E—Bibliography.....	673
Handbook Appendix A—Reviewers and Policy.....	678
Handbook Appendix B—Safety Signs.....	679
Handbook Appendix C—Metric Conversions.....	688
Handbook Appendix D—Cross References of Major OSHA and NESC Requirements.....	691
Handbook Appendix E—Application of the NESC Grandfather Clause.....	692
Handbook Appendix F—Scheduling Corrections of Noncompliant Conditions Identified During Inspections or Work Activities.....	697
Handbook Appendix G—Online Sources for NESC Revisions, NESC Tentative Interim Amendments, Official NESC Interpretations, NESC Errata, and Other Useful Information and Data.....	704
Handbook Appendix H—Major Changes in the 2017 NESC Rules and Tables.....	705

Figures

Premier Edition Handbook figures are listed flush left and usually have an “H” at the beginning of their numbers. Code figures are listed here with an indent and in italics. Most figures are numbered based on the Code rules to which they relate. For example, Figure H092B1 is a Handbook figure that relates to Rule 092B1, and Figure 110-1 is a Code figure that relates to Rule 110. (Numbers on figures in the definitions in Section 3 start with a “D.”)

<i>Figure D-1—Communication space</i>	23
<i>Figure D-2—Sag</i>	29
<i>Figure D-3—Wind span</i>	30
<i>Figure D-4—Weight span</i>	31
<i>Figure D-5—Supply space</i>	31
Figure H092B1—Utility system ground connections	41
Figure H092B3-1—Location of auxiliary grounding conductor	42
Figure H092B3-2—EXCEPTION to Rule 092B3	42
Figure H092C1—Voltage drop in messengers	43
Figure H092C3—Bonding of guys, messengers and neutrals	45
Figure H093D—Protection of grounding conductor by location	53
Figure H094-1—Relationships of made electrodes showing electrode contact area versus depth	62
Figure H096C-1—Sliding mile comparison	67
Figure H096C-2—Basic layout of rural area	67
Figure H096C-3—Grounds required in Mile A	68
Figure H096C-4—Grounds required in Miles B, C and D	68
Figure H097-1—Connections between primary and secondary installations allowed by NESC grounding rules	75
Figure H097-2—Connections between primary and secondary installations prohibited by NESC grounding rules	76
Figure H099C-1—Required bonding of ground rods	82
Figure H099C-2—Incorrect Bonding	82
<i>Figure 110-1—Safety clearance to electric supply station fences</i>	89
<i>Figure 110-2—Safety clearance to electric supply station impenetrable fence</i>	90
Figure H110A1-1—Signs on small supply station	92
Figure H110A1-2—Signs on station with recessed entrance	92
Figure H110A1-3—Signs on L-shaped station	92
Figure H110A1-4—Signs on long station	93
Figure H110A1-5—Fence height requirements	94
Figure H110A1-6—Supply station enclosure not meeting requirements of either Rule 110A1 requirements for limitation of climbability or Rule 124 for clearance to energized parts	95
Figure H110A1-7—Supply station fence gate with too large a gap between panels	95
Figure H110A2-1—Required clearance of live parts from fence	96
Figure H110A2-2—Fence clearance violation	97
Figure H110A2-3—Using solid wall section to get live parts closer to fence	97
Figure H110A2-4—Fence mesh allowed under solid section by TIA 2007-1	98
Figure H110A2-5—Solid vertical fence section	98
Figure H110A2-6—Solid section meeting TIA 2007-1 limits contact with close facilities, but does not comply with 2012 Rule 110A2 to have full vertical section solid	99
Figure H112C2-1—Elevated platform with railing	107
Figure H112C2-2—With ± 1070 mm (42 in.) railing with chain across opening	108
<i>Figure 124-1—Clearance from live parts</i>	117

Figure H124-1—"Taut String" measurement	119
Figure H124A3—Example of guard zone around 25 kV conductor	120
Figure H124C2—Height of guard around 25kV phase-to-phase, 150 kV BIL bus	122
<i>Figure 124-2—Railings or fences used as guards</i>	123
Figure H124C3-1—Location of protective railing inside perimeter fence	124
Figure H124C3-2—Example of interior railing or fence around capacitor bank inside electric supply station	124
Figure H124C3-3—Pad-mounted substation not meeting Rules 110A2, 124A1, or 124C3	125
<i>Figure 124-3—Taut-string measurement of vertical clearance to energized parts of equipment or behind barriers</i>	127
Figure H124-1—"Taut String" measurement [vertical portion \geq 1.5 m (5 ft)]	127
Figure H125—Requirements of Rule 125A and Table 125-1 for working space about electric equipment with energized parts of 0–600 V	138
Figure H180—Multiple Exits from Switchgear Room	166
Figure H215C—Multiple guy insulators to limit transfer of voltage from one level to another (this requirement was deleted in 2017)	186
Figure H217A1c—Power lines carried on bridge attachments	190
Figure H221-1—No conflict with complete separation of lines	201
Figure H221-2—Joint-use line near railroad	201
Figure H221-3—Supply line conflict with communication line	202
Figure H221-4—Joint use	202
Figure H225B—Broken trolley contact conductor clearance	207
Figure H230-1—Method of measurement	212
Figure H230-2—Classification of parts	213
<i>Figure 230-1—Clearance zone map of the United States</i>	215
Figure H230-3—Metal-sheathed cable meeting Rule 230C1a	219
Figure H230-4—Concentric neutral cable meeting Rule 230C1b	219
Figure H230-5—Triplex secondary cable meeting Rule 230C3	220
Figure H230-6—Covered conductor meeting Rule 230D	221
Figure H230-7—Covered conductor with deteriorated covering	222
Figure H231-1—Fire hydrant with portable gate valve attached	226
Figure H231-2—Structure clearances from the traveled way and shoulders of roadways	228
Figure H231-3—Poles back of curbs	229
Figure H231-4—Practical location for pole away from roadway and R/W line	229
Figure H231C-1—Structure clearances from railroad tracks	232
Figure H231C-2—Building A is controlling obstruction	233
Figure H232-1—Example of 1987 method—Basic clearance	234
Figure H232-2—Example of 1987 method—Long span clearance	235
Figure H232-3—Example of 1987 method—Operation above 120°F	235
Figure H232-4—Example of 1990 method—Any span	236
Figure H232-5—Alternate clearance for conductors over roads, streets, etc.	250
Figure H232-1FN7a—Residential driveway beside house	268
Figure H232-1FN7b—General use driveway beside house	268
Figure H232-1FN26—Overheight orchard management equipment	271
Figure T232-1_Cat5—Clearances for riders on large animals approach that of a full-size truck	274
Figure H232-1FN7/8—Applicability of Footnote 7 and Footnote 8 of Table 232-1	275
Figure H232-6—Clearance categories applying to road right-of-way	287
<i>Figure 233-1—Use of clearance envelope and conductor movement envelopes to determine applicable clearance</i>	291
<i>Figure 233-2—Conductor movement envelope</i>	292
<i>Figure 233-2—Conductor movement envelope</i>	293
<i>Figure 233-3—Clearance envelope</i>	294

Figure H233-1—Catenary curve and percentage total sag	306
Figure H233-2—Crossing conditions	312
<i>Figure 234-1(a)—Clearance diagram for building</i>	316
<i>Figure 234-1(b)—Clearance diagram for other structures</i>	317
<i>Figure 234-1(c)—Transitional clearance when H is greater than V</i>	317
Figure H234A-1—Relative wind and weight forces and wind deflection angles per linear foot of two conductors	319
Figure H234A-2—Wind displacement of copper conductors and cable relative to sag at 15 °C (60 °F)	320
Figure H234A-3—Wind displacement of ACSR conductors relative to sag at 15 °C (60 °F)	320
Figure H234A-4—Wind displacement of all-aluminum conductors relative to sag at 15 °C (60 °F)	321
Figure H234B—Skip-span pole not having vertical clearance required by Rule 234B2 of horizontal clearance at the structure required by Rule 235B	323
<i>Figure 234-2—Clearances of service drop terminating on support mast</i>	326
Figure H234-1—Clearances to buildings—1941 and 1968 NESC	334
Figure H234-2—Clearances to buildings—1977–1987 NESC	335
Figure H234-3—Clearance to buildings—1990 Code and later editions	335
Figure H234-4—Clearance to buildings—1997 Code; if horizontal clearance is greater than vertical clearance	336
Figure H_T234-1_1—Transformer bushing and jumper clearance less than required by Table 234-1 and Rule 234J	336
Figure H234C3d(1)—EXCEPTION where roof is not accessible to pedestrians	340
Figure H234C3d(2)—Potential locations for service drops on side of house	341
Figure H234D—Attachment of conductors to a bridge	343
<i>Figure 234-3(a)—Swimming pool clearances</i>	344
<i>Figure 234-3(b)—Aboveground swimming pool with deck</i>	344
<i>Figure 234-3(c)—Aboveground swimming pool without deck</i>	345
Figure H234E—Clearance above swimming areas	346
<i>Figure 234-4(a)—Clearance envelope for grain bins filled by permanently installed augers, conveyors, or elevators</i>	347
<i>Figure 234-4(b)—Clearance envelope for grain bins filled by portable augers, conveyors, or elevators</i>	348
Figure H234F—Grain bin clearance less than required by Rule 234F	349
Figure H234-4(b)—Vertical clearance above flat or sloping ground near grain bin filled with portable augers	351
<i>Figure 234-5—Rail car clearances</i>	354
Figure H235A3—Relative voltages between a conductor of one supply circuit and a conductor of another supply circuit on the same supporting structure	374
Figure H235-1—Vertical arrangement of circuits	382
Figure H235C2b—Clearance at pole based upon closes-approach midspan clearance	384
Figure H235C—Two possible positions of fiber-optic cable in the supply space	386
<i>Figure 235-1—Clearance diagram for energized conductor</i>	387
Figure H235D—Vertical and horizontal clearances on same pole line	388
Figure H235-2—Permissible arrangements of supply circuits of different consecutive voltage classifications on the same crossarm	391
Figure H235G4—Multiplex secondary cable attached to neutral bracket	393
Figure H236C—Crossarm location relative to climbing space	412
<i>Figure 236-1—Rule 236G, EXCEPTION 3</i>	415
Figure H236-1—Climbing space	416
Figure H237-1—Working space	418

Figure H237-2—Obstruction of working space by buckarm construction for crossing line	419
Figure H237-3—Obstruction of working space by buckarm construction for deadend tap line	420
<i>Figure 237-1—Obstruction of working space by buckarm</i>	<i>421</i>
Figure H238A—Older NESC requirements	423
Figure H238B-1—Basic required vertical clearances required by Rule 235C, Rule 238B, and Table 238-1	424
Figure H238B-2—Clearances allowed by the EXCEPTION to Rule 235C2b(1)(a) and Table 238-1	425
Figure H238D-1—Clearance of communication bolt to open luminaire drip-loop wires	426
Figure H238D-2—Clearance of communication bolt to open luminaire drip-loop wires with supplementary nonmetallic covering	426
Figure H238E—Antennas not allowed in communication worker safety zone	429
Figure H239D-1—Locating unguarded vertical runs to have least exposure to mechanical damage	432
Figure H239D-2—Bonding of metallic pipe to grounding conductor	432
Figure H239E—Wires run directly to luminaire head	434
Figure H250B—Ice on pole and supported facilities	454
<i>Figure 250-1—General loading map of United States with respect to loading of overhead lines..</i>	<i>462</i>
<i>Figure 250-2(a)—Basic wind speeds.....</i>	<i>463</i>
<i>Figure 250-2(b)—Basic wind speeds.....</i>	<i>464</i>
<i>Figure 250-2(c)—Western Gulf of Mexico hurricane coastline.....</i>	<i>465</i>
<i>Figure 250-2(d)—Eastern Gulf of Mexico and southeastern U.S. hurricane coastline.....</i>	<i>466</i>
<i>Figure 250-2(e)—Mid and northern Atlantic hurricane coastline.....</i>	<i>467</i>
<i>Figure 250-3(a)—Uniform ice thickness with concurrent wind.....</i>	<i>468</i>
<i>Figure 250-3(b)—Uniform ice thickness with concurrent wind.....</i>	<i>469</i>
<i>Figure 250-3(c)—Uniform ice thickness with concurrent wind.....</i>	<i>470</i>
<i>Figure 250-3(d)—Uniform ice thickness with concurrent wind.....</i>	<i>470</i>
<i>Figure 250-3(e)—Uniform ice thickness with concurrent wind.....</i>	<i>471</i>
<i>Figure 250-3(f)—Uniform ice thickness with concurrent wind.....</i>	<i>472</i>
Figure H252B—Wind on vertical cable runs to antenna can be a significant load— especially if cables are bridged by ice to form a solid panel	481
Figure H252D-1—Simultaneous loadings	485
Figure H252D-2—Design wind direction at angles	485
Figure H26-1—Forces producing load on supporting structures	488
Figure H260-3—Pole deformed by unbalanced service drop tension	491
Figure H261A2a—Consideration of portions of a guyed pole	495
Figure H261A2d—Example of steel trussing to restore ground-line bending strength of wood utility pole	497
Figure H264-1—Lead and height of guys	522
<i>Figure 279-1—Insulator used for BIL insulation.....</i>	<i>533</i>
<i>Figure 323-1—Roadway vehicle load.....</i>	<i>552</i>
<i>Figure 323-2—Wheel load area.....</i>	<i>552</i>
Figure H323A—Underground structure loading	553
<i>Figure 350-1—Symbols for identification of buried cables.....</i>	<i>563</i>
Figure H354D—EXCEPTION to rule 354D2a(3)	575
Figure H384C—Power and communication pedestals requiring bonding	583
Figure H441B—Clear insulation distance	626
Figure H441C—Clear live-line tool distance	627

Code Appendices

<i>Figure A-1—Clearance at maximum sag</i>	654
--	-----

Handbook Appendices

Figure B1—Signal Word Changes	680
Figure B2—Permitted Arrangements	684
Figure B3—Sign Readability—Signs Spaced for Message Word Readability	685
Figure B4—Sign Readability—Signs Spaced for Signal Word Readability	685
Figure B5—Symbols of Principal Interest to Utilities	686
Figure B6—Typical Safety Signs for Specific Hazards	687
Figure F1—Typical measurements above bottom of sternum (breastbone)	700
Figure F2—Working below secondary conductor or cable of 0–300 V between conductors	701
Figure F3—Work below secondary conductor or cable of 301–750 V between conductors	701
Figure F4—Work below primary conductors of 751 V to 15 kV between conductors	702

Tables

Premier Edition Handbook tables are listed flush left and usually have an “H” at the beginning of their numbers. Code tables are listed here with an indent and in italics. Tables are numbered based on the Code rules to which they relate. For example, Table H234-1 is a Handbook table that relates to Rule 234, and Table 441-1 is a Code table that relates to Rule 441.

