Changes to the NESC® 2017 Edition

General Intro to the Course

Welcome to the first Open Course on the web for the National Electrical Safety Code, or NESC, the standard that establishes the basic safety requirements for overhead and underground lines and equipment - that is both electrical and communications lines.

My name is Nelson Bingel, and I will be your Anchor Speaker for the next few weeks. I have been active on the NESC committee for over 25 years and became chairman in August of 2016.

This 4-week course, designed for participants of various experience levels, will explain the purpose and scope of the NESC. We will give an overview of the technical sections, NESC history and the revision process. We’ll discuss the relevance of this widely adopted safety code, as well as the various directions the NESC is heading and enhancements planned. We will also explain the many ways you can participate and collaborate to help maintain or improve safety for the public as well as power and communications workers.

This course is brought to you by IEEE, The Institute of Electrical and Electronics Engineers. It is the world's largest professional organization dedicated to advancing technology for the benefit of humanity.

Our intent is to provide you with short sessions every week, giving you plenty of time for Q&As, reading assignments, and more.

The course guide provided in the attached files includes:

- More information about this course
- A course outline
- Grading policy
- Discussion guidelines
- Other resources
- Speaker biographies
- and more.

Throughout your course adventure, the IEEE staff is here to help and to guide you. To get help about the content being presented, click the Discussion Tab and post a question. To get help with a technical problem, click Help to send a message to edX Student Support.
Please also visit our IEEE Standards University site for additional resources to help you learn more about technical standards.

Thank you for joining us! Best wishes for an informative and fun experience.

Course Expectations

In the coming weeks, our discussions will include:

...The NESC and the Grid

...A General Introduction to the NESC

...The Purpose and Scope of the NESC

that is, the intent along with what the NESC covers and does not cover

...NESC Committee structure and its three tiers, the Main Committee, an Executive Subcommittee and seven Technical Subcommittees

...The history of the NESC, from its beginnings in the early 1900's up to the 100 year anniversary in 2015

...The code of the future: how the code stays relevant and modern, along with adopting new energy technologies

...And finally the revision cycle.....how changes come about in the code and how the public can participate.

In some cases, these topics will be combined to equate to a week of course material. We will keep our lessons succinct to minimize the impact on your current workload and schedule.

You will also be able to review the recorded sessions and discussion forums, so you should be able to complete this NESC overview course with ease.

If you need any special support, please let us know. We are here to help.

Nelson Bingel received a BSME degree from Purdue University and has worked for 30 years at Osmose Utilities Services, now based in Atlanta, GA. Nelson is responsible for engineering and other technical aspects of wood,
steel, concrete and fiberglass utility poles and structures. This covers a wide range of activities such as inspection, maintenance, restoration and repair along with mitigation of deterioration and corrosion.

Nelson has designed unique software that is used during inspection of structures and also developed the O-Calc pole loading program that is used by companies nationwide for calculating comprehensive pole loading analysis. In addition, Nelson has been granted three United States Patents for unique designs of pole restoration systems.

Nelson has been active on the NESC for over 25 years and served as chairman of the Strength and Loading subcommittee until becoming Chairman of the NESC main committee in August 2016. Nelson is also a member of the executive subcommittee.

Nelson also chairs the American Standards Committee O5, which develops the standards for new wood poles and crossarms.

Dr. Lawrence (Larry) M. Slavin, currently Principal of Outside Plant Consulting Services Inc., has had a long career in the telephone industry, including AT&T/Lucent Bell Telephone Laboratories and Telcordia Technologies. Larry’s activities have included technical leadership in developing installation practices and “Generic Requirements” documents, introducing new construction methods, and performing analyses on a wide variety of technologies and products, including poles, duct, wire and cable, electronic equipment cabinets, flywheel energy storage systems, and turbine-generators.

Dr. Slavin serves on several NESC subcommittees, including SC4 (Clearances), SC5 (Strength & Loading), SC7 (Underground Lines), as well the Executive Subcommittee, Main Committee and Interpretations Subcommittee.

Danna Liebhaber has worked for Bonneville Power Administration for 14 years. She is currently the Principal Electrical Engineer in the Transmission Engineering Organization. This group is responsible for corona and field effects, transmission line insulation, lightning protection and grounding, obstruction marking and lighting among other responsibilities.

Danna has participated on the NESC for the last 5 years. She is currently a member of subcommittee 4 (clearances) and the main committee. Danna also chairs the IEEE Working Group on Corona and Field Effects.
Danna graduated from Washington State University with a BS in Electrical Engineering and a Master’s in Engineering Management. She is a registered professional engineer in the State of Washington.

As Senior Manager and Secretary, National Electrical Safety Code and Technical Programs, Sue Vogel is responsible for strategic planning, management, and growth of activities supporting the National Electrical Safety Code program for the IEEE Standards Association, or IEEE-SA.

Sue is an experienced standards professional at the IEEE-SA. She has supported a variety of programs and standards development projects, developed by a breadth of IEEE technical Societies and Committees, as well as ANSI Accredited Standards Committees, for 30 years. She has been responsible for publication of the last six editions of the NESC.

Next Topics

These are the topics we will be discussing during this session:

...The NESC and the Grid

You have probably heard the term “grid” but do you understand what makes up the grid? We’ll discuss each component of the grid and the role it plays in delivering electricity or telecommunications to you.

