NESC® Handbook

Eighth Edition

A Discussion of the National Electrical Safety Code®

Representation of the Code content is not included in this version of the Handbook.

IEEE

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A Discussion of the National Electrical Safety Code®

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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 drafting 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 Eighth Edition Handbook

Welcome to the Eighth Edition of the *NESC® Handbook*.

The Eighth Edition of the handbook represents a discussion of the grounding rules, general rules, and Parts 1, 2, 3, and 4 of the third (1920) through the 2017 editions of the National Electrical Safety Code (NESC), specially crafted for the professionals who need to understand the Code. Contributor commentary gives users insight into what lies behind the NESC rules and how users might apply them.

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.

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.

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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 6 (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), a 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.

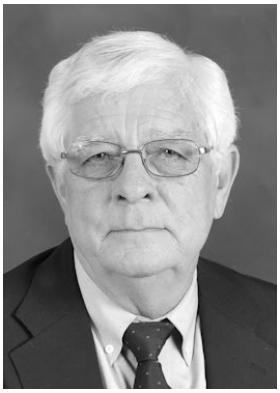
Mark has been a principal member of NESC Subcommittee 5 (Overhead Lines—Strength and Loading) since 2009. He has also been involved in the development of several standards as part of the IEEE Power and Energy Society's Towers, Poles, and Conductors Subcommittee since 2007. He is also a member of the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

(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 NFPA 70®, 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, *EXCEPTION*s, *RECOMMENDATION*s, *EXAMPLE*s, and *NOTE*s 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

(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

(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 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 lightning, the NEC will govern. This was clarified in Rule 011C of the 2002 NESC.

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

(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.