Table H016-1—Effective Dates	17
Table H094-1—Inputs for Dwight Calculations	60
Table H097-1—Grounding Separation Requirements	77
<i>Table 110-1—Values for use with Figure 110-1</i>	<i>90</i>
<i>Table 111-1—Illumination levels.....</i>	<i>103</i>
Table H111-1—Illumination Intensities	104
<i>Table 124-1—Clearances from live parts</i>	
<i>PART A—Low, medium, and high voltages (based on BIL factors) (meters)</i>	<i>128</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART B—Extra-high voltages (based on switching-surge factors) (meters)</i>	<i>129</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART C—Extra-high voltages (based on BIL factors) (meters).....</i>	<i>130</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART D—High voltage direct current (based on transient overvoltage) (meters)</i>	<i>130</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART A—Low, medium, and high voltages (based on BIL factors) (feet)</i>	<i>132</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART B—Extra-high voltages (based on switching-surge factors) (feet)</i>	<i>133</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART C—Extra-high voltages (based on BIL factors) (feet)</i>	<i>134</i>
<i>Table 124-1—Clearances from live parts</i>	
<i>PART D—High voltage direct current (based on transient overvoltage) (feet)</i>	<i>134</i>
<i>Table 125-1—Working space.....</i>	<i>136</i>
<i>Table 230-1—Ice thickness for purposes of calculating clearances</i>	<i>215</i>
<i>Table 230-2—Ice, wind pressures, temperatures, and additive constants for</i> <i> purposes of calculating final inelastic deformation</i>	<i>217</i>
Table H231B-1—First Harmful Event—Fixed Object Fatalities by Object Type	231
Table H232-1—Classification of Conductors, Wires, Cables, or Parts	243
<i>Table 232-1—Vertical clearance of wires, conductors, and cables above ground,</i> <i> roadway, rail, or water surfaces (meters)</i>	<i>251</i>
<i>Table 232-1—Vertical clearance of wires, conductors, and cables above ground,</i> <i> roadway, rail, or water surfaces (feet)</i>	<i>255</i>
<i>Table 232-2—Vertical clearance of equipment cases, support arms, platforms, braces</i> <i> and unguarded rigid live parts above ground, roadway, or water surfaces (meters).....</i>	<i>259</i>
<i>Table 232-2—Vertical clearance of equipment cases, support arms, platforms, braces</i> <i> and unguarded rigid live parts above ground, roadway, or water surfaces (feet).....</i>	<i>261</i>
Table 232-1 Category 1—Clearances Over Tracks of Railroads	264
Table 232-1 Category 2—Clearances Over Roads, Streets, and Other Areas	
Subject to Truck Traffic	266
Table 232-1 Category 3—Clearances Over Driveways, Parking Lots, and Alleys	269
Table 232-1 Category 4—Clearances Over Other Lands Traversed by Vehicles	272

Table 232-1 Category 5—Clearances Over Space and Ways Subject to Pedestrians and Restricted Traffic Only	275
Table 232-1 Category 6—Clearances Over Water Areas Not Suitable for Sailboating	277
Table 232-1 Category 7—(1987 System) Clearances Over Water Areas Suitable for Sailboating ...	281
Table 232-1 Category 7—(1990 System) Clearances Over Water Areas Suitable for Sailboating ...	282
Table 232-1 Category 8—(1987 System) Clearances Over Areas for Rigging or Launching Sailboat	284
Table 232-1 Category 8—(1990 System) Clearances Over Areas for Rigging or Launching Sailboat	285
Table 232-1 Category 9—Clearances Along and Within Rights-of-Way but Not Overhanging the Roadway of Roads, Streets, and Alleys	286
Table 232-1 Category 10—Clearances Along and Within Rights-of-Way but Not Overhanging Rural Roads—Where Vehicles Under the Line Are Unlikely	288
<i>Table 232-3—Reference heights</i>	289
<i>Table 232-4—Electrical component of clearance in Rule 232D3a</i>	290
<i>Table 233-1—Vertical clearance between wires, conductors, and cables carried on different supporting structures (meters)</i>	297
<i>Table 233-1—Vertical clearance between wires, conductors, and cables carried on different supporting structures (feet)</i>	299
<i>Table 233-2—Clearance between supply wires, conductors, and cables in Rules 233A and 233C3b(1) (meters)</i>	301
<i>Table 233-2—Clearance between supply wires, conductors, and cables in Rule 233A and 233C3b(1) (feet)</i>	302
<i>Table 233-3—Reference heights</i>	302
Table H233-1—Changes in Requirements for Crossings Not at Midspan: Assuming 3 Ft of Additional Sag at Midspan	307
Table H234-1—Changes in Required Horizontal Clearances of Open Conductors to Buildings	330
Table H234-2—Horizontal Clearance Required From Building for Phase Conductors of Three Voltage Classifications	331
Table H234-3	332
Table H234-4	332
<i>Table 234-1—Clearance of wires, conductors, cables, and unguarded rigid live parts adjacent but not attached to buildings and other installations except bridges (meters)</i>	356
<i>Table 234-1—Clearance of wires, conductors, cables, and unguarded rigid live parts adjacent but not attached to buildings and other installations except bridges (feet)</i>	360
<i>Table 234-2—Clearance of wires, conductors, cables, and unguarded rigid live parts from bridges (meters)</i>	364
<i>Table 234-2—Clearance of wires, conductors, cables, and unguarded rigid live parts from bridges (feet)</i>	366
<i>Table 234-3—Clearance of wires, conductors, cables, or unguarded rigid live parts over or near swimming pools (meters)</i>	368
<i>Table 234-3—Clearance of wires, conductors, cables, or unguarded rigid live parts over or near swimming pools (feet)</i>	369
<i>Table 234-4—Electrical component of clearance of buildings, bridges, and other installations</i> ...	370
<i>Table 234-5—Reference distances</i>	371
<i>Table 234-6—Clearance over roof not readily accessible (meters)</i>	371
<i>Table 234-6—Clearance over roof not readily accessible (feet)</i>	372
<i>Table 235-1—Horizontal clearance between wires, conductors, or cables at supports</i>	396

Table 235-2—Horizontal clearances between line conductors smaller than AWG No. 2 at supports, based on sags (meters)	397
Table 235-2—Horizontal clearances between line conductors smaller than AWG No. 2 at supports, based on sags (feet)	397
Table 235-3—Horizontal clearances between line conductors AWG No. 2 or larger at supports, based on sags (meters).....	398
Table 235-3—Horizontal clearances between line conductors AWG No. 2 or larger at supports, based on sags (feet).....	398
Table 235-4—Electrical clearances in Rule 235B3a(1).....	399
Table 235-5—Vertical clearance between conductors at supports (meters).....	400
Table 235-5—Vertical clearance between conductors at supports (inches)	402
Table 235-6—Clearance in any direction from line conductors at or near a support to supports, and to vertical or lateral conductors, service drops, span or guy wires, and to communication antennas attached to the same support (millimeters)	404
Table 235-6—Clearance in any direction from line conductors at or near a support to supports, and to vertical or lateral conductors, service drops, span or guy wires, and to communication antennas attached to the same support (inches)	407
Table 235-7—Clearance in any direction from line conductors to supports	410
Table 235-8—Vertical spacing between conductors supported on vertical racks or separate brackets.....	411
Table 236-1— Horizontal clearance between conductors bounding the climbing space	417
Table 238-1—Vertical clearance between supply conductors and communications equipment, between communication conductors and supply equipment, and between supply and communications equipment	427
Table 238-2—Vertical clearance of span wires and brackets from communication lines and equipment	428
Table 239-1—Clearance of open vertical and lateral conductors (millimeters).....	440
Table 239-1—Clearance of open vertical and lateral conductors (inches)	440
Table 239-2—Clearance between open vertical conductors and pole surface (millimeters).....	441
Table 239-2—Clearance between open vertical conductors and pole surface (inches)	441
Table 242-1—Grades of construction for conductors and cables alone, at crossing, or on the same structures with other conductors and cables	449
Table 250-1—Ice, wind pressures, and temperatures	473
Table 250-2—Velocity pressure exposure coefficient k_z	474
Table 250-3—Structure and wire gust response factors, G_{RF} (meters)	475
Table 250-3—Structure and wire gust response factors, G_{RF} (feet)	476
Table 250-4—Wind speed conversions to pressure.....	477
Table 251-1—Temperatures and constants	478
Table 253-1—Load factors for structures, crossarms, support hardware, guys, foundations, and anchors to be used with the strength factors of Table 261-1	486
Table 261-1—Strength factors for structures, crossarms, braces, support hardware, guys, foundations, and anchors	515
Table 261-2—Dimensions of crossarm cross section of select Southern Pine and Douglas Fir.....	516
Table 263-1—Sizes for Grade N supply line conductors.....	519
Table 263-2—Sizes of service drops of 750 V or less.....	520
Table 273-1—Insulation level requirements.....	526
Table 277-1—Allowed percentages of strength ratings	528

Table 341-1—Clearance between supply and communications facilities in joint-use manholes and vaults.....	560
Table 352-1—Supply cable, conductor, or duct burial depth.....	567
Table 410-1—Clothing and clothing systems (cal/cm ²) for voltages 50 V to 1000 V (ac)	595
Table 410-2—Clothing and clothing systems—voltage, fault current, and maximum clearing time for voltages 1.1 kV to 46 kV ac	596
Table 410-3—Live-line tool work clothing and clothing systems—voltage, fault current, and maximum clearing time for voltages 46.1 kV to 800 kV ac	597
Table 431-1—Communication work minimum approach distances (meters)	615
Table 431-1—Communication work minimum approach distances (feet)	616
Table 441-1—AC live work minimum approach distance	628
Table 441-2—AC live work minimum approach distances for altitudes less than 900 m above sea level, where T has been determined according to Rule 441A4 (meters)	629
Table 441-2—AC live work minimum approach distances for altitudes less than 3000 ft above sea level, where T has been determined according to Rule 441A4 (feet)	630
Table 441-3—AC live work minimum approach distances for altitudes less than 900 m above sea level, where T has been determined according to Rule 441A4 (meters)	631
Table 441-3—AC live work minimum approach distances for altitudes less than 3000 ft above sea level, where T has been determined according to Rule 441A4 (feet)	632
Table 441-4—AC live work minimum approach distances for altitudes less than 900 m above sea level, where T has been determined according to Rule 441A4 (meters)	633
Table 441-4—AC live work minimum approach distances for altitudes less than 3000 ft above sea level, where T has been determined according to Rule 441A4 (feet)	634
Table 441-5—DC live work minimum approach distance.....	635
Table 441-6—Altitude correction factor.....	636
Table 441-7—Maximum use voltage for rubber insulating equipment	636
Table 444-1—Minimum clearances for open air gaps	643

Code Appendices

Table A-1.....	650
Table A-2a—Reference components of Rule 232 (meters)	651
Table A-2a—Reference components of Rule 232 (feet)	652
Table A-2b—Reference components of Rule 234	653

Handbook Appendices

Table B1—Intended Uses of Safety Colors.....	680
Table B2—Information Required on Signs	681
Table B3—Classification of Signal Words	682
Table B4—Attributes of Environmental and Facility Safety Signs.....	683
Table C1—Length	688
Table C1—Length (continued).....	689
Table C2—Area	689
Table C3—Force.....	690
Table C4—Pressure.....	690
Table C5—Temperature	690

Letter symbols for units

This Code uses standard symbols for units. They have the following meanings:

A	ampere
C	degree Celsius
ft	foot
ft ²	square foot
ft ³	cubic foot
F	degree Fahrenheit
g	gram
Hz	hertz
h	hour
in	inch
in ²	square inch
k	kilo (10 ³)
kg	kilogram
kPa	kilopascal
km ²	square kilometer
kV	kilovolt (1000 V)
kVA	kilovoltampere
kW	kilowatt
m	meter
m ²	square meter
m ³	cubic meter
m	milli (10 ⁻³)
mA	milliampere
mi	mile (international)
mm	millimeter
min	minute (time)
N	newton
Pa	pascal
lb	pound
s	second (time)
V	volt
W	watt

Section 1. Introduction to the National Electrical Safety Code®

The National Electrical Safety Code (NESC®) is American National Standard C2. It is a consensus standard that has been prepared by the National Electrical Safety Code Committee under procedures approved by the American National Standards Institute (ANSI). The membership of the NESC Committee is composed of national and international organizations and is certified by ANSI as having an appropriate balance of the interests of members of the public, utility workers, regulatory agencies, and the various types of private and public utilities.

The NESC is used in whole or in part by statute, regulation, or consent as the standard (or basis of the standard) of safe practice for public and private utilities in the United States, as well various jurisdictions and industries in other countries.

(This section was created in the 1981 Code; Rules 010–015 were generally contained previously in the introductory rules of each separate part of the Code (Rules 100, 102, 103, 200, 201, 202, 210, 211, 300, 301, 302, 303, 310, 311, and 400). When all parts of the Code were simultaneously revised for the first time in the 1981 Code, these rules were collected in one place and revised for uniformity to eliminate redundant language, and to increase the clarity and specificity of requirements so as to increase the understandability of the NESC.)

The rules in Section 1 apply to all of the parts and sections in the NESC. Rule 010 (Purpose) says whom and what the NESC rules are to safeguard. The “whom” includes people, both the public and utility workers. The “what” refers to utility facilities, which include all utility-owned and -operated electric power generation systems, overhead and underground lines and equipment that deliver electric power to the end users, and communication overhead and underground lines and equipment that transmit electronic and voice data and signals.

The word “practical” is used to describe rules that are written to safeguard the public and the utility facilities. This phrasing means that requirements of the NESC rules must be *doable* and will create the *level of safety required for the activity or installation*. For example, the work rules require protective insulating equipment be used when workers are within reach of electric power lines; this requirement is practical, or doable, and protects the worker from injury; therefore, the requirement fulfills the rule’s intent. As another example, the clearance above ground for overhead wires, cables, and conductors must be high enough to safeguard the activity under the overhead lines and, to be practical, vary according to the activity under the lines. The clearance over railroad tracks is greater than the clearance over a road due to the height of a railroad boxcar compared to the height of a trailer truck. It is practical that the clearances are different and at the same time provide the desired level of safety to avoid contact between overhead lines and the objects or activity below the lines.

Rule 010 also states that the Code is not a design specification or an instruction manual. The NESC is a performance standard. It does not specify materials to be used for certain installations, nor does it provide instructions on how to meet the Code requirements. The Code recognizes that design specifications and work methods vary from utility to utility depending on many factors such as location, typical climate conditions, terrain, etc. The most common example of this rule is that the Code requires clearances above ground over which the overhead lines pass, but the Code does not require the use of a certain type of structure to support the overhead lines. Metal lattice-type towers, wood, concrete, fiberglass, or metal poles may be used as long as the structure meets the Code’s strength requirement and is high enough to provide the required clearance.

The clearances and strength requirements are basic requirements. The rules stating clearance and strength requirements use the words “not less than” where a clearance or strength requirement is specified. If so desired, utilities may exceed these requirements, but failing to meet the specified clearance or strength requirements creates a condition affecting compliance with this Code. If a utility constructs a system that meets the basic requirements, it provides the practical safeguarding of persons and utility facilities specified in the Code.

Rule 011 (Scope) describes, in detail, what is covered by the Code and what is not covered by the Code. Generally every function performed by a public or private electric supply utility is covered. The NESC coverage stops at the customer or user service point. Also covered by the NESC are independent

electric generators that supply electricity to electric supply utilities only. Communication utilities including telephone, TV cable, and data transmission utilities that use overhead and underground lines to transmit or receive signals, as well as overhead trolley lines and street and area lighting system controlled and operated by public or private utilities that are supplied from lines on the line side of the service point, are also covered. Similar utility systems that are not operated by utilities such as large industries or government-owned systems (military bases) are covered by these rules.

Electric supply stations are covered by this Code. The building wiring, i.e., ceiling lights and wall sockets in offices that are not part of the generation or substation bus work or wiring, is not covered by this Code. It is covered by the National Electrical Code® (NEC®).

Not covered by the Code is all wiring beyond the service point. The service point for overhead lines is usually at the weatherhead. In underground service areas, the service point may be in an underground vault, at a pad-mounted transformer, at the building wall, or inside the building in the main switch equipment. In residential areas where the utilities are underground, the service point is usually at the residence metering point. However, the metering equipment is covered by this Code regardless of its location.

Rule 012 (General rules) requires all electric supply and communication lines and equipment to be designed, constructed, operated, and maintained to meet the rules in the Code. It also requires all entities designing, constructing, maintaining, and operating electric supply or communication lines and equipment covered by the Code to be responsible for meeting the applicable requirements. For example, if a utility contracts with a construction company to build or maintain an overhead line, the contractor is responsible for making sure the work is done according to the NESC safety rules for over line work.

Rule 012C is a rule that requires practical safeguarding for situations that are not specifically covered by the Code. This rule is referred to when it is not practical to meet a Code requirement or the situation is not specifically covered by the Code although it is within the scope of normal Code requirements. Safeguarding must be done based on the known conditions at the time and should be comparable to the level of safety that the Code would normally provide. For example, when an overhead line is to be constructed along a road that passes through a ravine, the vertical clearance above ground will be determined and met based on the ground clearance rules. The Code does not specify diagonal or horizontal clearances to ground. If the side of the ravine is accessible to persons or will be maintained by roadway maintenance crews, doing nothing is not an option. Appropriate clearance should be determined and the line constructed to provide the needed safe clearance for the activity on the side of the ravine.

Rule 013 (Application) requires all new installations and extensions or additions to utility installations to meet the Code unless the governmental agency that oversees the enforcement of the Code waives the rules. Again, the requirement to provide safeguarding for the public and utility workers does not go away; equivalent levels of safeguarding are required by this rule.

The application rules also allow utilities to experiment with different types of construction and methods that are specified by the Code if qualified supervision is provided, the level of safety is maintained, and, when joint-use structures are involved, all affected joint users are notified.

The application rules include extensive rules covering existing installations. The first application rule states that if an existing installation meets or is altered to meet this Code edition, then it meets the Code and is not required to meet earlier editions of the Code.

The second application rule says that if an existing installation, including maintenance replacements, meets an earlier edition, then it meets the Code. However, if the government agency that administers the Code requires updating for safety reasons, then this rule does not apply. This situation may occur where the building clearance allowed by earlier editions is less than the clearance specified in the current edition. Also if the structure is being replaced, this rule and Rule 202 require the structure to meet Rule 238C of the current edition.

The third application rule allows the addition, alteration, or replacement of lines or equipment on an existing structure without replacing or modifying the structure if (a) the installation meets the applicable Code edition in effect when the installation was originally constructed, or (b) the structure and the attached facilities were modified after the original construction date and updated to the Code in effect at that time, or (c) the structure meets the present Code when the work is finished.

For example, an overhead line was constructed meeting the 1984 Code. Work was done on the structure during the time when the 1990 Code was in effect. If the installation was updated to meet the 1990 Code, then the 1990 Code becomes the applicable Code for this installation. If the installation still met the 1984 Code and was not modified to meet the 1990 Code, then the 1984 Code is still the applicable Code. Additions or modifications may be done on this structure while the present Code is in

effect. After the additions and modifications are made, the structure must meet the applicable Code requirements. If the structure was not modified to meet the present Code, then the structure must be in compliance with the applicable Code that resulted from the previous work done when the 1990 Code was in effect. If the installation was updated to meet the rules in the present Code, then the present Code is the applicable Code. Neither the 1984 Code nor the 1990 Code may be used as the applicable Code for this installation.