...A general introduction to the NESC along with the purpose and scope discussion will define the reason for the NESC along with its range of jurisdiction.

...And remember, the discussion forum will be open for the duration of the Course so feel free to post additional questions and comments there.

And please, type in a brief bio or introduction of yourself or your company. That will help break the ice and make this learning experience a more personal and productive for everyone.

The NESC and the Grid

The National Electrical Safety Code establishes the safety requirements for construction, operation and maintenance of overhead and underground lines, often referred to as the GRID.
The GRID includes the infrastructure that provides electricity across America. A similar network applies to communications services; sometimes called the PTSN (Public Switched Telecommunications Network) but these facilities have now expanded to support wireless, cloud and Internet systems communications.

In the case of electricity, it starts with Generation at the traditional coal/gas/hydroelectric power station or possibly alternative sites such as wind or solar farms .......

Then High Voltage Transmission lines deliver the power over long distances to points of distribution .........

Substations house a series of transformers that reduce the transmission voltages to lower levels. At these lower voltage levels, the power can be transmitted across distribution lines, which deliver power to local consumers in a more practical and usable format.

The voltage is further reduced to levels that can be utilized as it gets closer to the consumer. If the system is overhead, these smaller transformers are mounted on utility poles. When lines run underground, which is common in relatively new residential communities, the transformers are usually installed in cabinets and vaults at ground level, near the street.

The most common voltages for utilization are 110 and 220 volts which power lighting, appliances, computers, equipment and other electrical devices.

Electricity is delivered to homes, commercial businesses, industry, schools and a wide range of consumers.

Long distance communications facilities are analogous to the transmission network for power..... and local communications facilities are also referred to as distribution lines. Communications services are delivered over different wires and cables, but often share the same overhead or underground “joint” infrastructure. In some cases, telecommunication companies own utility structures and allow power to attach their facilities. In the majority of cases, however, power companies own the structure and allow the telecommunication companies to attach. This is enabled through Joint-Use Agreements and Pole Attachment Agreements.

General Intro to the NESC

In 1972, IEEE was designated as secretariat of the NESC and has published the document ever since. A new edition of the code is published every five years.

Once again, the major segments of infrastructure and facilities addressed by the code include:
• Generation
• Transmission and distribution lines
  o Both Overhead and underground
• Substations
• Service Drops – usually meaning the lines that lead to the meter of the consumer.

Electrical safety on the customer or load side of the meter is governed by the National Electrical Code, which is produced by the National Fire Protection Association. We’ll discuss the NEC shortly.

**Purpose and Scope**

One of the basic Rules of the Code, Rule 10, states that the purpose of the NESC is the practical safeguarding of persons and utility facilities under conditions specified within the code; for example weather conditions, such as a wind speed and temperature.

“Safeguarding” refers to practices to help shield - in this case, the public, utility workers and utility facilities - from danger, injury, destruction or damage.

NESC rules are globally recognized. They are intended to provide a practical standard of safe practices that can be adopted by utility companies and other ruling bodies that have control over safe practices. This applies during the design, installation, operation, and maintenance of electric supply, communications, street and area lighting, signal or railroad utility facilities.

There is a clarification in Rule 010C that the NESC is not intended as a design specification or as an instruction manual. Nonetheless, utility and communications companies typically adopt criteria that are specified in the NESC for defacto minimum design purposes, including wind pressure, thickness of radial ice on wires, “load” and “strength” factors and grades of construction. However, the NESC does not provide sufficient details to represent a comprehensive design document or construction guideline (how-to) for utility lines.

The Scope of the NESC is specified in Rule 11 and indicates what is directly covered and what is not.

The NESC covers everything on the line side. As you can see, the line side includes the facilities up to the service point such as the meter. The load side is the consumer side, and falls within the scope of the NEC.
In general terms, the NESC covers facilities for supply and communications that are part of a public or private electric supply. These facilities include communications, railway, trolley, street and area lighting, traffic signal, irrigation district or other community owned utility or a similar utility in the exercise of its function as a utility.

The NESC also covers the generation, transmission and distribution of electricity, lumens, communications signals and communications data through public and private utility systems that are under the exclusive control of utilities or their authorized representatives. Generation facilities include those based on fossil fuel, hydraulic, nuclear, wind, solar, or any other source of energy.

Similarly, street and area lights that are powered from the line side, and are under the exclusive control of utilities, including their authorized contractors or other qualified persons, are within the scope of the NESC.

Wiring within supply stations or in underground facilities is covered by the NESC if it is maintained and under the exclusive control of utility companies and necessary for the operation of the supply station or underground facility.

The basic safety rules also apply to mines and similar systems that are under the exclusive control of authorized persons.

Rules 011B1 and 011B2 explain items not covered by the NESC that fall under the jurisdiction of the NEC, also known as NFPA-70. These items include utilization equipment and premises wiring located beyond utility service points, usually the meter, in buildings or outdoor installations.

Rules 011B3 and B4 state that the NESC also does not cover luminaires and industrial complexes not under the exclusive control of utility companies and underground mine wiring, nor installations in ships, railway rolling equipment, aircraft or automotive equipment.

A residential service drop gives you an idea of the jurisdiction limits for the NESC and NEC, which are separated by the "service point" sometimes called the demarcation point. The service point is located between the pole and the premises, such as the meter, and can vary from utility to utility, usually determined by the utility.