A new rule was added in the 2017 Code to the application rules to allow addition or modifications to a structure that does not comply with the applicable rules. If the addition or modification does not create a structural, clearance, or grounding noncompliance or will make an existing noncompliance worse, then the addition or modification is allowed before the noncompliant condition is corrected. The rules requiring inspections, testing, and correcting noncompliant conditions are still in effect and are not affected by this rule.

The application rule also requires the current inspection and work rules to be used on new and existing installations. This rule was added to require work on existing lines and equipment be done using the up-to-date work rules instead of the work rules in effect when the installation was constructed or modified. Inspection and work rules shall always be applicable to the current edition even though the applicable edition for the installation may be a previous edition of the Code.

Rule 014 (Waiver for emergency and temporary installations) specifies what can be done to restore service during an emergency or to provide service during an emergency and what are the requirements for temporary installations.

The rule allows emergency installations to meet lower clearances for overhead lines and the use of underground cable to be laid on the ground to provide or restore service quickly and safely. Generally emergencies occur when disastrous storms cause severe damage to overhead lines and equipment that necessitates abnormal yet safe construction to restore service to the affected area. The emergency installations must be replaced as soon as practical after the emergency has ended.

Temporary installations are done to provide service during construction of residences, buildings, or other large construction projects where utility service is required for construction. Temporary lines may be required to provide clearances for roadway or bridge construction. Temporary lines may be built using less than normally specified strength materials, but the overhead lines must meet the clearance requirements. There are no time constraints on temporary installations.

Rule 015 (Intent) explains what is required when the Code uses the action words “shall” and “should,” which can be found in the rules throughout the Code. The rule also defines the effects of footnotes, *EXCEPTIONs*, *RECOMMENDATIONs*, *EXAMPLEs*, and *NOTEs* that may be added to the rules.

Rule 016 (Effective date) states the date that this Code edition will become effective. This date is 180 days after the publication date which is usually August 1. Therefore, the effective date is usually the following February 1. The Code may be used during this six-month period if desired. The 180 days provides time for utilities to update their design standards and for regulatory authorities to review and approve the Code.

Rule 017 (Units of measure) explains that numerical measurements in the Code are stated in the metric system and the customary inch, foot, and pound measurements. The metric measurements are shown first, and the customary measurements are shown next in parentheses. Tables that are relatively large are separated into metric tables, which are labeled with the letters **m** or **mm**, and the customary unit tables are labeled with the letters **in** and **ft**. The numbers in the tables are not exactly the same since the values are rounded off to convenient numbers; generally 1 decimal place is used in the customary unit tables, and 2 decimal places are used in the metric tables. For example, the clearance between an overhead electric supply conductor energize at 120 volts and a communication cable is 1 meter in the metric table and 40 inches in the customary unit table; the difference between the actual measurements is less than 0.5 inches. Both are considered equivalent and safe.

Rule 018 (Method of calculation) requires the resultant of calculations to be rounded off to the nearest significant digit unless the rule specifies a different method.

The rules of the NESC detail the requirements that are practical and necessary to reduce exposure to known or expected hazards to personnel or equipment. To that end, the NESC Subcommittees have been diligent in the development and analysis of data concerning (1) the construction, operation, and maintenance of lines and equipment and (2) the problems and benefits of each method.

The Code is prepared by a diversified group of active participants; they represent a wide variety of public and industry viewpoints and bring to the codification process a great depth of experience covering the entire field of utility system construction, operation, maintenance, and use. The process is public, and proposed changes are widely distributed, so that interested parties may comment and

provide additional data. These rules, therefore, reflect the considered judgment of a wide body of expertise. The rules are reviewed on a regular basis; they are revised, as necessary, to reflect changes in materials or methods and, as experience indicates, to recognize changes in the nature and degree of problems presented.

010. Purpose

A. The purpose of the NESC is the practical safeguarding of persons and utility facilities during the installation, operation, and maintenance of electric supply and communication facilities, under specified conditions.

NOTE: NESC rules are globally recognized and intended to provide a practical standard of safe practices that can be adopted by public utilities, private utilities, state or local utility commissions or public service commissions, or other boards or bodies having control over safe practices employed in the design, installation, operation, and maintenance of electric supply, communication, street and area lighting, signal, or railroad utility facilities.

B. NESC rules contain the basic provisions, under specified conditions, that are considered necessary for the safeguarding of:

1. The public,
2. Utility workers (employees and contractors), and
3. Utility facilities.

C. This Code is not intended as a design specification or as an instruction manual.

Rule 010. *(This rule was formed in 1981 from previous Rules 100, 200, 202, 210, 211, 300, 310, 311, and 400.)*

In the 1977 Code and later editions, it is made clear by choice of wording that the purpose of these rules is the practical safeguarding of persons during the installation, operation, or maintenance of overhead and underground supply and communication lines and their associated equipment. The NESC Subcommittees made every effort to emphasize that it is not merely enough that an installation be *possible*—it must be *practical* as well—to qualify as a requirement of the Code. It is unfortunate that earlier editions sometimes used the word “practicable” and that some individuals instigating legal actions have tried to infer that the word was intended to convey the meaning “possible.” It is clear from the official Discussion of the very earliest codified edition, the 1916 Code, that general practicality of installation was intended. This emphasis on “practicality,” as opposed to the extreme requirement of “possibility,” is especially noted in Rule 202 (Design and Construction) of the 1916 Code and its Discussion. The language of that rule is as follows: “*202—Design and Construction. All electrical supply lines and equipment shall be of suitable design and construction for the service and conditions under which they are to be operated, and all lines shall be so installed and maintained as to reduce the life hazard as far as practicable.*”

The language of the 1916 Code Discussion is as follows: “*This rule...strikes the keynote of the code. There is no intention of requiring or even recommending more expensive construction than good practice requires and good business justifies. But it must be remembered that the public in the end pays whatever extra cost is caused by requiring safer and better construction, and hence the public may rightly require a good degree of safety in the construction...*”

Rules 101, 201, and 301 of the 1920 Code and later editions included either exactly or substantially the following language: “*The rules shall apply to all installations except as modified or waived by the proper administrative authority. They are intended to be so modified or waived whenever they involve expense not justified by the protection secured, or for any other reasons are impracticable; or whenever equivalent or safer construction can be more readily provided in other ways.*”

It is clear that the original codifiers intended to achieve a reasoned balance between the public’s needs for both safe and economical utility service, reflecting both the expected degree of a problem and the degree of difficulty in solving the problem. That balance has been continued in the intervening years, as operating conditions have changed and new equipment and installation types have become available. Although these words no longer appear in the NESC, their effect does. The practical experience of the intervening years has led to the inclusion of more stringent requirements in some

areas and more relaxed requirements in others. As a result, the NESC is itself the compilation of design, installation, operation, and maintenance requirements that have been shown over the entire history of utility construction to be appropriate to “reduce the life hazard as far as practicable.”

The NESC comprises specific actions required in recognition of specific conditions. These actions are based upon the potentially conflicting activity that is normally encountered or reasonably anticipated. For example, in all areas except those limited to pedestrians or restricted-height vehicles, the clearances above grade plan for a 4 m (14 ft) high truck (see NESC Appendix A). Vertical clearances are based upon the reference distance based on potentially conflicting activity plus the clearance building block that includes appropriate mechanical and electrical components based upon the part, conductor, or cable above the area. Where the conditions encountered in a given local situation are those specified within the NESC, the required actions constitute good practice for the specific conditions.

Where the local conditions differ in some particular way from those specified in the NESC, it is the responsibility of the appropriate party to recognize the differences in conditions with actions that constitute good practice under such differing conditions. Such practice may be reflected in the design of the installation, the construction practices, the maintenance practices, the operating practices, or some combination of the above, as applicable for the given local conditions. An example of such an area is a lumber yard, where fork lifts are normally encountered or reasonably anticipated with vertical extensions exceeding a 4.0 m (14 ft) truck. In such a case, the expected height of the forklift can be added to the appropriate mechanical and electrical component from Table A-1 of NESC Appendix A to produce the appropriate clearance. However, the better way to perform the same task would be to add the difference between the expected conflicting activity and the applicable reference dimension from NESC Appendix Table A-1 (i.e., a 4.0 m [14 ft] truck in this case) to the clearance in the applicable table, thus recognizing the difference in conditions. The result is the same, but it avoids any problem with pulling the wrong mechanical and electrical component from NESC Appendix Table A-2, which is a more complicated table than Table A-1.

It is important to note that the NESC recognizes the limitation on expected activities around electrical facilities required under federal and state regulations, Occupational Health and Safety Administration (OSHA) regulations, and high-voltage line safety acts. Those performing acts around power lines have a personal responsibility to plan and control their actions so as to avoid contact with power lines.

The rules for lines differ from those for stations. In stations, the apparatus, equipment, and wires are confined to limited areas where access is restricted to trained personnel. In these latter cases, the safeguarding of persons by (1) actual enclosure of the current-carrying parts, (2) use of barriers, or (3) elevation of such parts beyond reach is not only desirable but generally feasible.

With overhead lines, on the other hand, the wires and equipment are not confined to limited areas and, with few exceptions, are not under constant observation by trained personnel. Safeguarding by enclosure is feasible with underground lines and, in fact, is in most cases essential to operation. For overhead lines, however, isolation by elevation generally must be depended upon for the safety of persons in the vicinity. The elevations required for effective isolation of overhead lines must be greater than ordinarily would be required inside buildings; the voltages are usually higher, and the height of expected traffic is usually greater.

Practice and experience have determined reasonable limits for elevation of lines and equipment and for the necessary strength of their construction. These rules are intended to include the more important requirements from the standpoint of safety, both to the public and to utility workers. Clearance requirements are determined relative to the degree of hazard involved, and strength requirements necessary to meet the required clearances are determined by (1) the degree of safety problem presented by the installation and (2) the mechanical loads to which it is assumed the lines may be subjected.

The NESC is a performance code, not a set of design specifications. The NESC construction rules specify *what* is to be performed, not *how* it is to be accomplished. For example, to meet the vertical clearance required above a corn field, either (1) taller structures spaced farther apart or (2) shorter structures spaced closer together may be used. The NESC is indifferent to what type of structures or materials are used, as long as applicable clearances and strength requirements are met.

In essence, the rules of the NESC give the basic requirements of construction that are necessary for safety. If the responsible party wishes to exceed these requirements for any reason, he may do so for his own purpose, but need not do so for safety purposes. For example, if the combination of required pole placement and overhead clearance requirements indicated that a 11.4 m (37.5 ft) pole would be needed, a 12.2 m (40 ft) pole could be used. Because poles are inventoried in 1.50 m (5 ft) increments

for economy purposes, the additional 0.8 m (2.5 ft) of conductor attachment height would be for economy purposes; it is not required for safety. Thus, even though older editions of the Code sometimes used the word “minimum” for clearance or other requirements, the wording generally used in later editions is “not less than” to indicate the basic amount that is required for *safety* purposes.

The 1990 Code was specifically editorially revised to delete the use of the word “minimum” because of intentional or inadvertent misuse of the term by some to imply that the NESC values were some kind of minimum number that should be exceeded in practice; such is not the case. The NESC is the best information that we have available about what needs to be done for safety and what must not be done in various circumstances; it is based on the experiences of hundreds of thousands of installations located in and serving areas with a variety of conditions in a variety of ways. The NESC is *the* national standard for safety in the installation, maintenance, and operation of electric supply and communication system facilities.

Rule 010 is a general statement of the purpose of the Code; the bulk of the rules are concerned with applying this principle in detail to the various construction situations. Where a specific rule provides detailed requirements for particular conditions, the general “purpose” rule is considered to be superseded by the specific requirements.

NOTE: Where an individual rule or subrule consists of an overarching paragraph and several distinctive subparts, both the overall requirements and the applicable subrequirements must be met.

The 2012 Code significantly revised the language of Rule 010 by adding “affected property” and “utility facilities” to the purpose rule as a result of a joint NESC/NEC Task Force that addressed the Purpose and Scope rules of both the NESC and the NEC to limit confusion as to which code applies in different circumstances. The 2017 Code further clarified the language by removing the verbiage “affected property” from the purpose rule due to its being vague and not fully understood.

011. Scope

A. Covered

See Figure 011-1.

The NESC covers:

1. Supply and communication facilities (including metering) and associated work practices employed by a public or private electric supply, communications, railway, trolley, street and area lighting, traffic signal (or other signal), irrigation district or other community owned utility, or a similar utility in the exercise of its function as a utility.
2. The generation, transmission, and distribution of electricity, lumens, communication signals, and communication data through public and private utility systems that are installed and maintained under the exclusive control of utilities or their authorized representatives.
3. Utility facilities and functions of utilities that either (a) generate energy by conversion from some other form of energy such as, but not limited to, fossil fuel, chemical, nuclear, solar, mechanical, wind, or hydraulic or communication signals or accept energy or communication signals from another entity or (b) provide that energy or communication signals through a delivery point to another entity.
4. Street and area lights that provide a supply of lumens where these facilities are supplied from the line side of the service point by underground or overhead conductors maintained and/or installed under the exclusive control of utilities (including their authorized contractors or other qualified persons).
5. Utility facilities and functions on the line side of the service point supplied by underground or overhead conductors installed and/or maintained under exclusive control of utilities located on public or private property in accordance with legally established easements or rights-of-way, contracts, other agreements (written or by conditions of service), or as authorized by a regulating or controlling body.

NOTE: Agreements to locate utility facilities on property may be required where easements are either (a) not obtainable (such as locating utility facilities on existing rights-of-way of railroads or other entities, military bases, federal lands, Native American reservations, lands controlled by a port authority, or other governmental agency) or (b) not necessary (such as locating facilities necessary for requested service to a site).

6. Wiring within a supply station or in an underground facility that is (a) installed in accordance with Part 1 or Part 3 of this Code and maintained under the exclusive control of utilities and (b) necessary for the operation of the supply station or underground facility.
7. Utility facilities installed, maintained, and controlled by utilities on surface or underground mine sites, including overhead or underground distribution systems providing service up to buildings or outdoor equipment locations on the line side of the service point.
8. Similar systems to those listed above that are under the exclusive control of qualified persons and authorized by a regulating or controlling body, including those associated with an industrial complex or utility interactive system.

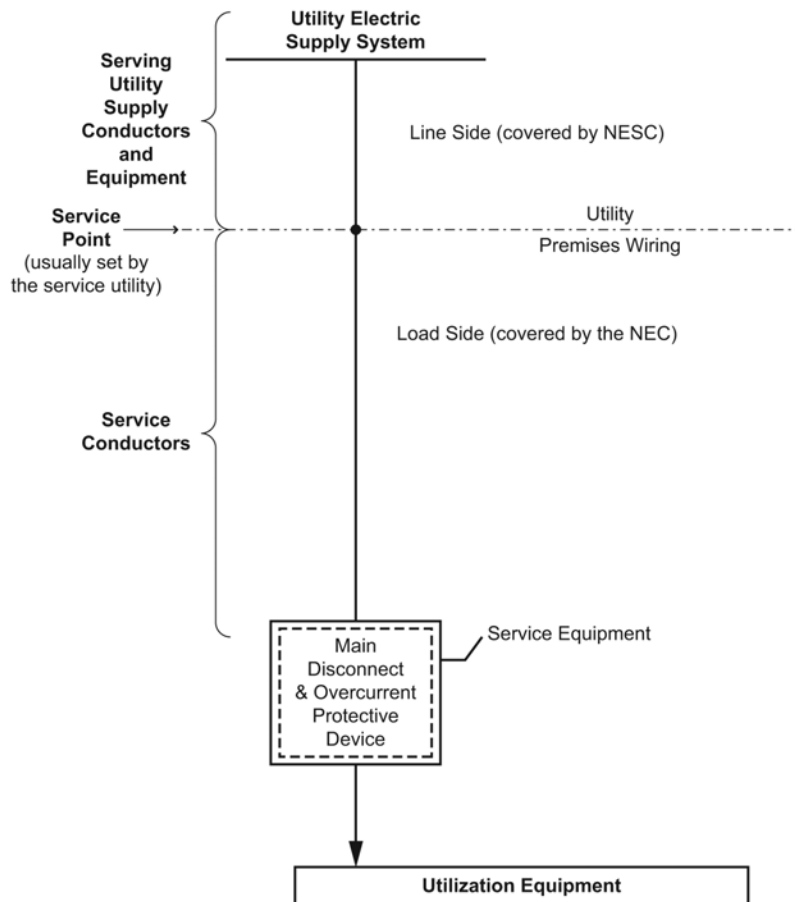


ILLUSTRATION
UTILITY ELECTRIC SUPPLY AND
PREMISES WIRING

Figure 011-1—Service point—General illustration of what is covered and not covered by the NESC

B. Not covered

See Figure 011-1.

NESC rules do not cover:

1. Utilization equipment or premises wiring located beyond utility service points to buildings or outdoor installations, or
2. Underground mine wiring or installations in ships, railway rolling equipment, aircraft, or automotive equipment, or
3. Luminaires not installed or maintained under exclusive control by utilities, or
4. Industrial complex or utility interactive systems that are not controlled exclusively under utilities or qualified persons or are located on the premises wiring side of the service point.

NOTE: The National Electrical Code[®] (NEC[®]) (NFPA 70[®], 2011 Edition) covers utilization wiring requirements beyond the service point and luminaires that are not controlled exclusively by utilities.¹

C. Types of requirements

1. These rules specify:
 - a. Loadings and factors related to required strength of utility structures and supported facilities;
 - b. Clearances and spacings between: (1) facilities of different utilities, (2) facilities of same utility, and (3) utility facilities and public facilities;
 - c. Grounding; and
 - d. Other requirements related to the safeguarding of persons and facilities, including associated safe work practices, to be employed by a utility in the exercise of its function as a utility up to the service point.
2. Utilities operating under the NESC are required to maintain control over the system up to the service point such that:
 - a. The system is designed to meet the requirements of specified conditions, and
 - b. The personnel installing, maintaining, and operating the system and its components are qualified to do so, are adequately supervised, use appropriate tools, and follow safe work procedures.

Rule 011. *(This rule was formed in 1981 from previous Rules 101, 201, and 301.)*

This rule details the coverage of the NESC. The Code covers supply and communication lines, equipment, and associated work practices employed by a *public* or *private* electric supply, communications, railway, or similar utility in the exercise of its function as a utility. The NESC no longer covers electric fences, radio installations, or utilization equipment [see the National Electrical Code[®] (NEC[®])] except as covered in Part 1 or Part 3. It does not cover mines, ships, aircraft, automotive equipment, or railway rolling stock. (Refer to the edition of the NEC called out in the applicable edition of the NESC.)

The difference between the facilities involved in the *utility* function (covered by the NESC) and those involved in the *utilization* function (covered by the NEC) was amplified in the 1990 Code. This language was again revised in the 1993 Code to clearly state that these requirements apply to *public* and *private* utility systems.

In the 1980s and early 1990s, electricians started a controversy over whether area lights installed by an electric utility and fed off the distribution system could only meet the NESC or had to meet the NEC. Such installations have always been covered by the NESC and exempted from the NEC. The 1996 NEC revised its Article 90-2(b)(5) to exclude lighting associated with an electric distribution system that is under the exclusive control of an electric utility and is located on or along public highways, streets, roads, etc., or outdoors on private property by established rights such as easements. As a practical matter, customers generally grant either specific or “blanket” easements to utilities when applying for area lighting. If the electrical system feeding the lighting comes directly off the utility distribution system, it is clear that the NESC applies to such installations. However, if the lights are fed off the customer service entrance equipment, or if the customer has access to a switch to control the lighting, the NEC will govern. This was clarified in Rule 011C of the 2002 NESC.

¹Information on references can be found in Section 3.

Both the NESC and the NEC cover some equivalent facilities, such as service drops, because they could be maintained by the customer or the utility. Depending upon local ordinances, if the installation is under qualified control (such as in some large industrial and large commercial complexes), the utility delivery system portion of such installations would be entirely under the NESC until such point as they connected to the utilization wiring system (such as at a building weatherhead on an aerial service), at which point the NEC would take over.

Historical NOTE from Editor Allen Clapp: The utility functions of private utilities have always been covered by the NESC since its inception. Ralph M. Lee, my predecessor as chair of the NESC, was employed by DuPont and nationally recognized as an expert in application of the NESC to the internal generation and distribution of power (and signals) in large industrial plants, as well as an expert in appropriate safety rules for work on distribution and transmission voltage systems. Mr. Lee is the foremost example of many employees of large industries who have (1) designed, constructed, operated, and maintained their private utility facilities to meet the requirements of the NESC, (2) regularly contributed to the scientific improvement of safe utility system designs and work methods, and (3) contributed to the improvement of the NESC throughout its history.

In 2002, the NESC added an explanatory note under Rule 011B referencing the *service point* as the point where the NEC picks up from the NESC. The service point (point of delivery) between the NESC- and the NEC-covered facilities is easy to determine for overhead service. The connectors form the service point between the NESC-covered utility service drop conductors and the NEC-covered premises-wiring service entrance conductors located at the weatherhead. The NEC allows the NESC-covered utility meter to be located in the NEC-covered service entrance conductor run and, in a fine print note (FPN), exempts the metering from NEC application.

In an underground service, the underground service cable can be under either code, depending upon ownership and control. In a typical installation where the utility installs the service drop cable underground from the transformer (or underground secondary bus cable) to the building and brings it up to the meter base, the service drop is covered by the NESC. If the customer ran the cable from the building out to the utility transformer *and maintained ownership and control over the service drop*, the NEC would govern. In some situations, the customer's electrical workers will initially install the underground service cable out to a utility transformer pad and the customer will transfer ownership to the utility which will own, control, and maintain the service drop from then on. In such cases, the NESC applies.

The 2012 Code significantly revised the language of Rule 011 to more fully reflect the practical scope of the NESC that has existed since its inception. These revisions were the result of considerations by a joint NESC/NEC Task Force that addressed the Purpose and Scope rules of both the NESC and the NEC to limit confusion as to which code applies in different circumstances. By fleshing out the language of each of the codes with more detail about the respective scopes, each of the codes will aid its users in better understanding the differences in intended application.

The NESC addresses utility system installations under the exclusive control of utilities. The NEC addresses utilization wiring and premise wiring systems, as well as other systems not under the exclusive control of a utility.

Part of the confusion results from the fact that both codes must address certain types of facilities and installations, because those facilities might be under the exclusive control of a public or private utility in one instance (in which case, the NESC applies) and might *not* be under exclusive control of a utility in another instance (in which case, the NEC applies).

For example, consider the question of whether the NESC or the NEC applies to service drops in a situation in which a utility secondary cable runs from a line pole out at the road to a center pole in a farm yard and individual service drops run from the center pole to each barn or other building. If the utility installs and maintains the service drops under its exclusive control, the NESC applies to the service drops. However, if the center pole is a meter pole and the farmer runs service drops to the farm buildings, those service drops are not under exclusive utility control and the NEC applies to the service drops.

Similarly, if a utility installs and maintains area lighting under its control, the NESC applies. However, if the customer requests that 120 V outlets be placed at the base of each luminaire structure to allow the use of electric weed trimmers, etc., the system is not under exclusive control of a utility and the NEC applies.

The 2012 Code language revisions also recognized that provision of lumens from luminaires is different from provision of electricity; the systems for each are subject to NESC requirements if under the exclusive control of a public or private utility and on the line side of the *service point*. Extensive

revisions, including lists of applicable utilities and facilities and a new Figure 011-1 were added to Rule 011 to clearly indicate what is covered by the NESC and what is not covered by the NESC to help limit confusion between the codes. These revisions are not changes in scope; rather, they are clarifications to answer questions that have arisen in the past few years. The 2017 Code further clarified that the NESC applies to underground and overhead facilities located on the line side of the service point under exclusive control of utilities.

The 2017 Code modified Rule 011A3 in response to IR 572 issued 28 May 2013 to clearly show that solar and wind farm generation under exclusive control of a public or private utility are included along with more traditional forms of generation in the scope of the NESC.

012. General rules

- A. All electric supply and communication lines and equipment shall be designed, constructed, operated, and maintained to meet the requirements of these rules.
- B. The utilities, authorized contractors, or other entities, as applicable, performing design, construction, operation, or maintenance tasks for electric supply or communication lines or equipment covered by this Code shall be responsible for meeting applicable requirements.
- C. For all particulars not specified, but within the scope of these rules, as stated in Rule 011A, construction and maintenance should be done in accordance with accepted good practice for the given local conditions known at the time by those responsible for the construction or maintenance of the communication or supply lines and equipment.

Rule 012. *(This rule was formed in 1981 from previous Rules 102, 200, 201, 202, 210, 211, 300, 303, 310, and 311.)*

Rules 012A and 012C were in one paragraph until Rule 012B was added in 1993. The required construction is intended to be in accordance with good practice and, indeed, to set a standard of good practice in many respects: see Rule 012A. Safety is promoted by uniformity in practice; this, in turn, tends to avoid confusion and misunderstanding, both in construction and operation.

It is not sufficient to provide only against possible hazards in new construction. Deterioration in materials of construction makes it essential that adequate safety be preserved by inspection and maintenance. Certain rules in Section 26 specify quantitatively the amount of deterioration permissible before replacement but, in general, this must depend upon the good judgment of those in charge. This subject is further considered in Rule 214.

When Rule 012 was created in the 1981 Code from prior similar rules located in the different parts of the Code, it was specifically reworded to the current language to remove references to “conditions under which the line is to be operated.” The previous language had been misinterpreted by some to mean that utilities, as agents of the ratepayers, were required to provide clearances for any activity that could possibly occur. It must be recognized that it is not only impractical but absolutely impossible to provide special clearances or other construction for every location where it is *possible* for a negligent or impaired human to contact a utility installation with a vehicle or with a crane, antenna, metal ladder, extended paint-roller handle, irrigation pipe, portable conveyor, or other special apparatus. See additional discussion under Rule 010.

The 1997 Code further clarified this issue in Rule 012C by requiring good practice for the *conditions known at the time* by those responsible for the construction or maintenance of the communications or supply lines and equipment. In essence, if the utility has knowledge that a condition not specified in the Code will be normally encountered or is reasonably anticipated, the utility should use good practice to reflect the differences (if any) in those conditions and those specified in the Code. On the other hand, the utility cannot be expected to be clairvoyant.

The requirements of the NESC apply to the entity performing the work. Rule 012B recognizes that many public and private utilities contract with another party to perform some or all work, often including supervision and inspections, relating to a particular job. Although recognized by the codifiers for decades, the responsibilities of contractors (rather than owners or operators in many cases) to meet NESC requirements was explicitly stated for the first time in the 1993 Code.

The 2017 Code clarified that Rule 012C applies to particulars not specified in the NESC but within the scope of the Code that is stated in Rule 011.

013. Application

Rule 013. (This rule was formed in 1981 from previous Rules 102, 202, and 302).

A. New installations and extensions

1. These rules shall apply to all new installations and extensions, except that they may be waived or modified by the administrative authority. When so waived or modified, safety shall be provided in other ways.

EXAMPLE: Alternative working methods, such as the use of barricades, guards, or other electrical protective equipment, may be implemented along with appropriate alternative working clearances as a means of providing safety when working near energized conductors.

2. Types of construction and methods of installation other than those specified in the rules may be used experimentally to obtain information if:
 - a. Qualified supervision is provided,
 - b. Equivalent safety is provided, and
 - c. On joint use facilities, all affected joint users are notified in a timely manner.

Rule 013A. Rule 013A directly recognizes that *if* there is a controlling authority such as a state public utility commission, such authority *may* have the right to waive or modify NESC rules in their jurisdiction. The provisions now found in Rule 013A have changed over the years as more specificity has been added in the NESC as to expected actions under various conditions. For example, the limits imposed on clearances and strengths of emergency and temporary installations are now specified in Rule 14 and Rule 230A. The requirements of the NESC have been well planned to consider the full effects of these actions under the specified circumstances; Rule 013A1 thus requires equivalent safety to be achieved using other methods, systems, work methods, etc., when an NESC rule is modified by an administrative authority. The *EXAMPLE* was added in the 1993 Code.

Rule 013A2 is not intended to allow a utility system operator to disregard these rules. It recognizes the need for experimentation with new methods, systems, etc. It requires qualified supervision. The 2002 Code required equivalent safety and agreement between all parties involved for experimentation to occur in or on a facility.

The 2012 Code revised Rule 013A2c to *notify* all *joint-users* in a timely manner when experiments will be performed on joint-use facilities. Agreement is no longer required, as a result of issues relating to competitors being able to delay each other for reasons other than safety. Notification allows a joint user who believes that it may be adversely affected in the way of safety to work with the experimenting utility to limit adverse safety impacts.

B. Existing installations

1. Where an existing installation meets, or is altered to meet, these rules, such installation is considered to be in compliance with this edition and is not required to comply with any previous edition.
2. Existing installations, including maintenance replacements, that currently comply with prior editions of the Code, need not be modified to comply with these rules.

EXCEPTION 1: For safety reasons, the administrative authority may require compliance with these rules.

EXCEPTION 2: When a structure is replaced, the current requirements of Rule 238C shall be met, if applicable.

3. Where conductors or equipment are added, altered, or replaced on an existing structure, the structure or the facilities on the structure need not be modified or replaced if the resulting installation will be in compliance with either (a) the rules that were in effect at the time of the original installation, or (b) the rules in effect in a subsequent edition to which the installation has been previously brought into compliance, or (c) the rules of this edition in accordance with Rule 013B1. When an existing installation is brought into compliance with a subsequent edition, earlier editions no longer apply.

4. For structures that currently do not comply with Rule 013B3, if adding a new item, or replacing or rearranging existing items would not in itself, either (1) create a structural, clearance, or grounding non-conformance, or (2) worsen an existing non-conformance, then the addition, replacement, or alteration may be performed prior to correcting existing non-compliance items. For existing non-compliance items, see Rules 214A4 and A5.

Rule 013B. If the existing installation is old enough, the Code edition in effect at the time of the original construction may no longer be allowed to apply. (Before the addition of the so-called *grandfather clause* in the 1970s, each new edition required all existing installations to meet the new edition or be guarded—which effectively made it meet the new edition.) Further, if a later edition has been applied to an existing installation, the earlier edition has effectively been removed from the available choices, because the intention is to move forward in application, not backward.

As increased experience with supply and communication installations has matured the Code over the years, and as formerly nonconforming installations have been retired or replaced, the Code requirements relating to reconstruction of facilities have reflected these changes. For example, Rule 201B (Realization of intent) of the 1968 Code and prior editions indicated that the new rules should be applied “in full to all new installation, reconstructions, and extensions, except where for special reasons any rule is shown to be impracticable or where the advantage of uniformity with existing construction is greater than the advantage of construction in conformity with” the new rules. The obvious intention was to discontinue outdated construction practices and to apply the new Code when adding or altering conductors or equipment, except in special cases. As in previous editions, the 1968 Code continued the use of Rule 201A (Intent, modification), which stated the intention that the rules should be “modified or waived whenever they involve expense not justified by the protection secured or for any other reasons are impracticable; or whenever equivalent or safer construction can be more readily provided in other ways.” See the discussion of Rule 010.

One of the reasons for the particular wording of old Rules 201A and B (and the similar rules in the other parts) was that lines that dated from the pre-Code era still existed in many areas of the country. As a result, essentially all overhead facilities built before the 1977 Code should be expected to be in conformance with the requirements of the 1968 Code.

The revision of Part 1 (Installation and Maintenance of Electric Supply Stations and Equipment) in the 1971 Code required application of the rules “in full to all new installations, alterations, reconstructions, and extensions.” In short, the new edition was intended to apply to any installation that was not limited to maintenance replacement, except that this was the first revision that allowed the so-called *grandfather clause* to be applied to existing electric supply station installations when the code edition changed (see Handbook Appendix E).

When the 1973 Code created Part 3 (Installation and Maintenance of Underground Electric Supply and Communication Lines), it also added a grandfather clause for underground lines. Similarly, the 1977 Code added the grandfather clause for overhead lines (see Handbook Appendix E).

The revision of Part 2 in the 1977 Code recognized the maturing character of the utility industries. Although Rule 202B of the 1977 Code continued to use language similar to that of old Rules 201A and 201B, the 1977 Code restricted the use of waivers with Rule 0601813801202C (Waiver), which only allowed waiver “in cases of emergency, temporary installations, or installations which are soon to be discarded or reconstructed...”

In the 1981 Code, the applicability rules of the various parts of the NESC were consolidated into a new Section 1 (Introduction to the National Electrical Safety Code) and several word changes were made. In Rule 013A, the successor to old Rule 202B1, the word “reconstruction” was dropped; this word had only caused confusion between maintenance replacements (which are not intended to be required to be subject to a new code provision) and new installations and extensions (which are subject to new code requirements). In Rule 013B, the successor to old Rule 202B2, a new paragraph 013B2 was added.

Rule 013B3 (Rule 013B2 of the 1981–1987 Codes) was intended to state the intention of the Code with respect to *other* facilities when conductors or equipment of the Code are added, altered, or replaced on an existing structure. This entire area of the Code was editorially revised in the 1990 Code to clearly indicate the requirements that have been intended since 1977. Rule 013B1 now reflects that the latest edition contains the best knowledge of appropriate requirements. If an installation meets the present requirements, it is acceptable—regardless of what provisions may have been in effect at the time of its construction. Thus, when work on an existing structure is completed, it may meet the current edition requirements or those of a previous applicable edition.

The addition of new facilities does not require changing the existing line facilities, as long as the existing facilities (including the structure itself), *after the new addition*, still meet the strength, clearance, and other requirements of an earlier edition of the Code that is applicable *even if the existing facilities do not meet present code requirements*. However, if for example, the structure or the supply conductors would not, after the addition of communication cable, meet the grade of construction and strength requirements of the edition of the Code that was in effect at the time of their installation, the addition would not be allowed. If a problem exists in obtaining required clearances from existing facilities, nonconforming existing facilities may be moved on the existing structure. If the latter is the case, the modification is required to meet the Code requirements of the applicable edition unless the structure is replaced with a larger, stronger, or taller unit (see below).