Rule 011C states that the NESC rules address loading and strength of structures and supported facilities, clearances, loading and strength and other aspects of safeguarding persons and facilities, such as safe work practices.

There are specific safety Rules for:
- Grounding,
- Electric Supply Station and Equipment,
- Overhead Lines,
- Underground Lines, and
- Work Rules for Power & Communications Employers and Employees

The general use clauses in Rule 012 provide a catchall principle to help ensure that industry best practices should be followed for any particular circumstances not explicitly detailed in the NESC.

This concludes Week 1 of our NESC overview. Next week, we’ll look at the NESC organization structure and the technical subcommittees. Thanks for joining us.

Committee Organization

Welcome to Week 2 of this NESC Overview MOOC. We’ll cover the NESC organization structure and give you a general overview of the seven technical subcommittees.

The American National Standards Institute, or ANSI, accredits the NESC committee and approves its procedures to ensure compliance with ANSI’s Essential Requirements. The NESC Main Committee and subcommittees must follow essential principles of standards development, including openness, due process, and balance. Having a proper balance of interested parties in membership and participating in the process is very important.

The NESC organization structure is comprised of the NESC Main Committee, an Executive Subcommittee, and seven technical subcommittees. The NESC Main Committee is responsible for

- approving new editions of the NESC,
- approving organizational members of the NESC Main Committee, and
- setting the direction for the NESC.

Members of the Main Committee are organizations, associations, and government agencies many of which are national in scope, all having a direct and material interest in the activities of the Committee, for example:

- American Public Power Association
- Alliance of Telecommunication Industry Solutions
• Bonneville Power Administration
• Edison Electric Institute
• Independent Electrical Contractors
• International Brotherhood of Electrical Workers
• IEEE
• National Association of Regulatory Commissioners
• National Cable Television Association
• National Electrical Contractors Association
• National Electrical Manufacturers Association
• Society of Cable Television Engineers
• Solar Energy Industries Association
• Tennessee Valley Authority
• Western Area Power Administration
• And others.

The NESC Executive Subcommittee serves as a steering committee for the NESC. It also approves the chairs and members of subcommittees with an eye on maintaining the proper balance of interests, as required by ANSI. The Executive Subcommittee members also are responsible for acting as the ballot resolution body for comments received on the NESC ballot.

(Introduction to discussions about the subcommittees)

The Technical Subcommittees are responsible for the definitive technical content of the NESC. This responsibility is achieved by careful review and voting on all submitted change proposals as well as public comments that are received. Each subcommittee focuses on a specific area of interest and expertise such as Grounding, Clearances, Strength and Loading and other distinct aspects of the infrastructure where safety needs to be addressed.

There are seven technical subcommittees and each has a specific focus. Subcommittee one for example deals with definitions, references and coordination while other subcommittees work through issues related to grounding, substations, clearances, strength and loading, underground lines or work rules.

For the 2017 edition, over 700 change proposals were received for consideration by the technical subcommittees. The proposals generally cover all aspects of the code so following the end of the submission period, the proposals are provided to the proper subcommittee for review.

Some change proposals are submitted by members of subcommittees or by an entire subcommittee. In instances where the entire subcommittee has a chance to review, edit and comment on draft change proposals
before they are officially submitted, the members can work through the implications of the proposal before
they are official submitted. This allows the committee to prepare proposals that are technically correct and
able to be implemented in a practical way.

Other change proposals come directly from the public including users of the code and interested parties that
are affected by the NESC implementation.

All change proposals are given the same technical consideration and review.

The next sessions will provide a high level overview of each technical subcommittee.

SC1- Definitions, References, Coordination

Subcommittee 1 is responsible for ensuring coordination amongst all the technical subcommittees. The
principal members of this group are comprised of the Main Committee Chair, the Interpretations
Subcommittee Chair, and the Chairs of all other technical subcommittees, with the secretaries of those
committees acting as alternates.

Each technical committee reviews and votes on Subcommittee 1 proposals that could impact the sections for
which they have responsibility. The Chair or Secretary will vote the consensus of their respective subcommittee.

Subcommittee 1 also has the responsibility for Section 1 of the NESC, which includes the Scope, Purpose and
Application; Section 2, Definitions; and Section 3, References.

Sometimes definitions require the greatest amount of time to reach a consensus. Finalizing the wording so
that all subcommittees agree that it accords with how the term is used in their section of the code as well as to
help ensure someone will not misinterpret a definition can be intricate work. This is why a definition that
applies to other subcommittees is also reviewed and voted on by those subcommittees.

SC2- Grounding Methods

Subcommittee 2 is responsible for Section 9 of the NESC. This section contains rules that provide the means
of grounding supply and communications lines and facilities, as may be required in other sections of the Code,
to help protect employees and the public. This section is intended to provide a consistent, effective method of
bonding and grounding throughout the code.
The rules contain methods of protective grounding of supply and communications conductors and equipment. However, these rules do not cover the grounded return of electric railways or lightning protection wires that are independent of supply or communications wires or facilities; for example, the wires connected to a lightning rod on top of a building.

Requirements are provided for the grounding conductors and/or electrodes, including:

- points of connection
- composition (like materials and design)
- ampacity
- mechanical strength
- electrode alternatives, both existing (like water pipes) and made (like ground rods)
- and their methods of connection

Grounding may be required at messenger wires, guys, fences, and at the source and/or line side of the supply.

The ground resistance must be low enough to minimize hazards to personnel and allow prompt operation of circuit protective devices. In some cases, separate grounding conductors or physically separated electrodes will be required.

Additional details are also specified for appropriate bonding and grounding of communications apparatus.

**SC3- Electric Supply Stations**

Part 1 of the code covers the safe installation, operation and maintenance of electric supply stations.

The rules in this part cover the electric supply conductors and equipment, along with the associated structural arrangements in electric supply stations that are accessible only to qualified and authorized personnel.

Section 11 contains general requirements for safety clearance zones particularly those associated with fences, illumination, exits and fire-extinguishing equipment.

Section 12 covers the installation and maintenance of equipment in electric supply stations. These rules include inspection requirements, guarding of moving parts, grounding requirements, and working space around electric equipment. This section also has a number of rules on how to guard live parts and electrical installations in classified, or hazardous, areas.
Sections 13-19 contain rules for various equipment in electric supply stations including:

- rotating equipment,
- storage batteries,
- transformers and regulators,
- conductors,
- circuit breakers, reclosers, switches and fuses
- switchgear and metal-enclosed bus, and
- surge arrestors.

**SC4- Overhead Lines-Clearances**

Consistent with the overall purpose and scope of the NESC, Part 2 of the code covers overhead electric supply and communications lines. Part 2 is organizationally divided into Sections 20 to 23, covered by Subcommittee 4 and Sections 24 to 27, covered by Subcommittee 5.

**GENERAL**

Sections 21 and 22 contain general requirements, including rules for inspections, vegetation management, relative levels of different classes of conductors, and important grounding rules for circuits, supporting structures and associated hardware and equipment.

Proper grounding, and/or insulation, of anchor guys, span guys and span wires, like supporting luminaries and traffic signals, helps protect both the worker and the public, including in the event they become slack or break.

....

**RELATIVE LEVELS**

In principle, electric supply and communications lines may be located at various locations or heights along the overhead structures, and it is essential to manage their location and separation to avoid conflicts. This is especially important in common joint-use situations in which power and communications share the same structure. It has become even more imperative as wireless and fiber-based Internet architectures expand greatly to provide broadband services everywhere as well as for the incorporation of smart grid devices into the grid.

The NESC indicates the appropriate relative levels of the supply and communications lines, with supply being preferred at the higher level. Similarly, for structures supporting only supply circuits, the higher voltage lines should typically be placed at the higher levels.
Special rules apply for communications circuits mounted within the supply space and vice versa; for instance, where low voltage and/or low power supply circuits located within the communications space and used exclusively for communications circuits.

CLEARANCES

Section 23 is the most extensive and prescriptive of the sections of the NESC. It contains numerous rules and associated tables of quantitative clearances and required minimum spacing between various overhead facilities.

The safety of utility worker and the public often rely on the physical separation of the electric power and communications facilities from each other, as well as from public or private travel ways, buildings, bridges, and other locations.

The NESC rules for separation may be considered to be in two general categories:

(1) those whose primary function is to protect the public,

and (2) those whose primary function is to protect the utility workers and the utility lines themselves.

Rules for protecting the public include those specifying minimum clearances for wires, conductors, cables and equipment above ground, roadway, rail, or water surfaces, as well as buildings, bridges, rail cars, swimming pools, and other installations. Vertical clearances are specified for the first category, while vertical and/or horizontal clearances are specified for the second case.

Rules for protecting the utility worker and utility lines include those specifying minimum clearances or separations between wires, conductors, cables and equipment. Such separations, including vertical and/or horizontal, are specified between wires carried on the same supporting structure, as well as those carried on different structures. Clearances and separations are also provided between the various conductors and equipment located on the same structure.

In addition, minimum dimensions are specified to help provide adequate safe climbing and working space for the utility worker of all parties attached to the joint-use structure.

The aforementioned clearances between the electric supply and communications facilities located on the same structure or within the same span define the “Communications Worker Safety Zone,” or CWSZ. The CWSZ is intended to provide a safe working environment for the communications worker, who is typically not trained for working within the “supply space”, typically located above the “communications space” as well as provide adequate working space for a power utility employee working above in supply space.
CONDUCTOR OR WIRE SAG

Many of the various clearances and separations, as described above, refer to minimum distances between wires, conductors, or cables, including both at the supporting structure and within their respective spans. It is therefore necessary to consider the quantitative amount of sag of the wires between their support points.

The degree of wire or conductor sag, at the conditions under which the clearance is to be determined, depends on many factors. These factors include the amount of sag provided at initial installation, the temperature at installation, the specified environmental conditions – such as ice, wind, or temperature - under which the clearance is to be determined, and the individual conductor characteristics as well as its past history.

The knowledge from the past history and long experience of the utilities is relevant for conductors that may experience permanent, or “inelastic” elongation due to long term creep, or after exposure to previous wind and ice storms.

Electric supply conductors with aluminum components are examples of conductors that may experience such permanent deformation.

The “final” sag is therefore determined after the conductors have previously been exposed to the loadings - ice, wind, temperature - of the “Clearance Zone” in which they are situated.