The language of Rule 013B3 was carefully chosen to require that the *resulting installation* meet the applicable edition whenever conductors or equipment are added, altered (rearranged), or replaced on an *existing structure*. The two key issues are:

- (1) The rule only applies whenever an existing structure is being modified by the addition or replacement of conductors or equipment or facilities on an existing structure are being moved around (such as moving a neutral up or communication cable down to accommodate another communication cable). If a new structure is required to provide the necessary strength or clearances, Rule 013A applies and the current edition must be used. If an existing structure is being replaced as a maintenance replacement under Rule 013B2 as a matter of convenience while the other work is being performed, the previously applicable edition may still be used for the resulting installation.
- (2) When the work is complete, the entire *resulting installation* must meet the applicable edition of the NESC.

This language was added to address two issues. First, one code edition must be used for the whole structure, including all of its supported facilities; installers cannot selectively pick code provisions from different editions.

Second, the whole installation needs to be inspected for potential problems, such as conductors with excess sag/pulled too tight or out of place, broken insulators, loose guys, etc., that might affect code compliance and present a potential safety hazard to public personnel around the installation or the next workers on the installation. This requirement is a complement of Rules 121A, 214A2, and 313A2, as well as Rule 230I, and it helps to limit the opportunity for changes or damage that occur after initial installation to cause a later problem.

If the existing structure is replaced in kind, regardless of the reason, it is generally considered maintenance; it may be replaced without affecting other existing facilities, if the resulting installation would conform to the applicable edition of the Code. Existing transformers may be replaced with larger transformers if the strength requirements of the applicable Code edition are met. The fact that several structures or other installations within an existing line or section are replaced at one time does not negate this allowance, except that Rule 202 requires a replaced structure to meet the current edition of Rule 238C.

However, replacement with stronger, larger, or taller units to meet strength or clearance requirements related to an addition(s) to the structure(s) is not considered maintenance and, therefore, requires conformance to the current Code requirements. Existing facilities may be rearranged on an existing or maintenance replacement structure as long as they meet the requirements of the applicable edition.

A frequent question concerns the appropriate edition for facilities that are temporarily relocated for highway reconstruction work. If trenches are dug beside the poles and the pole butts are kicked over to the new location, the previously applicable edition applies; if new structures are used, the current edition applies.

This rule plainly states the intentions of the Code with respect to application of new or revised rules to existing installations. It should be stressed that, in general, the edition of the NESC that is applicable to a given installation is the edition that was in effect at the time of construction (see Rule 016). In later years, a subsequent edition will be applicable if the facilities are “upgraded.” A change of voltage of an existing line does not affect the applicable edition unless the change cannot be made under the applicable older edition; if the structures need to be changed out to accommodate the voltage change, the current edition would then apply. The utility always has the option of meeting current requirements, whether current requirements are the same, greater, or lesser than those in effect at the time of original construction or a subsequent applicable edition.

In the 1993 Code, the word *currently* was added to Rule 013B2 to eliminate confusion with the so-called “grandfathering” of existing installations. See the discussion of Rule 230I and Handbook Appendix E for more detail.

The intention of the Code is that good practice be met for the conditions in place. For example, the designer of a line crossing a roadway can either install the line with enough extra clearance to allow for future road resurfacing or can plan to raise the line when the resurfacing occurs. A line over water must meet the requirements for sailboat clearances, if sailing is expected. If such a line originally was over pasture land that is now flooded, and the original structures were tall enough to allow the installation to meet good practice for sailboating areas, the previously applicable edition can remain applicable if so desired. Otherwise the structure would need to be changed out to meet the present edition.

Interpretation Request 548 issued 26 March 2009 reinforced the discussion of the intent of *resulting installation* given above and also addressed whether planned work can be performed before an identified noncompliant facility is corrected. Rule 013B3 was amended in the 2017 Code to clarify that such work can only be performed before correction of the noncompliant defect or condition if (1) it would not make the original noncompliance worse or create a new noncompliance and (2) the identified noncompliance was not a structural issue of a significant nature. If the identified problem is a significant structural issue, it must be corrected before the planned work is performed. In the 2017 Code, Rule 013B3 was also modified in response to IR 548 to clearly indicate that, when an installation is brought into compliance with a later edition of the NESC, the provisions of the later edition then apply and any previous edition to which the installation may have earlier complied no longer applies.

C. Inspection and work rules

Inspection rules and work rules in the current edition of the NESC shall apply to inspection of or work on all new and existing installations.

Rule 013C. The 2007 Code added this rule to clarify which inspection rules and work rules apply to both existing and new facilities. Rule 013A requires the use of the current edition for physical construction attributes of new facilities. Rule 013B1 allows the current edition to be used for the physical construction attributes of existing facilities built before the current edition, if so desired, but it does not mandate using the current edition. Rule 013B3 allows a choice of the current edition or the previously applicable edition for the physical construction attributes when adding, altering, or replacing facilities on existing installations. However, regardless of which edition of the NESC is being used for the physical construction requirements (such as location, clearances, grounding, loadings, strengths, etc.) against which existing facilities are inspected, the inspection requirements contained in the current edition shall be used to determine the responsibilities of the utility(ies) involved. Similarly, the work rules in the current edition must always be used, regardless of whether the work is on an existing or new installation. The grandfather clause of Rule 013B2 applies only to the physical attributes of the installations, not to the inspection or work methods.

014. Waiver for emergency and temporary installations

The person responsible for an installation may modify or waive rules in the case of emergency or temporary installations.

A. Emergency installations

1. The clearances required in Section 23 may be decreased for emergency installations. See Rule 230A.
2. The burial depth requirements in Part 3 may be waived for the duration of the emergency. See Rule 311C.
3. The strength of material and construction for emergency installations shall be not less than that required for Grade N construction. See Rule 263.
4. Emergency installations shall be removed, replaced, or relocated, as desired, as soon as practical.

B. Temporary overhead installations

When an installation is temporary, or where facilities are temporarily relocated to facilitate other work, the installation shall meet the requirements for non-temporary installation except that the strength of material and construction shall be not less than that required for Grade N construction. See Rule 263.

Rule 014. *(This rule was formed in 1981 from previous Rules 102, 202, and 302.)*

Although earlier editions of the Code allowed waivers to be given for the use of different construction requirements than those in the Code, the 1977 Code and later editions have specifically limited waivers to emergency or temporary installations. Before the 1977 Code, the Code was updated on a sporadic basis and an expanded waiver allowance was appropriate. However, with the maturation of the Code and its scheduled, frequent revisions, such waiver is no longer appropriate. Rule 013A2 allows experimentation; if the results are favorable and convincing, it is expected that such methods or conditions would be recognized by the Code as part of the frequent revision process.

In the 1990 Code, the limits of the waiver authority given under both emergency and temporary conditions were completely specified.

In both emergency and temporary conditions, strengths are required to meet Grade N. This recognizes that these installations are not expected to be in place long enough for significant deterioration to occur. In some cases, seasonal design loadings may not be expected. Grade N requires consideration of the loadings that are expected to occur during the life of the installation.

In *emergency* installations only, certain clearances are allowed to be reduced during the term of the emergency. The reduced clearances are specified for cables and for open supply conductors of 0–750 V. For *temporary* installations, no decrease in clearances is allowed.

Specifications for the reduced clearances allowed during emergencies were added in the 1990 Code; they were moved to Rule 230A in the 1993 Code. For open conductors above 750 V, the utility is allowed some flexibility; Rules 014A1b and 014A1c allow unspecified reductions, but *appropriate recognition to the difference in voltage* is required. This recognizes that the safety afforded by traffic signals and highway lighting during emergency times is often so great that it is worth the short-lived clearance changes to decrease the time required to reinstate these services.

The 2012 Code specifically allowed a waiver of burial depth requirements for underground cables during the term of an emergency, thus matching provisions in the existing Rules 230A2d and 311C.

015. Intent

- A. The word “shall” indicates provisions that are mandatory.
- B. The word “should” indicates provisions that are normally and generally practical for the specified conditions. However, where the word “should” is used, it is recognized that, in certain instances, additional local conditions not specified herein may make these provisions impractical. When this occurs, the difference in conditions shall be appropriately recognized and Rule 012 shall be met.
- C. Footnotes to a table are designated by a circle surrounding the footnote number. Footnotes to a table have the same force and effect that is required or allowed by the rule that specifies the use of the table.
- D. The word “*EXCEPTION*” indicates a specified option that may be substituted for one or more of the requirements stated in the rule or table, at the option of the utility. *EXCEPTIONS* to a rule have the same force and effect that is required or allowed by the rule to which the *EXCEPTION* applies.

NOTE: EXCEPTIONS recognize alternatives to generally applied requirements that are safe under the specified conditions. In some cases, an EXCEPTION may merely be a less frequently used safe option that may be preferable under the particular constraints of the site or work.

- E. The word “*RECOMMENDATION*” indicates provisions considered desirable, but that are not intended to be mandatory.

- F. The word “NOTE” or the word “EXAMPLE” used in a rule indicates material provided for information or illustrative purposes only. NOTES and EXAMPLES are not mandatory and are not considered to be a part of Code requirements.
- G. A RECOMMENDATION, EXCEPTION, or NOTE applies to all text in that rule above its location that is indented to the same level.

Rule 015. *(This rule was formed in 1981 from previous Rules 102, 202, and 302.)*

This rule clarifies the intent of the use of “shall,” “should,” “RECOMMENDATION,” “NOTE,” and “EXAMPLE.”

The difference between a “shall” requirement and a “should” requirement is, in essence, the difference between “possible” and “practical.” For a “shall” requirement, the requirement is expected to be met in all specified conditions. A “should” requirement recognizes that the requirement may not be practical in all cases; it is intended to be mandatory where practical. Where a “should” requirement is not practical, the installation should be designed, installed, and maintained in a manner that is consistent with the prevailing conditions and in accordance with Rule 012. The 2002 Code clarified that EXCEPTIONS have always been intended to have the same force and effect as the main rule. Similarly, footnotes to tables are an integral part of the table. It is only NOTES to rules and EXAMPLES to rules or tables that are purely informative and not considered to be part of the code.

The 2012 Code added explanatory information about footnotes in tables and EXCEPTIONS.

016. Effective date

This edition may be used at any time on or after the publication date. Additionally, this edition shall become effective no later than the first day of the month after 180 days have elapsed following its publication date for application to new installations and extensions where both design and approval were started after the expiration of that period, unless otherwise stipulated by the administrative authority. *EXAMPLE:* If the NESC is published on August 1, 2016, then it will become effective on February 1, 2017.

NOTE: A period of not less than 180 days is allowed for utilities and regulatory authorities to acquire copies of the new edition and to change regulations, internal standards, and procedures as may be required. There is neither an intention to require or imply that this edition be implemented before 180 days from the publication date, nor an intention to prohibit earlier implementation.

Rule 016. *(This rule was new in 1981.)*

This rule recognizes that the design and approval processes may be so lengthy for major facilities that it is impractical to make a change in design or construction in response to a revision of the NESC. Obviously, where responsive changes can be made before construction without undue burden, they should be made, but it must be recognized that they are not required if either design or approval was started before the effective date of the revision. This rule was initiated in the 1981 Code. The 180-day period before the effective date recognizes that a time lag is often required to obtain copies of the new editions, review standards, train workers, and implement the change. Previously no effective date was specified.

The 2012 Code relieved the user from having to calculate exact dates by moving the effective date to the first day of the month after the 180-day period has expired. It also prevented the often-asked question of whether the effective date was the 180th day or the 181st day (it is the next day after the 180 days, including the issue date, expired). This will be especially helpful if the Code is ever issued on a different date.

The new editions of the Code have always been intended to be able to be used when they are issued. The rule was revised in the 1990 Code to clarify that a new edition *may* be used on and after its publication date, but is not required to be used until the 180-day grace period has elapsed. On occasion, a greater lag time is given to allow for full implementation; such was the case with the cable-marking requirements of Rule 350G of the 1993 Code, which were initially delayed until 1 January 1994, and subsequently delayed until 1 January 1996.

Table H16-1 shows the publication dates and effective dates of various editions of the NESC. Many early editions were revised piecemeal; that is, individual Parts were issued when revised, rather than waiting until all were revised. This table omits the dates of the several National Bureau of Standards handbooks that reprinted the various parts of editions in groups.

Table H016-1 Effective Dates

Parts	Code	Publication Date	Effective Date
Work Rules	1	1 Aug 1914	NS*
1-4	2	15 Nov 1916	NS
1-4	3	31 Oct 1920	NS
1	4	5 Feb 1926	NS
2	4	15 Apr 1927	NS
3	4	12 Mar 1926	NS
4	4	15 July 1926	NS
5	4	15 July 1926	NS
1	5	8 May 1940	NS
2	5	23 Sep 1941	NS
3	5	23 Jan 1940	NS
4	5	13 Oct 1938	NS
5	5	1 Dec 1939	NS
6	5	17 Apr 1940	NS
2 only	6	1 Nov 1961	NS
2 (Supp. 1)	6	15 Dec 1965	NS
2 (Supp. 2)	6	Mar 1968	NS
3, 5, 6	Deleted	1970	NS
1	(6) 1971	Jun 1972	NS
3,† 4	1973	20 Jul 1973	NS
2	1977	28 Feb 1977	NS
1-4	1981	5 Sep 1980	180 days
1-4	1984	26 Sep 1983	180 days
1-4	1987	1 Aug 1986	180 days
1-4	1990	1 Aug 1989	180 days
1-4	1993	1 Aug 1992	180 days
1-4	1997	1 Aug 1996	180 days
1-4	2002	1 Aug 2001	180 days
1-4	2007	1 Aug 2006	180 days
1-4	2012‡	1 Aug 2011	180 days (1 Feb 2012)

*This is the year that underground rules moved from Section 29 to Part 3. The previous Part 3 had been title Utilization Wiring; those requirements are now contained in the National Electrical Code (NEC).

†1,2 not specified.

‡The 2012 Edition changed the effective date to the first day of the month after 180 days from the date of publication.

017. Units of measure

- A. Numerical values in the requirements of this Code are stated in the metric system and in the customary inch-foot-pound system. In text, the metric value is shown first with the customary inch-foot-pound (inside parentheses) following. Extensive detailed tables are duplicated. The first, marked **m**, contains metric (SI) values; the second, marked **in**, **ft**, or **lb**, contains the inch-foot-pound values. Tensions and wind loads are stated in newtons, the SI unit of force.

The SI values and the customary inch-foot-pound values are not, nor are they intended to be, identical measures. The values shown in each system of measurement have been rounded to convenient

numbers in order to simplify measurement and to minimize errors. The values shown in each system are functional equivalents for safety purposes.

The values required in this Code have been carefully developed and evaluated to ensure that the intended levels of safety are provided in both systems; neither is distinguishable from the other for safety purposes. The values specified in either system of measurement may be used, or the values of the two systems may be intermixed, as desired.

NOTE 1: Le Système International d'Unités (The International System of Units [or SI] in the modern version of the metric system). For basic information and conversion factors, see IEEE/ASTM SI 10™-2010 [B31].²

NOTE 2: It is recognized that many equivalent utility system components may be purchased in both SI and customary units.

- B. Unless dimensions are specifically stated in this Code, the dimensions of physical items referenced in this Code, such as wires, are “nominal values” assigned for the purpose of convenient designation. Due to manufacturing limitations or other restraints, other standards may set tolerances, variations, or ranges for the dimensions of such items.

Rule 017. (*This rule was new in 1984.*)

Metric values were introduced in the 1984 Code for information only; the customary inch-foot-pound values governed with respect to rule requirements until 1990, when either system was allowed to be used. The metric values are not identical equivalents to the customary values; the metric values have been rounded to provide convenient working numbers.

In the 1993 Code, the intention of Rule 017B was originally clarified to indicate that the required dimensions of items such as ground rods be considered to be nominal dimensions, and that the tolerances allowed by applicable standards are acceptable by the Code. During that revision cycle, existing standards for ground rods were considered and the dimensions were found to be appropriate for utility grounding. However, at a later date, NEMA GR-1 was revised to allow lesser dimensions of ground rods. As a result, the grounding rules were revised in the 2007 Code to specifically state dimensional requirements and the language of this rule was also revised to delete the reference to ground rods and apply *nominal values* only to dimensions not specified in the NESC.

The 1997 Code reversed the order of the values to put metric first, but either may still be used.

018. Method of calculation

Where calculations are required by these rules, the resultant value shall be rounded off to the nearest significant digit, unless otherwise specified in the applicable rule(s).

Rule 018. (*This rule was new in 2007.*)

In 2007, a coordinated effort was made to use values with appropriate decimal places in rules, tables and calculations. Each of the areas of the NESC was reviewed and appropriate requirements were placed therein. For example, the results of calculations required by the overhead clearances rules in Section 23 must be rounded up to specified digits. If there is no specific requirement for rounding the results of calculations required by the NESC in a particular rule or section, the result is now required by Rule 018 to be rounded off to the nearest significant digit.

²The numbers in brackets correspond to the numbers in the bibliography in Appendix E.

Section 2.

Definitions of special terms

Section 2 contains definitions for terms and words applicable to the NESC. The terms are used in the Code to name or describe facilities or activities that are associated with electric supply and communication utilities. For example, to people outside the utility industry, the word *vault* usually means a secure room in a bank or large jewelry store that is used to store money, valuable records, or jewels and gold. In the electric supply and communication utility world, a vault is also a room, but it is usually underground and contains electric supply equipment and cables or communication cables and equipment.