SC5 - Overhead Lines-Strength and Loading
Part 2 Sections 24 - 27

Subcommittee 5 is responsible for sections 24 through 27 which cover:

Grades of Construction with different margins of safety
Loadings, which are wind and ice conditions
Strengths of different structural materials
And Insulator electrical and mechanical requirements

Utility structures are loaded in all directions, vertical, longitudinal – that is, in the direction of the wires - and transverse or perpendicular to the wires. However, the typical governing design criteria is usually the transverse loading case, the ice requirements added to the diameter of the wires along with the wind loads applied perpendicular to the wires. In other words, these requirements prevent the poles from blowing over sideways.

The two main grades of construction are Grade B and Grade C, with Grade B having the higher requirements. Grades of construction effectively create a margin of safety beyond the specified loadings. This is accomplished with two factors.

The specified loading is increased by applying a load factor which is greater than one. This increases the applied load above likely expected loads.

The strength of a structure is multiplied by a strength factor which may be equal to one or a lesser value depending on the characteristics of the material.

For example, the bending strength factor for steel in grade B is 1.0 which means all of the capacity can be utilized in a design because steel structure bending strength is based on minimum values with a narrow range of variation.

Wood poles, on the other hand, have bending strength values that are an average number with a wider coefficient of variation. Therefore, the strength factor in Grade B for wood poles is .65 which means the design can only be applied to sixty five percent of the bending capacity of the wood pole.

As a comparison, 0.85 or 85 percent of wood pole capacity can be applied to the design of Grade C construction.

Where wires of one line cross over wires of another line, different grades of construction may be specified for the upper line compared to the lower line to enhance the safety factor for this situation. Wires are also considered to be at a crossing if they cross over or overhang a railroad track, the traveled way of a limited access highway, which is a highway that has on ramps and off ramps, or navigable waterways requiring waterway crossing permits. In these cases, Grade B construction is required.
Table 242-1 specifies the grade of construction required for conductors and cables that may be the only attachment on a structure, either at a crossing or on the same structure with other conductors and cables. The table has several categories starting with selected types of ground activities under the lines, followed by communications conductors and cables, and then three ranges of supply voltage starting with 0 to 750 volts, and ending with any circuit exceeding 22 kV, or 22,000 volts.

One other grade of construction, Grade N, is used for emergency and temporary construction. It is initially referred to in Rule 014 as a waiver for emergency and temporary construction. Emergency construction is usually in response to poles or lines being damaged from storms, car/truck impacts, and other situations where power needs to be quickly restored. Temporary construction is most often installed by a utility as part of a larger construction or other type of project where the structures will only be in place for a limited time. Grade N is also used for service drops, and is the baseline minimum requirement for most low voltage lines. The utility may, however, elect to build to a higher grade of construction.

The requirements for Grade N construction are specified in Rule 263, where it states that the structure shall be strong enough to withstand expected loads and is not necessarily required to meet or exceed Grade C requirements.

Section 25 of the NESC specifies the loadings for Grade B and C. Rule 250 includes three different load cases delineated in Rules 250B, 250C and 250D.

250B loads are defined in Figure 250-1 and apply to all structures, no matter their height above ground. This is the most often used loading case for the distribution plant. The zones of the district load map are so named for the amount of ice included, not the total load applied. Light loading adds no ice to wires or cables while the medium district adds a quarter inch of radial ice and the heavy district adds a half inch of radial ice to each wire and cable.

The loading in Rule 250B is deterministic, which means they were determined to be a likely winter storm but have no associated probability of occurrence. The wind is specified as a pressure in terms of pounds force per square foot of surface area. The wind pressure in the light district is 9 pounds per square foot, which is approximately a 60-mile an hour wind. The medium and heavy districts incorporate a 4 pound wind or approximately a 40 mile-per-hour wind.

Rule 250C uses an extreme wind map published by the American Society of Civil Engineers in document ASCE 74-10, Guidelines for Electrical Transmission Line Structural Loading. This map was established using wind data collected during the summer season, when ice is not a factor.

If a structure or its supported facilities do not extend more than 60 feet above ground or water level, this extreme wind load case does not need to be applied.

The map shows that 90 miles-per-hour is the predominant expected maximum wind speed across the country except for the eastern and gulf coastal areas where speeds can reach 150 miles-per-hour. The wind pressures...
in Rule 250C have a lower load factor applied since the published wind speeds have a coinciding probability of occurrence.

Rule 250D incorporates a weather map from ASCE 7-05 which delineates extreme ice conditions along with a concurrent wind. This map also has a probability of occurrence like the extreme wind map so the overload factors are lower than those used in Rule 250B, the District Loads.

Although this map has some higher ice thickness values and a wider range of wind speeds, the resulting loads are generally lower than the loads generated using the District Load criteria because of the difference in load and strength factors. This load case was brought into the code in 2007 as an alternate consideration to the District Load Map because it has much more modern weather data. Given more time for evaluation and comparison, this load case may eventually replace the District Loads.

Section 26 addresses the strength requirements of structures as well as some individual structural components. The range of materials that are typically used as utility structures are all addressed.

Wood is by far the most commonly used material for utility poles. Approximately 150 million are in use around the country. Several varieties of Southern Pine are most commonly used east of the Rocky Mountains while Douglas-fir and Western red cedar poles are most common west of the Rockies. This is simply because those are the common species of trees growing in those regions and transportation costs can be a significant factor.

During the manufacturing process, the wood poles are pressure treated with a preservative to resist decay, which most often occurs in the groundline zone. Oil-based treatments create the darker brown poles that you see, and water-based treatments result in greenish tinted poles.

Wood poles are unique in that they have a higher initial strength requirement. This is because wood strengths are average values. The requirement also accounts for an allowable loss of strength while in-service. Wood poles subject to district loads are not required to be restored or replaced until the remaining bending strength is reduced to two thirds of the required strength. An effective inspection program that includes applying supplemental preservative treatments to wood poles can prevent loss of strength in the groundline zone and extend their useful life by many decades.

Steel, pre-stressed concrete and fiberglass poles have lower initial strength requirements largely because the strengths used for these engineered materials are minimum values with a narrow range of variation. As a result, these structures are not allowed to deteriorate below initial strength requirements.

While these structures may be considered less likely to deteriorate, the NESC still requires inspection and maintenance on a regular cycle. In the past decade, many utility companies have discovered that steel towers installed many years ago are prone to groundline deterioration similar to wood poles owing to galvanic and stray current corrosion effects.

Section 27 addresses requirements for line insulation and applies to open-conductor supply lines. The primary function of an insulator is to support the line mechanically while the secondary function is electrical insulation.
Air insulates and the insulator on an electrical line helps maintain an air gap between the supply line voltage and ground.

We can think of insulators in three different applications:

- **Distribution lines** Thru 69 kV
- **Transmission lines** 69 kV and up
- **Substations** All voltages

Distribution lines incorporate pin insulators, line posts, dead end, spool and strain insulators

Transmission lines use suspension or line post insulators which have greater strength and insulation requirements.

Substation insulators may be post, suspension or cap and pin types.

The insulation level is expressed in terms of a dry flashover voltage rating while the mechanical strength requirement is based on the way that the insulator is loaded. For example a suspension insulator is loaded in tension while a pin insulator experiences cantilever loading.

**SC7- Underground Lines**

**Purpose and Scope**

**Part 3** of the code covers belowground, or "underground" electric supply and communications lines, including both underground conduit systems and direct-buried cable. The latter category also includes individual cables within a duct, the combination of which are direct-buried, but not part of a comprehensive conduit system or network.

The rules cover the associated structural arrangements and extensions into buildings.

They do not cover installations in electric supply stations.

**General**

**Section 31** contains general requirements, including rules for accessibility and inspection and testing, as appropriate and necessary.

Cable sheaths and shields, equipment frames and cases, and conductive-material ducts and riser guards enclosing electric supply lines - or exposed to contact with open supply conductors - must be effectively grounded.
Neutrals and surge protectors must be effectively grounded.

Under normal conditions, supply circuits must not employ “earth” as a sole conductor for any part of the circuit.

Communications apparatus must be protected if the associated lines may be subject to lightning, or voltages in excess of 300 V.

**Conduit Systems**

Section 32 contains requirements for the conduit systems, including location; construction, including excavation and backfill; and individual duct materials and joints, such as installation, strength.

Manholes, vaults and handholes interface with the individual conduits or ducts, and allow access to the cables as necessary.

The structures must allow convenient, safe access, and withstand expected loads, including those due to heavy trucks for roadway applications.

**Supply Cable**

Section 33 provides high-level end-point requirements to help ensure the reliability of the supply cables in their belowground application, including resistance to mechanical, thermal, environmental and electrical stresses.

**Cable in Underground Structures**

Section 34 contains detailed rules for installing the supply and communications cables within the conduits, supporting and arranging cables within structures like manholes and vaults, and local grounding and bonding.

**Direct-Buried Cable (and Cable in Duct)**

Section 35 provides requirements related to the marking, location, installation, and separation of direct-buried cables and cables in single buried ducts.

Cables should be routed to avoid natural hazards, or placed beneath buildings, railroad tracks, or highways.

Cables may be placed by various techniques – such as trenching, plowing, or boring - but must be placed at appropriate depths.

Supply and communications cables may be placed with a deliberate separation of 12-inch from each other and from other belowground facilities, including water, sewer, and gas.

“Random Separation” that is, less than a 12-inch separation between supply and communications cables is allowed, depending on the supply voltage, cable construction and bonding/grounding procedures.
**Risers, Terminations, Equipment, Tunnels**

**Sections 36 and 37** address the protection of the cables as they are brought to the surface, or above, including supply cable terminations and vertical risers on poles that transition between underground and aerial plant.

**Section 38** provides requirements for equipment to be used in manholes or in aboveground enclosures that are pad-mounted or pedestals, including design, location, and grounding.

**Section 39** helps ensure a controlled safe environment for workers, as well as the public, if accessible.

**SC8- Work Rules**

Subcommittee 8 is responsible for Part 4 of the code. Part 4 covers work rules to be followed during the installation, operation and maintenance of electric supply and communications systems.

Part 4 work rules are in harmony with relevant OSHA Rules found in 1910.269 and 268.

Section 41 covers the Rules for employers. These include:

(1) the requirement of the employer to provide training for employees who will perform work in the vicinity of energized lines,

(2) the hazard risk assessment of electric arc exposure to employees to ascertain the level of arc rated clothing necessary and

(3) the use of protective devices, including signs, fall protection and Personal Protection Equipment referred to as PPE.