The following list summarizes significant revisions and additions for this section:

- (1) Before 1970, the Code included requirements relating to radio installations and included a definition of antenna conflict. This definition was carried forward in later editions as a result of an editing error. The Code was not specific about clearances or other construction requirements relating to antennas. Because the definition served no purpose, it was removed.
- (2) This section includes several definitions relating to voltage. Unless otherwise indicated, the term *voltage* as used in the Code refers to root-mean-square (rms) voltage. Where crest voltage is specified, such as in the calculation of alternate clearances under Rule 232D, a voltage value of 1.414 times the rms value is intended to be used. Most of the tables in the Code use phase-to-ground voltages. Where circuits are not effectively grounded, the highest nominal voltage available between any two conductors is to be used. For example, if a 19.9/34.5 kV three-phase circuit is effectively grounded, 19.9 kV would be used in the tables; otherwise, 34.5 kV is to be used. The rules use nominal voltages through 50 kV to ground; above 50 kV, the maximum operating voltage is to be used.
- (3) Line conductors and cables, as well as equipment, are classified as either *supply* or *communication* and are intended to be located accordingly in their respective spaces. Items not meeting the definition of a communication line are considered as supply.
- (4) When fiber-optic cables began to be commonly used, they were not identified specifically as to their intended treatment. The difficulty in identifying appropriate treatment lay in the fact that, while the fibers themselves were of dielectric material and were not a safety concern from the voltage perspective, they were frequently accompanied by a metallic messenger or sheath or both, which obviously could form a path for the flow of current. Today, some fiber-optic cables have metallic “talk” pairs of ordinary, telephone type for use in trouble shooting. The wording of the definition and specific rules have been revised several times in an attempt to clarify the intended use of such systems. Although the definition of a fiber-optic supply cable would not appear to allow placement in the communication area of the pole, other rules allow treatment of fiber-optic supply as fiber-optic communication under specified conditions. In such cases, the fiber-optic supply cable cannot be placed between the supply and communication spaces on an overhead structure; any transition must occur on one structure and meet the requirements for a vertical conductor of its type. In the 1990 Code, the definitions of fiber-optic cables were revised and, in 1993, Rule 224 and Table 235-5 were revised to explicitly limit such placement. (see also Rule 230F).
- (5) Definitions for **in service** and **out of service** were added in the 1993 Code to limit the opportunity for misinterpretation of Rule 214 and similar rules regarding inspection requirements.
- (6) The requirements for “effectively grounded” are sometimes confused with the requirements for “multiple grounding” as used in Section 9. The multiple grounding requirements of Section 9 require not less than 4 or 8 ground connections in each 1.6 km (mile) of overhead, messenger, or underground line segment. However, the definition of effectively grounded does not depend upon a particular number of grounds but rather on the adequacy of the connected grounds and their ability to take surge current away fast enough to limit voltage buildup to required levels. Depending upon the type of electrodes used and the soil resistance, the number of ground connections required to meet multiple grounding requirements of Section 9 may be sufficient or insufficient to meet the effectively grounded definition.
- (7) The 1997 Code revised the definition of **vault** to further differentiate a vault from an electric supply station. The 2002 Code further clarified the distinction between the enclosure systems. A

- key requirement is limitation of access to vaults to *qualified* personnel, whereas the access to electric supply stations may also include *authorized* personnel. A main difference in the rules specifying conditions in vaults (Part 3) versus supply stations (Part 1) is that vertical clearances are *specified* for supply stations and are not specified for vaults. The requirements for guarding are similar, but less detailed in the vault rules of Part 3.
- (8) Although no definition for *surge-protection wire* (or *overhead static wire*) was presented here until **shield wire/conductor** was added in 2002, there were and are definitions of supply lines and communication lines. Surge-protection wires are grounded conductors, but they are not considered to be line conductors. Many are not continuous or do not have a direct connection to a circuit or form a part thereof. However, an effectively grounded neutral line conductor can be used as an overhead shield wire. The rules specifying clearances or other requirements make this differentiation. Shield wires may, or may not, meet the multi-grounding and effective grounding that would allow them to be connected to co-function as a distribution neutral. In 2007, overhead ground wire, static wire, surge protection wire, and shield wire were all defined and related to each other.
 - (9) New definitions for **neutral conductor** and **multiple grounded/multiple grounded system** were added in 2002.
 - (10) The 2002 Code redefined **de-energized** as **disconnected** and added an information note. This change was coordinated with changes in Part 4 to refer to **de-energized and grounded** to more specifically detail requirements. Merely disconnecting does not necessarily make it safe to touch.
 - (11) The definition of **readily climbable** was completely revised in 2002 to specify in detail what is or is not considered to be a readily climbable supporting structure. It was further revised in 2007 by defining both **readily climbable** and **not readily climbable** under **supporting structure**.
 - (12) The definition of **qualified** was expanded in 2002 to require training and demonstration of knowledge.
 - (13) Single grounded, ungrounded, and ungrounded systems were defined in 2002.
 - (14) The 2012 Code added several definitions to support the revised language relating to scope and purpose of the NESC. Among them were area lighting, authorized person, exclusive control and exclusive control of **utility, premises** and **premises wiring (system), restricted access, supervised installation**. Existing definitions of **service point, utility** (including new **public utility** and **private utility**), and **utilization equipment** were also extensively revised. These definitions were prepared with the assistance of the NESC-NEC Task Force. The term **delivery point** distinguishes the point at which one public or private utility delivers energy or signals to another public or private utility from the **service point**, where the utility wiring connects to the **premises wiring**.
 - (15) In 2012, a new definition of **vertical conductor** was added and the definition of **lateral conductor** was extensively revised to clarify which conductors are intended to meet rules using those terms. **Lateral conductors** are usually jumpers connecting items on a structure and may extend horizontally, vertically, diagonally, or any combination thereof. The term **vertical conductor** usually refers to a wire or cable riser attached to the structure, but it can also refer to a vertical portion of a **lateral conductor**.
 - (16) In 2012, the issue of what it means to be **effectively grounded** was clarified by revising that definition and adding a new definition of **effectively grounded neutral conductor**. To be an **effective ground** or to be **effectively grounded**, the item must be *bonded to an effectively grounded neutral or to a grounding system designed to minimize hazard to personnel and having resistances to ground low enough to permit prompt operation of circuit protective devices*. The definition of an **effectively grounded neutral conductor** requires (a) a direct or high-impedance connection to the source transformer neutral, (b) not less than four grounds in each mile of line, and (c) sufficient size to carry the available fault current and permit prompt operation of circuit protective devices.
 - (17) The definition of **communication lines** was revised in 2012 to refer to those communication lines *located in the communication space* versus those *located in the supply space*.
 - (18) The 2012 Code revised **electric supply lines** to clarify traffic signal lines of any voltage are supply lines. Signal lines of less than 400 V (which could be treated as ordinary communication) may be treated as supply lines if they are so run and operated throughout. Fiber-optic lines are always considered as communication lines, regardless of whether they are located in the supply space or communication space, but the electric supply conductors feeding light amplifiers are considered to be supply lines—unless they are (a) inside a communication cable and (b) meet the requirements allowed by the definition of **communication lines** and applicable rules.

- (19) A new definition of **joint-use lines** was added in 2012. Two or more different utilities are required. Two different types of lines owned by only one utility are not enough to make the underground or overhead line be considered as a joint-use line.
- (20) The 2017 Code added definitions of **communication equipment**, **communication space**, and **supply space**, along with new **Figures D-1 and D-5**. It also modified the definition of **electric supply equipment**. These changes illustrate the separation of the facilities in the supply space from those in the communication space by the *communication worker safety zone* created by the clearances of Rules 235C and 238. Communication facilities are allowed in the supply space only if they meet the requirements of Rule 224A: they must have permission to be there and all work on them must be performed using the supply space work rules by personnel qualified to work in the supply space. In addition, these 2017 Code changes clarified what is considered to be supply equipment versus communication equipment. See also Rules 235C4 and 238E.

NOTE: If permission is granted to place all communication facilities in the supply space and all personnel working on the communication facilities are qualified to work in the supply space and use supply work rules of NESC Sections 42 and 44, there is no requirement to have a communication space and communication worker safety zone. However, if ordinary communication workers will work on any of the communication lines and equipment, those facilities must be located in a separate communication space separated from the supply space by a communication worker safety zone.

- (21) The 2017 Code added private toll operators to the entities that control **limited access highways**. This recognizes that many states now allow private companies to build and operate toll roads with limited access that functionally are equivalent to Interstate highways and other government operated non-toll and toll roads.
- (22) Interpretation Request 565 issued 10 April 2012 discussed confusion existing between the multitude of sub-definitions of **sag** in the NESC. The 2017 Code simplified the definitions into two sub-definitions (**initial sag** and **final sag**), deleted the other sub-definitions, and revised the language used throughout the rules to match the simplified sub-definitions. Companion changes were made to the definition and use of **tension**.
- (23) The 2017 Code added definitions of **span**, **wind span**, and **weight span** to help users understand the length to be used for different purposes. **Wind span** is used for transverse loading and **weight span** is used for vertical loading in the rules.
- (24) The 2017 Code clarified that supply cable messengers and communication cable messengers are among the items considered as a **supported facility**.
- (25) Over the couple of decades preceding the 2017 Code, the term “rural” has slowly been deleted from the code rules to reflect the fact that, with the increasing population and mobility of people seeking out remote places, there are few places where a fallen line would not present a personal safety hazard. Further, the character of land can change rapidly from formerly rural to urban, as farms are turned into residential, commercial, or industrial complexes, etc. The 2017 Code deleted the definitions of **urban districts** and **rural districts**.

The following definitions are for use with the National Electrical Safety Code. For other use, and for definitions not contained herein, the *IEEE Standards Dictionary Online* should be referenced.

NOTE: The *IEEE Standards Dictionary Online* is available at <http://ieeexplore.ieee.org/xpls/dictionary.jsp>.

administrative authority. The governmental authority exercising jurisdiction over application of this Code.

ampacity. The current-carrying capacity, expressed in amperes, of an electric conductor under stated thermal conditions.

anchorage. A secure point of attachment to which the fall protection system is connected.

area lighting. An electrical installation that provides lumens on public or private property.

NOTE: Area lighting installations under the exclusive control of a utility are covered by the NESC. All other area lighting installations are covered by the NEC.

authorized person. A person who has been authorized by the controlling utility or its designated representative to perform specified duties in, on, or in the vicinity of utility facilities, as applicable.

automatic. Self-acting, operating by its own mechanism when actuated by some impersonal influence—as, for example, a change in current strength; not manual; without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

backfill (noun). Materials such as sand, crushed stone, or soil, that are placed to fill an excavation.

ballast section (railroads). The section of material, generally trap rock, that provides support under railroad tracks.

bonding. The electrical interconnecting of conductive parts, designed to maintain a common electrical potential.

cable. A conductor with insulation, or a stranded conductor with or without insulation and other coverings (single-conductor cable), or a combination of conductors insulated from one another (multiple-conductor cable).

cable jacket. A protective covering over the insulation, core, or sheath of a cable.

cable sheath. A conductive protective covering applied to cables.

NOTE: A cable sheath may consist of multiple layers, of which one or more is conductive.

cable terminal. A device that provides insulated egress for the conductors. *Syn:* **termination.**

circuit. A conductor or system of conductors through which an electric current is intended to flow.

circuit breaker. A switching device capable of making, carrying, and breaking currents under normal circuit conditions and also making, carrying for a specified time, and breaking currents under specified abnormal conditions such as those of short circuit.

clearance. The clear distance between two objects measured surface to surface, and usually filled with a gas such as air.

climbing. The vertical movement (ascending and descending) and horizontal movement to access or depart the worksite.

common use. Simultaneous use by two or more utilities of the same kind.

communication equipment. Equipment that produces, modifies, regulates, or controls communication signals. This equipment may also produce, modify, or safeguard a supply of electric energy for the exclusive use of communication devices as long as the equipment and communication devices being served are owned and operated by the same party. *See:* **electric supply equipment.**

communication lines. *See:* **lines.**

communication space. The space on joint-use structures where communication facilities are separated from the supply space by the communication worker safety zone. See Figure D-1.

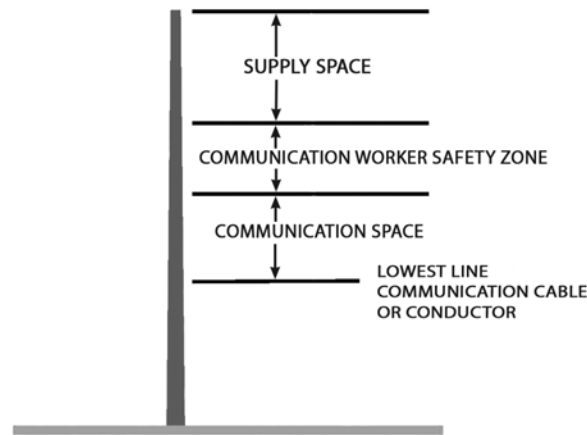


Figure D-1—Communication space

conductor.

1. A material, usually in the form of a wire, cable, or bus bar, suitable for carrying an electric current.
2. **bare conductor.** A metallic conductor without a covering.
3. **bundled conductor.** An assembly of two or more conductors used as a single conductor and employing spacers to maintain a predetermined configuration. The individual conductors of this assembly are called *subconductors*.
4. **covered conductor.** A conductor covered with a dielectric having no rated insulating strength or having a rated insulating strength less than the voltage of the circuit in which the conductor is used.
5. **fiber-optic conductor.** *See: fiber-optic cable—communication or fiber-optic cable—supply.*
6. **grounded conductor.** A conductor that is intentionally grounded, either solidly or through a noninterrupting current-limiting device.
7. **grounding conductor.** A conductor that is used to connect the equipment or the wiring system with a grounding electrode or electrodes.
8. **insulated conductor.** A conductor covered with a dielectric (other than air) having a rated insulating strength equal to or greater than the voltage of the circuit in which it is used.
9. **lateral conductor.** A wire or cable entirely supported on one structure and extending in a general horizontal, vertical or diagonal direction to make connections to line conductors, service drops, equipment, or other facilities supported on the same structure. Lateral conductors may be attached directly to the structure or supported away from the structure.
10. **line conductor.** (Overhead supply or communication lines.) A wire or cable intended to carry electric currents, extending along the route of the line, supported by poles, towers, or other structures, but not including vertical or lateral conductors.
11. **open conductor.** A type of electric supply or communication line construction in which the conductors are (a) bare, covered, or insulated, (b) do not have grounded shielding, and (c) are individually supported at the structure either directly or with insulators. *Syn: open wire.*
12. **vertical conductor.** Either a wire or cable riser attached to a pole or a vertical portion of a lateral conductor.

conductor shielding. An envelope that encloses the conductor of a cable and provides an equipotential surface in contact with the cable insulation.

conduit. A structure containing one or more ducts.

NOTE: Conduit may be designated as iron-pipe conduit, tile conduit, etc. If it contains only one duct, it is called *single-duct conduit*; if it contains more than one duct, it is called *multiple-duct conduit*, usually with the number of ducts as a prefix, e.g., *two-duct multiple conduit*.

conduit system. Any combination of duct, conduit, conduits, manholes, handholes, and/or vaults joined to form an integrated whole.

current-carrying part. A conducting part intended to be connected in an electric circuit to a source of voltage. Non-current-carrying parts are those not intended to be so connected.

de-energized. Disconnected from all sources of electrical supply by open switches, disconnectors, jumpers, taps, or other means.

NOTE: De-energized conductors or equipment could be electrically charged or energized through various means, such as induction from energized circuits, portable generators, lightning, etc.

delivery point. The point at which one utility delivers energy or signals to another utility.

designated person. A qualified person designated to perform specific duties under the conditions existing. *Syn:* **designated employee.**

disconnecting or isolating switch. A mechanical switching device used for changing the connections in a circuit or for isolating a circuit or equipment from a source of power.

NOTE: It is required to carry normal load current continuously as well as abnormal or short-circuit current for short intervals, as specified. It is also required to open or close circuits either when negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the switch poles occurs. *Syn:* **disconnector, isolator.**

duct. A single enclosed raceway for conductors or cable.

effective ground/effectively grounded: Bonded to an effectively grounded neutral conductor or to a grounding system designed to minimize hazard to personnel and having resistances to ground low enough to permit prompt operation of circuit protective devices.

effectively grounded neutral conductor: A conductor that is intentionally connected to the source transformer neutral directly or through an impedance to limit phase-to-ground fault current and has not less than four grounds in each 1.6 km (1.0 mi) of line. The conductor shall be of sufficient size to carry the available fault current and permit prompt operation of circuit protective devices.

electric supply equipment. Equipment that produces, modifies, regulates, controls, or safeguards a supply of electric energy for the electric power supply grid that is (1) transferred to supply lines, or (2) used to provide power and/or control for other electric supply equipment, or (3) used to provide power to the devices of another utility. *Syn:* **supply equipment.**

NOTE: *Electric supply equipment* does not include equipment whose purpose is to provide power to support locally mounted communication systems. For example, power supplies supporting CATV or communication amplifiers or repeaters are not considered to be supply equipment.

electric supply lines. *See:* **lines.**

electric supply station. Any building, room, or separate space within which electric supply equipment is located and the interior of which is accessible, as a rule, only to qualified persons. This includes generating stations and substations, including their associated generator, storage battery, transformer, and switchgear rooms or enclosures, but does not include facilities such as pad-mounted equipment and installations in manholes and vaults.