The general rules for employees are covered in Section 42.

These rules include the requirement that employees shall only perform tasks for which they are trained, equipped, authorized and so directed.

There are a number of rules covering specific situations or equipment. These include tools and protective equipment, ladders and supports, fall protection, fire extinguishers, and communications antennas.

Also included in this section are general operating routines and overhead and underground line operating procedures that cover concerns for working from aerial lift trucks and in excavations.
Section 43 contains the additional rules pertinent to communications employees, including the minimum approach distances for communications workers to energized facilities on joint use structures.

And lastly, Section 44 covers the additional rules for supply employees. These rules include:

- minimum approach distances,
- switching control procedures,
- procedures for working on energized lines and equipment
- procedures for de-energizing equipment or lines
- for installing or removing protective grounds
- and requirements for performing live work.

This concludes Week 2 of our NESC overview MOOC. Next week, we'll take a look back at the evolution of the NESC, from the early 1900’s to the present. Thanks for joining us.

**History**

Welcome to Week 3 of our NESC Overview. We will cover the history of the NESC, from its beginnings in the early 1900’s up to the 100 year anniversary in 2015. We'll also discuss how the code stays relevant and modern. Let’s begin.

Looking back, the expansion of electricity in the early 1900’s was a bit like the wild west. In this image of a street in Buffalo, New York, you’ll notice that the congestion and confusion of communications wires located above the electric wires.

Here is an early municipal generation plant in New York. Most electric generation at that time was produced by independent operations and there was a lack of uniform construction and operational standards.

This lack of uniform standards resulted in poor safety records. Accidents and fatalities were regular occurrences for both workers and the public. The primary issues of that era were clearances to energized parts, strengths of supporting structures, wiring methods and worker safety methods.

A newspaper article from the early 1900s, when communications wires were still attached above supply lines, tells the story of a man who was electrocuted when he picked up his phone. The service drops had crossed each other on the span from the pole to the house and energized the phone line.
The origins of the NESC extend back to a request from the U. S. Congress to the National Bureau of Standards in 1913. Some informational circulars were published by the National Bureau of Standards in 1914, but they only covered work rules.

In 1915, 85 participants attended a two-week meeting organized by the National Bureau of Standards and held in New York City. That effort led to the first publication of a safety code. This version of the code included three parts of rules for installation and maintenance of:

- Electrical Supply Stations and Equipment, (Part 1)
- Electrical Supply and Signal Lines (Part 2), and
- Electrical Utilization Equipment (Part 3).

In 1918 the “Scope and Application of the National Electrical Safety Code” was issued. This publication outlined the Code development process guidelines and described how the Code was intended to be used.

The document outlined approximately 100 typical accident cases including injuries to the public and electrical workers.

The fourth edition was published in 1926, the fifth in 1948 and the sixth in 1961. With the exception of a few significant changes in the late 1930’s and early 1940’s, the requirements of the 3rd edition (1920) continued with only minor changes until the 1970’s.

In 1972, IEEE became the secretariat of the NESC.
Meetings became more regular, especially for the Overhead Clearances and the Overhead Strengths and Loadings subcommittees.

Several editions were issued between 1972 and 1990 and during that period, there was a heavy emphasis on clearances. The 1990 edition adopted the Uniform System of Clearances that had previously been posted in Appendix A.

Another change of note was the “grandfather” clause that was introduced in 1977 for Part 2, Overhead Lines. A similar clause was present in the previous edition for Part 3, Underground Lines.

This rule states that existing construction does not need to be upgraded to meet requirements of a subsequent edition that are greater than the edition in effect when the line was constructed. Prior to this edition, all installations, new and existing, had to meet the rules for the 1961 edition for overhead lines.

With the publishing of the 1993 edition, the revision cycle was changed from 3 to 5 years, with an interim 4-year Code cycle resulting in the 1997 edition, followed by the 2002 edition.

From the development of the 1997 edition to the present, there has been a major emphasis on refining and improving the strength and loading sections. A significant change occurred in 1997 when combined Overload Capacity Factors were separated into separate Load Factors and Strength Factors. This positioned the code to be amenable to Load Resistance Factor Design, or LRFD, which is a common design practice in structural applications. The strength and loading rules continue to evolve as a result of Subcommittee 5 Strength & Loading activities.

The 2012 Edition brought significant revisions to the purpose and scope to clarify the role of the NESC versus the NEC and other standards.

In Part 2, clearance zone maps of Section 23 were made independent of loading maps in Section 25 with related clarifications to the clearance tables and language in Rule 235. Rule 215 covering grounding guys were improved for usability.

The two tables for Grades of construction for supply lines and communications lines were merged into a single, more convenient, table.

The alternate method for specifying load factors was deleted. The procedure based on separate load and strength factors, consistent with Load Resistance Factor Design is the only method provided.
For underground lines, an Exception was added to allow less than 12 inches of separation between supply conductors operating at not more than 300 V and gas and other lines that transport flammable materials where supplemental mechanical protection is provided.

The minimum approach tables for worker safety rules were greatly simplified (and recalculated), providing distances at the accepted historic maximum overvoltage levels, along with additions for calculation of arc flash risk assessment and appropriate protective clothing.