1. **generating station.** A plant wherein electric energy is produced by conversion from some other form of energy (e.g., fossil fuel, chemical, nuclear, solar, mechanical, wind, or hydraulic) by means of suitable apparatus. This includes all generating station auxiliaries and other associated equipment required for the operation of the plant. Not included are stations producing power exclusively for use with communications systems.
2. **substation.** An enclosed assemblage of equipment, e.g., switches, circuit breakers, buses, and transformers, under the control of qualified persons, through which electric energy is passed for the purpose of switching or modifying its characteristics to increase or decrease voltage or control frequency or other characteristics.
3. **switching station.** *See:* **substation.**

enclosed. Surrounded by case, cage, or fence designed to protect the contained equipment and limit the likelihood, under normal conditions, of dangerous approach or accidental contact by persons or objects.

energized. Electrically connected to a source of potential difference, or electrically charged so as to have a potential significantly different from that of earth in the vicinity. *Syn:* **live.**

equipment. A general term including fittings, devices, appliances, fixtures, apparatus, and similar terms used as part of or in connection with an electric supply or communications system.

exclusive control. Generally covers installation, ownership, restricted access, operation, and maintenance by qualified and authorized persons.

exclusive control of utility. Where (a) energized facilities are separated from public access by a spatial or a physical barrier and accessible only to qualified personnel authorized by the serving utility, and (b) the utility is responsible for connection/disconnection of such facilities to/from energized sources of energy or signals.

exposed. Not isolated or guarded.

fall arrest system. The assemblage of equipment, such as a line-worker's body belt, aerial belt, or full body harness in conjunction with a connecting means, with or without an energy absorbing device, and an anchorage to limit the forces a worker can experience during a fall.

fall prevention system. A system, which may include a positioning device system, intended to prevent a worker from falling from an elevation.

fall protection program. A program intended to protect workers from injury due to falls from elevations.

fall protection system (hardware). Consists of either a fall prevention system or a fall arrest system.

fiber-optic cable—communication. A fiber optic cable meeting the requirements for a communication line and located in the communication space of overhead or underground facilities.

fiber-optic cable—supply. A fiber-optic cable located in the supply space of overhead or underground facilities.

grounded. Connected to or in contact with earth or connected to some extended conductive body that serves instead of the earth.

grounded effectively. *See:* **effective ground/effectively grounded.**

grounded system. A system of conductors in which at least one conductor or point is intentionally grounded, either solidly or through a noninterrupting current-limiting device.

guarded. Covered, fenced, enclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats or platforms, designed to limit the likelihood, under normal conditions, of dangerous approach or accidental contact by persons or objects.

NOTE: Wires that are insulated but not otherwise protected are not normally considered to be guarded. See *EXCEPTIONS* under applicable rules.

handhole. An access opening, provided in equipment or in a below-the-surface enclosure in connection with underground lines, into which personnel reach but do not enter, for the purpose of installing, operating, or maintaining equipment or cable or both.

harness. A component with a design of straps that is fastened about the worker in a manner so as to contain the torso and distribute the fall arrest forces over at least the upper thighs, pelvis, chest, and shoulders with means for attaching it to other components and subsystems.

NOTE: Wherever the word harness is used in this Code, it refers to full body harness.

in service. Lines and equipment are considered in service when connected to the system and intended to be capable of delivering energy or communication signals, regardless of whether electric loads or signaling apparatus are presently being served from such facilities.

insulated. Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

NOTE: When any object is said to be *insulated*, it is understood to be insulated for the conditions to which it is normally subjected. Otherwise, it is, within the purpose of these rules, uninsulated.

insulation (as applied to cable). That which is relied upon to insulate the conductor from other conductors or conducting parts or from ground.

insulation shielding. An envelope that encloses the insulation of a cable and provides an equipotential surface in contact with the cable insulation.

insulator. Non-conductive device designed to provide mechanical connection and electrical separation between objects.

NOTE: Examples include but are not limited to pin, post, or suspension insulators supporting conductors; electrical bus support insulators; and guy strain insulators.

isolated. Not readily accessible to persons unless special means for access are used.

isolated by elevation. Elevated sufficiently so that persons may safely walk underneath.

isolator. *See:* **disconnecting or isolating switch.**

jacket. A protective covering over the insulation, core, or sheath of a cable.

joint use. Simultaneous use by two or more utilities.

lanyard. A flexible line or webbing, rope, wire rope, or strap that generally has a connector at each end for connecting the line-worker's body belt, aerial belt, or full body harness to an energy absorbing device, lifeline, or anchorage.

lightning arrester. *See:* **surge arrester.**

limited access highways. As used herein, *limited access highways* are fully controlled highways where access is controlled by a governmental authority or a private toll road operator for purposes of improving

traffic flow and safety. Fully controlled access highways have no grade crossings and have carefully designed access connections.

lines.

1. communication lines.

a. **located in the communication space.** The conductors and their supporting or containing structures, equipment, and apparatus that are used for public or private signal or communications service, and which operate at potentials not exceeding 400 V to ground or 750 V between any two points of the circuit, and the transmitted power of which does not exceed 150 W. When operating at not more than 90 V ac or 150 V dc, no limit is placed on the transmitted power of the system. Under specified conditions, communication cables may include communication circuits exceeding the preceding limitation where such circuits are also used to supply power solely to communications equipment. Fiber-optic cables are considered as communication lines, regardless of whether they are installed in the communication space or supply space in accordance with applicable rules.

NOTE: Public and private telephone, telegraph, railroad-signal, data, clock, fire, police-alarm, cable-television, and other systems conforming with the above are included. Lines used for signaling purposes, but not included under the above definition, are considered as supply lines of the same voltage and are to be so installed. Traffic signal light lines are considered as supply lines, not communication lines.

b. **located in the supply space.** Communication lines located in the supply space and meeting Rule 224A may (a) operate at any voltage, (b) include supply circuits of any voltage, or (c) be included within a supply conductor or cable operating at any voltage.

2. **electric supply lines.** Those wires, conductors, and cables used to transmit electric or light energy and their necessary supporting or containing structures, equipment, and apparatus that are used to provide public or private electric supply or lighting service.

Signal lines of more than 400 V and traffic signal lines of any voltage are always considered as supply lines within the meaning of the rules, and signal lines of less than 400 V may be considered as supply lines, if so run and operated throughout.

Although fiber-optic lines are considered as communication lines, regardless of whether they are installed in the communication space or supply space in accordance with applicable rules, electric supply conductors to light amplifiers, etc., are considered as supply lines, unless contained within a communication cable in accordance with the definition of communication lines and applicable rules.
Syn: **supply lines.**

3. **joint-use lines.** Overhead or underground lines containing or supporting facilities of two or more utilities. Lines containing or supporting facilities delivering two or more types of service by the same owner, such as electricity and lighting supply service or telephone and CATV communication service, are not considered as joint-use lines, unless also accompanied by one or more lines of another utility.

line-worker's body belt. A belt that consists of a belt strap and D-rings and which may include a cushion section or a tool saddle.

live. *See:* **energized.**

manhole. A subsurface enclosure that personnel may enter used for the purpose of installing, operating, and maintaining submersible equipment and cable.

manhole cover. A removable lid that closes the opening to a manhole or similar subsurface enclosure.

manhole grating. A grid that provides ventilation and a protective cover for a manhole opening.

manual. Capable of being operated by personal intervention.

minimum approach distance. The closest distance a qualified employee is permitted to approach either an energized or a grounded object, as applicable for the work method being used.

multi-grounded/multiple grounded system. A system of conductors in which a neutral conductor is intentionally grounded solidly at specified intervals. A multi-grounded or multiple grounded system may or may not be effectively grounded. *See: effective ground/effectively grounded.*

neutral conductor. A system conductor other than a phase conductor that provides a return path for current to the source. Not all systems have a neutral conductor. An example is an ungrounded delta system containing only three energized phase conductors.

out of service. Lines and equipment are considered out of service when disconnected from the system and when not intended to be capable of delivering energy or communications signals.

overhead ground wire. *See: shield wire.*

overvoltage. Voltage between two points of a system that is greater than the highest value appearing between the same two points under normal service conditions. Overvoltages include, but are not limited to, switching impulse (switching surge) overvoltages and temporary (transient) overvoltages.

pad-mounted equipment. A general term describing enclosed equipment, the exterior of which enclosure is at ground potential, positioned on a surface-mounted pad.

positioning device system. A system of equipment or hardware that, when used with its line-worker's body belt or full body harness, allows a worker to be supported on an elevated vertical surface, such as a pole or tower, and work with both hands free.

positioning strap. A strap with snap hook(s) to connect to the D-rings of a line-worker's body belt or full body harness.

premises. The land and buildings of a user located on the user side of the service point (sometimes called the *utility-user network point of demarcation* for communication wiring) to electric supply, communication, or signal premises wiring.

premises wiring (system). Interior and exterior wiring, including power, lighting, control, communication, and other signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed either (a) from the service point or premises power source to the outlets, or (b) where there is no service point, from and including the non-utility power source to the outlets.

Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment, nor does it include utility equipment and wiring on the utility side of the service point.

prestressed-concrete structures. Concrete structures that include metal tendons that are tensioned and anchored either before or after curing of the concrete.

pulling iron. An anchor secured in the wall, ceiling, or floor of a manhole or vault to attach rigging used to pull cable.

pulling tension. The longitudinal force exerted on a cable during installation.

qualified. Having been trained in and having demonstrated adequate knowledge of the installation, construction, or operation of lines and equipment and the hazards involved, including identification of and exposure to electric supply and communication lines and equipment in or near the workplace. An employee

who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person, is considered to be a qualified person for the performance of those duties.

qualified climber. A worker who, by reason of training and experience, understands the methods and has routinely demonstrated proficiency in climbing techniques and familiarity with the hazards associated with climbing.

raceway. Any channel designed expressly and used solely for holding conductors.

random separation. Installed with less than 300 mm (12 in) separation and without deliberate separation.

remotely operable (as applied to equipment). Capable of being operated from a position external to the structure in which it is installed or from a protected position within the structure.

restricted access. Where exclusive control is maintained.

roadway. The portion of highway, including shoulders, for vehicular use. *See also:* **shoulder**; **traveled way**.

NOTE: A divided highway has two or more roadways.

sag.

1. The distance measured vertically from a conductor to the straight line joining its two points of support. Unless otherwise stated in the rule, the sag referred to is the sag at the midpoint of the span. See Figure D-2.
2. **initial sag.** The sag of a conductor prior to the application of any external load.
3. **final sag.** The sag of a conductor under specified conditions of loading and temperature applied, after it has been subjected for an appreciable period to the loading specified for the clearance zone in which it is situated or equivalent loading, and this loading is then removed. Final sag includes the effect of inelastic deformation.

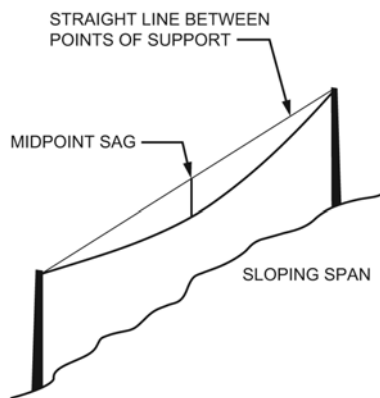


Figure D-2—Sag

separation. The distance between two objects, measured surface to surface, and usually filled with a solid or liquid material.

service drop. The overhead conductors between the electric supply or communication line and the building or structure being served.

service point. The point of connection between the facilities of the serving utility and the premises wiring.

NOTE: The service point is the point of demarcation between the serving utility and the premises wiring. The service point is the point on the wiring system where the serving utility wiring ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the utility's condition of service.

Because the location of the service point is generally determined by the utility, the service-drop conductors and the service-lateral conductors may or may not be part of the service covered by the NEC. For these types of conductors to be covered, they must be physically located on the premises wiring side of the service point. If the conductors are located on the utility side of the service point, they are not covered by the NEC definition of service conductors and are therefore not covered by the NEC.

Based on the definitions of the terms *service point* and *service conductors*, any conductor on the serving utility side of the service point generally is not covered by the NEC. For example, a typical suburban residence has an overhead service drop from the utility pole to the house. If the utility specifies that the service point is at the point of attachment of the service drop to the house, the service-drop conductors are not considered service conductors because the service drop is not on the premises wiring side of the service point. Alternatively, if the utility specifies that the service point is "at the pole," and the service-drop conductors are not under utility control, the NEC would apply to the service drop.

Exact locations for a service point may vary from utility to utility, as well as from occupancy to occupancy.

shield wire (also referred to as overhead ground wire, static wire, or surge-protection wire). A wire or wires, which may or may not be grounded, strung parallel to and above phase conductors to protect the power system from lightning strikes.

shoulder. The portion of the roadway contiguous with the traveled way for accommodation of stopped vehicles for emergency use and for lateral support of base and surface course.

side-wall pressure. The crushing force exerted on a cable during installation.

single-grounded system/ungrounded system. A system of conductors in which one conductor is intentionally grounded solidly at a specific location, typically at the source.

spacer cable. A type of electric supply-line construction consisting of an assembly of one or more covered conductors, separated from each other and supported from a messenger by insulating spacers.

spacing. The distance between two objects measured center to center.

span.

1. **span length.** The horizontal distance between two adjacent supporting points of a conductor.
2. **wind span.** The sum of half of the span lengths on either side of the supporting structures. See Figure D-3.

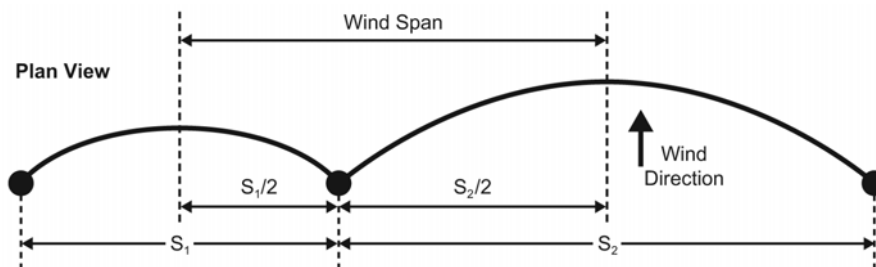
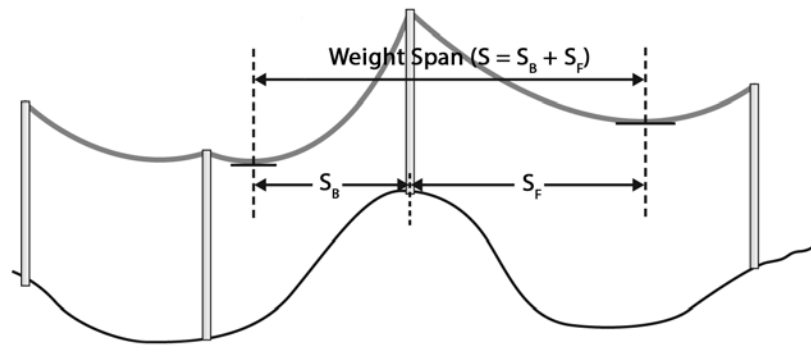


Figure D-3—Wind span

3. **weight span.** The sum of the horizontal distances from the supporting structure to the real or projected low point of conductor/cable sag in each supported span. See Figure D-4. *Syn:* **vertical span.**

NOTE: Where the projected low point is beyond the adjacent structure, the weight span may exceed the actual span.



Subscripts B and F stand for backspan and forespan, respectively.

Figure D-4—Weight span

span wire. An auxiliary suspension wire that serves to support one or more trolley contact conductors or a light fixture and the conductors that connect it to a supply system.

static wire. *See:* **shield wire.**

structure conflict. A line so situated with respect to a second line that the overturning of the first line will result in contact between its supporting structures or conductors and the conductors of the second line, assuming that no conductors are broken in either line.

substation. *See:* **electric supply station.**

supervised installation. Where conditions of maintenance and supervision ensure that only qualified persons monitor and service the system.

supply equipment. *See:* **electric supply equipment.**

supply space. The space on joint-use structures where supply facilities are separated from the communication space by the communication worker safety zone. *See* Figure D-5.

NOTE: Communication facilities may be located in the supply space (*see* Rule 224A).

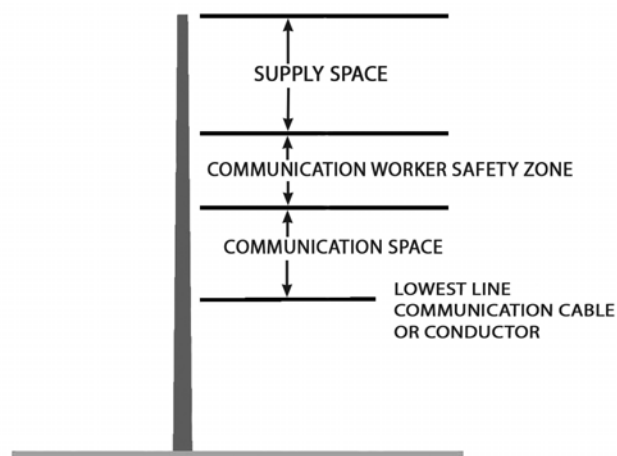


Figure D-5—Supply space

supply station. *See:* **electric supply station.**

supported facility. Any component of an overhead line system that is supported on, but is not intended to provide structural strength to, the supporting structure or mechanical support system.

NOTE: Examples of supported facilities include, but are not limited to, components such as messengers, conductors, line hardware, equipment hanger brackets, and switches.

supporting structure. The main supporting unit (usually a pole or tower) used to support supply and/or communication conductors, cables, and equipment.

NOTE: A supporting structure may consist of a single or multiple pole arrangement that supports supply and/or communication conductors, cables, and equipment at a line location.

1. **readily climbable.** A supporting structure having sufficient handholds or footholds so that the structure can be climbed easily by an average person without using a ladder, tools or devices, or extraordinary physical effort.
2. **not readily climbable.** A supporting structure not meeting the definition of a readily climbable structure, including but not limited to the following:
 - a. supporting structures, including poles and tower legs, with handholds or footholds arranged so that there is not less than 2.45 m (8 ft) between either: (1) the lowest handhold or foothold and ground or other accessible surface, or (2) the two lowest handholds or footholds. Diagonal braces on towers are not considered to be handholds or footholds except at their points of attachment.
 - b. guy wires

surge arrester. A protective device for limiting surge voltages.

surge-protection wire. *See:* **shield wire.**

susceptiveness. The characteristics of a communication circuit, including its connected apparatus, that determine the extent to which it is adversely affected by inductive fields.

switch. A device for opening and closing or for changing the connection of a circuit. In these rules, a switch is understood to be manually operable, unless otherwise stated.

switchboard. A type of switchgear assembly that consists of one or more panels with electric devices mounted thereon, and associated framework.

tag. Accident prevention tag (DANGER, PEOPLE AT WORK, etc.) of a distinctive appearance used for the purpose of personnel protection to indicate that the operation of the device to which it is attached is restricted.

tension.

1. **initial.** The tension in a conductor prior to the application of any external load.
2. **final.** The tension in a conductor under specified conditions of loading and temperature applied, after it has been subjected for an appreciable period to the loading specified for the loading district (zone) in which it is situated, or equivalent loading, and this loading removed. Final tension includes the effect of inelastic deformation (creep).

termination. *See:* **cable terminal.**

transferring (as applied to fall protection). The act of moving from one distinct object to another (e.g., between an aerial device and a structure).

transformer vault. An isolated enclosure either above or below ground with fire-resistant walls, ceiling, and floor, in which transformers and related equipment are installed, and which is not continuously attended during operation. *See also:* **vault.**

transitioning (as applied to fall protection). The act of moving from one location to another on equipment or a structure.

traveled way. The portion of the roadway for the movement of vehicles, exclusive of shoulders and full-time parking lanes.

ungrounded system. A system of conductors in which no conductor or point is intentionally grounded, either solidly or through a noninterrupting current-limiting device.

ungrounded system. *See:* **single-grounded system/ungrounded system.**

utility. An organization responsible for the engineering and supervision (design, construction, operation, and maintenance) of a public or private electric supply, communication, area lighting, street lighting, signal, or railroad utility system.

1. **public utility.** A public utility is an entity that performs or provides one or more utility services for the benefit of multiple customers (at retail, wholesale, or both), including utilities formed for a singular purpose (including but not limited to providing street and outdoor lighting, municipal traffic signal control, or distributed generation). Public utilities include investor-owned, municipality/government-owned, cooperative-owned utility, public utility districts, irrigation districts, lighting districts, traffic signal or other signal utilities, and similar utilities.
2. **private utility.** A private utility is an entity that (a) performs or provides one or more utility services to its own facilities, such as a large industrial complex, large campus, military complex, railroad system, trolley system, or extensive gas or oil field through its own electric supply, communication, street and area lighting, or signal system and/or (b) generates or transmits power that is delivered to another utility.

NOTE: Although many private utilities only operate a distribution level system, others operate generation and transmission systems.

utility interactive system. An electric power production system that is operating in parallel with and capable of delivering energy to a utility electric supply system.

utilization equipment. An electrical installation that uses electric or light energy for electronic, electromechanical, chemical, heating, lighting, testing, communication, signaling, or similar purposes on the premises wiring side of the service point.

NOTE: Utilization equipment and premises wiring on the load side of the service point is intended to be performed under the NEC, regardless of whether a utility has exclusive control.

vault. A structurally solid enclosure, including all sides, top, and bottom, that is (1) associated with an underground electric supply or communication system, (2) located either (a) above or below ground or (b) in a building, and (3) where entry is limited to personnel qualified to install, maintain, operate, or inspect the equipment or cable enclosed. The enclosure may have openings for ventilation, personnel access, cable entrance, and other openings required for operation of equipment in the vault.

voltage.

1. The effective (rms) potential difference between any two conductors or between a conductor and ground. Voltages are expressed in nominal values unless otherwise indicated. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The operating voltage of the system may vary above or below this value.

2. **voltage of circuit not effectively grounded.** The highest nominal voltage available between any two conductors of the circuit.

NOTE: If one circuit is directly connected to and supplied from another circuit of higher voltage (as in the case of an autotransformer), both are considered to be of the higher voltage, unless the circuit of the lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

3. **voltage of a constant-current circuit.** The highest normal full-load voltage of the circuit.
4. **voltage of an effectively grounded circuit.** The highest nominal voltage available between any conductor of the circuit and ground unless otherwise indicated.
5. **voltage to ground of:**
 - a. **a grounded circuit.** The highest nominal voltage available between any conductor of the circuit and that point or conductor of the circuit that is grounded.
 - b. **an ungrounded circuit.** The highest nominal voltage available between any two conductors of the circuit concerned.
6. **voltage to ground of a conductor of:**
 - a. **a grounded circuit.** The nominal voltage between such conductor and that point or conductor of the circuit that is grounded.
 - b. **an ungrounded circuit.** The highest nominal voltage between such conductor and any other conductor of the circuit concerned.

wire gauges. Throughout these rules, the American Wire Gauge (AWG) is the standard gauge for copper, aluminum, and other conductors, excepting only steel conductors, for which the American Steel Wire Gauge (Stl WG) is used.

worksite (as applied to fall protection). The location on the structure or equipment where, after the worker has completed the climbing (horizontally and vertically), the worker is in position to perform the assigned work or task.

Section 3. References

Section 3 lists all of the standards referred to by the rules in the Code. These standards are referenced in the rules as standards to be followed when purchasing equipment, designing utility facilities, and working in and on utility facilities.

The following standards form a part of the NESC to the extent indicated in the rules herein.

ANSI C29.1-1988 (R2012), American National Standard Test Methods for Electrical Power Insulators. [Rules 272, 273, and Table 277-1]

ANSI C29.2 (Superseded) (1.2 standard deviation M&E), American National Standard for Wet-Process Porcelain and Toughened Glass Insulators (Suspension Type). [Rules 272, Table 277-1, 441B4b, and 441B4c]

ANSI C29.2A-2013, American National Standard for Distribution Class Insulators.

ANSI C29.2B-2013 (3.0 standard deviation M&E), American National Standard for Transmission Class Insulators.

ANSI C29.3-2012, American National Standard for Wet-Process Porcelain Insulators (Spool Type). [Rule 272 and Table 277-1]

ANSI C29.5-2012, American National Standard for Low- and Medium-Voltage Pin Type Wet-Process Porcelain Insulators. [Rule 272 and Table 277-1]

ANSI C29.6-2012, American National Standard for High-Voltage Pin Type Wet-Process Porcelain Insulators. [Rule 272 and Table 277-1]

ANSI C29.7-2012, American National Standard for High-Voltage Line-Post Type Wet-Process Porcelain Insulators. [Rule 272 and Table 277-1]

ANSI C29.8-2012, American National Standard for Wet-Process Porcelain Insulators—Apparatus, Cap, and Pin Type. [Table 277-1]

ANSI C29.9-2012, American National Standard for Wet-Process Porcelain Insulators—Apparatus, Post Type. [Table 277-1]

ANSI C29.12-2012, American National Standard for Insulators—Composite Suspension Type. [Table 277-1]

ANSI C29.13-2013, American National Standard for Insulators—Composite-Distribution Deadend Type. [Table 277-1]

ANSI C29.17-2002, American National Standard for Insulators—Composite-Line Post Type. [Table 277-1]

ANSI C29.18-2013, American National Standard for Insulators—Composite-Distribution Line Post Type. [Table 277-1]

ANSI O5.1-2015, American National Standard Specifications and Dimensions for Wood Poles. [Rule 261A2b(1)]

ANSI O5.2-2012, American National Standard for Wood Products—Structural Glued Laminated Timber for Utility Structures. [Rule 261A2b(2)]

ANSI O5.3-2008, American National Standard for Solid Sawn-wood Crossarms and Braces—Specifications and Dimensions. [Rule 261A2b(2)]

ANSI Z535.1-2011, American National Standard for Safety Colors. [Rules 110A1 NOTE, 112B NOTE, 124C1 NOTE, 146B NOTE, 180B11 NOTE, 180D2 NOTE, 217A1c NOTE, 217A2a NOTE, 323C4a NOTE, 323E3 NOTE, 381G2 NOTE, and 411D]

ANSI Z535.2-2011, American National Standard for Environmental and Facility Safety Signs. [Rules 110A1 NOTE, 112B NOTE, 124C1 NOTE, 146B NOTE, 180B11 NOTE, 180D2 NOTE, 217A1c NOTE, 217A2a NOTE, 323C4a NOTE, 323E3 NOTE, 381G2 NOTE, and 411D]

ANSI Z535.3-2011, American National Standard for Criteria for Safety Symbols. [Rules 110A1 NOTE, 112B NOTE, 124C1 NOTE, 146B NOTE, 180D2 NOTE, 180B11 NOTE, 217A1c NOTE, 217A2a NOTE, 323C4a NOTE, 323E3 NOTE, 381G2 NOTE, and 411D]

ANSI Z535.4-2011, American National Standard for Product Safety Signs and Labels. [Rules 110A1 NOTE, 112B NOTE, 124C1 NOTE, 146B NOTE, 180D2 NOTE, 180B11 NOTE, 217A1c NOTE, 217A2a NOTE, 323C4a NOTE, 323E3 NOTE, 381G2 NOTE, and 411D]

ANSI Z535.5-2011, American National Standard for Safety Tags and Barricade Tapes (for Temporary Hazards). [Rules 110A1 NOTE, 112B NOTE, 124C1 NOTE, 146B NOTE, 180B11 NOTE, 180D2 NOTE, and 411D]

ANSI/ASME B15.1:2000, ASME Standard for Mechanical Power Transmission Apparatus. [Rule 122A]

ANSI/SIA A92.2-1992, American National Standard for Vehicle Mounted Elevating and Rotating Aerial Devices. [Rule 446B1]

ASCE 7-2010, ASCE Standard for Minimum Design Loads for Buildings and Other Structures. [Rule 250C and Tables 250-2 and 250-3]

ASCE 74-2010, Guidelines for Electrical Transmission Line Structure Loading. [Rule 250C]

ASTM D 178-01 (2010), ASTM Standard Specification for Rubber Insulating Matting. [Rule 124C4]

IEEE Std 4TM-1995, IEEE Standard Techniques for High-Voltage Testing. [Tables 410-2 and 410-3]

IEEE Std 516TM-2009, IEEE Guide for Maintenance Methods on Energized Power-Lines. [Rules 441A4 NOTE 2, 446B1, and 446D3]

IEEE Std 1427TM-2006, IEEE Guide for Recommended Electrical Clearances and Insulation Levels in Air-Insulated Electrical Power Substations.

IEEE Std 1584TM-2002, IEEE Guide for Performing Arc Flash Hazard Calculations. [Table 410-1, Footnotes 1, 3, 6, and 14]

IEEE Std C62.82.1TM-2010, IEEE Standard for Insulation Coordination—Definitions, Principles, and Rules.

NFPA 30-2000, Flammable and Combustible Liquids Code. [Rule 127C, 127D, and 127F]

NFPA 30A-2000, Flammable and Combustible Liquids Code. [Rule 127E]

NFPA 58-2001, Storage and Handling of Liquefied Petroleum Gases. [Rule 127K]

NFPA 59-2001, Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants. [Rule 127K]

NFPA 59A-2001, Production, Storage, and Handling of Liquefied Natural Gas (LNG). [Rule 127L]

NFPA 70[®], 2011 Edition, National Electrical Code[®] (NEC[®]). [Rules 011B4, 099C, 124C6a, and 127]

NFPA 496-1998, Standard for Purged and Pressurized Enclosures for Electrical Equipment. [Rule 127H]

NFPA 8503-1997, Standard for the Installation and Operation of Pulverized Fuel Systems. [Rule 127A5]

NOTE 1: The standards listed here were the editions used in this revision of the Code. In some cases, newer editions may be in effect. Contact the publisher for information about availability.

NOTE 2: ANSI publications are available from the American National Standards Institute (<http://www.ansi.org/>).

NOTE 3: ASCE publications are available from ASCE Publications (<http://www.asce.org/>).

NOTE 4: ASTM publications are available from the American Society for Testing and Materials (<http://www.astm.org/>).

NOTE 5: IEEE publications are available from The Institute of Electrical and Electronics Engineers (<http://standards.ieee.org/>).

NOTE 6: The IEEE standards or products referred to in this section are trademarks of The Institute of Electrical and Electronics Engineers, Inc.

NOTE 7: NFPA publications are available from the National Fire Protection Association (<http://www.nfpa.org/>).

Section 3. (*This section was added in the 1984 Code.*)

From 1981 through 1993, Section 3 included in one place the standards that are referenced within various other sections of the Code. They form a convenient reference for checking library copies for up-to-date versions of other standards that are specified in the current edition of the Code.

In 1997, the references were split into two parts. Section 3 includes only standards that form a part of the NESC to the extent called out in the rules. Other standards that are cited for information or documentation purposes are shown in a bibliography, originally designated as the Code's Appendix B. (It moved to the Code's Appendix E in 2007).

Both Section 3 and the bibliography appendix are updated with each new edition.

Section 9. Grounding methods for electric supply and communications facilities

The methods covered in Section 9 of the NESC are intended to deliver a desired safe performance level. The methods in Section 9 outline required and recommended methods for making connections, selecting appropriate materials, and installing those materials to create an appropriate grounding system when “effective grounding” is required. Specific grounding levels (such as, but not limited to, particular ohm values) are rarely indicated in Section 9. As in other parts of the Code, it is recognized that a certain level of safe performance can be achieved in a variety of ways. There is no desire to tie the hands of the user of the Code on achieving safe performance.

090. Purpose

The purpose of Section 9 of this Code is to provide practical methods of grounding, as one of the means of safeguarding employees and the public from injury that may be caused by electrical potential.

Rule 090. The purpose of Section 9 is to provide practical *methods* of grounding for use where grounding is required as a means of safeguarding employees and the public from injury that may be caused by electrical potential on electric supply or communications facilities. The *requirements* to ground items are found in Parts 1–4.

The object of protective grounds on electric circuits or equipment, as required by the rules of the NESC, is to keep some point in the electric circuit or equipment at, or as near as practical to, the potential of the earth in the vicinity. Grounding helps to prevent harm to persons or damage to property in the event of accidental contact by persons with conductive equipment casings or enclosures, guys, conduit, etc.; direct or near hits by lightning; accidental contact of high-voltage conductors with low-voltage conductors; breakdown between primary and secondary windings of transformers; etc.

In order of descending effectiveness, ground systems serve to (1) enhance prompt operation of system fault-protective devices and (2) minimize the exposure of personnel to electrical potential.

The ideal condition would be to have a grounding electrode with a resistance to ground so small that the voltage to ground would be held to a small value under any condition. In many situations, however, this is not practical due to either high soil resistivity or very low circuit impedance. In such cases, a high degree of protection is obtained if the grounding electrode has a low enough resistance to ground to ensure the current flow required to promptly operate protective devices and remove the source of the potential (see Rule 096 [Ground resistance]).

Under high-capacity ground fault or lightning conditions, substantial voltages may develop between locations on the earth’s surface only a few feet apart, due principally to the very appreciable resistance of the earth itself. Good grounding alone will not remove this hazard; additional means are required. Where there is a high probability that personnel may be exposed to large step potentials resulting from the operation of fault-current or other protective devices, such as in a supply substation, the effective potential may be minimized by the use of properly spaced buried grid conductors and by covering the earth with coarse crushed rock in the critical areas.

091. Scope

Section 9 of this Code covers methods of protective grounding of supply and communication conductors and equipment. The rules requiring grounding are in other parts of this Code. For rules requiring conductors or equipment to be effectively grounded, methods described in this section shall be used and the definition of effectively grounded shall be met.

These rules do not cover the grounded return of electric railways nor those lightning protection wires that are normally independent of supply or communication wires or equipment.