2015 marked the 100 year anniversary of the NESC. To commemorate the event, the committee organized the inaugural NESC Summit held in Washington, DC in April of 2015. The keynote speakers were from the Department of Energy and OSHA, and several executives from utility companies and industry provided insights on many of their current and future objectives.

Attendees also participated in visioning sessions that were focused on topics like

- the Future of the NESC,
- Safety versus Design versus Resiliency
- And NESC Process.

Presentations from the Summit can be viewed at the following link.

One of the most endearing presentations was provided by Don Hooper who has been around for the greatest portion of the NESC’s first 100 years. Don has been using the code since 1948 and has been active on developing the code since 1969 and a great deal of the material in the history section of this session was provided by Don.

There are several outputs from the Summit that are available for reference today. A white paper is available that details the visioning discussions. There are also six NESC videos created that address:

- Perspectives on Resiliency
- Engaging the Next Generation
- Focus on Worker Safety
- A Legacy of Safety
- Department of Energy Overview at the Summit
- OSHA Overview at the Summit
These videos can be viewed through links to standards university or through IEEE YouTube links by searching for NESC.

The 2017 edition of the code was published on August 1 of 2016 and becomes effective February 1 of 2017. A great deal of effort for this edition focused on making the code more easily readable and intuitive. There were also some significant technical changes and all of the new material is explained in a separate course focused on the 2017 edition.

IEEE also publishes the NESC Handbook. One version of the most recent edition of the Handbook has a new format. For easier reference, a representation of the language in the code is included along with the usual detailed explanation of the rule and historical discussion. The Handbook is not developed by the NESC, but by individual contributors who participate extensively in NESC committees.

This MOOC is the introductory overview of the NESC. Additional MOOCs and eLearning courses will be available and will explain the technical subcommittee subject matter in greater detail. Topics will include

- Definitions and references
- Grounding
- Substations
- Overhead Lines
- Underground lines
- and Work Rules

IEEE is sponsoring an NESC Workshop in San Antonio, Texas on October 18 and 19, 2016. The first morning will be a review of changes in the 2017 edition presented by each subcommittee.

Afternoon presentation topics will include

- Renewable and emerging generation technology
- Microgrids
- and then Interconnection Issues
The first day will conclude with speakers reviewing a white paper that describes and compares the roles of the NESC compared to the NEC which regulates the electrical system on the customer or load side of the meter.

The second day will focus on topics of

Resiliency

New wind loading maps

The future of worker safety in the code

And distributed energy resources

After an initial presentation on resiliency and the subsequent breakout sessions, the groups will help to set priorities for NESC work efforts going forward.

This concludes Week 3 of our NESC overview MOOC. Next week, we will discuss the NESC revision cycle and how to make changes in the code.

Thanks for joining us.

Revision Cycle

Welcome to Week 4 of this NESC Overview MOOC. This week, we will examine the NESC revision cycle, and learn how changes come about in the code and how the public can participate.

In general, work on the next edition begins soon after the newly available version becomes effective.

Change proposals can usually be submitted within the first half of the year preceding the deadline for receipt of proposals – for instance, March, prior to a July deadline. The next deadline for receipt of proposals for the 2022 edition is July 15th, 2018. Change proposals can be submitted by any substantially interested person, an interested organization, an NESC subcommittee or any member of the NESC committee or its subcommittees.

The proposal must be submitted on the NESC Change Proposal template, which requires the submitter’s name and indication of whether the proposal is being submitted by an individual or an organization. The Rule number and page number of the NESC are also included.
The proposal must be a statement in NESC rule form that shows the exact changes, deletions, additional text, rewording or new material proposed. Deleted words must be stricken through and words to be added must be underlined.

It is important to also provide supporting technical and safety related comments indicating the reasons why the NESC should be revised in the manner described.

Proposals must be submitted electronically to the Secretary of the National Electrical Safety Code Committee. An automatic email will acknowledge receipt of the proposal. Since the entire process is now electronic, proposals cannot be accepted in any other format. One may visit the NESC website to access the electronic revision process.

Following the submission deadline - for example, July 2018 for next code - the NESC Secretary compiles all proposals and distributes them to the appropriate subcommittees.

In the fall of that year, the subcommittees meet to vote and make initial recommendations on the proposals. A majority approval is required for each proposal to pass. Subcommittee Recommendations can be to

- Accept,
- Reject,
- Accept as Modified, or
- Accept in Principle, while referring to a similar, related change proposal that was accepted.

If any subcommittee member votes negative or abstains on the motion, the member must provide a written reason for voting negative on the subcommittee recommendation which is published in the Preprint.

After all subcommittees have voted, the NESC Secretary compiles all the proposals and any modified proposals, along with the subcommittee recommendations and explanations of negative votes. This compilation is referred to as the "Preprint".

Fourteen months after the deadline to submit change proposals, the Preprint is published and available for public comment.

The Preprint is automatically distributed to all members of the NESC subcommittees and representatives of organizations comprising the NESC committee. Notice of the Preprint’s availability is published in ANSI Standard Action and copies are available for sale to other interested parties.

The Preprint includes information on how to submit comments, also an electronic process. There is an eight month window for the public to submit comments. After the comment period closes, the subcommittees reconvene in the fall to review every proposal that received a comment. The comments are considered and final recommendations are made for those proposals. The recommendations determine whether the proposed change is accepted, modified or rejected.
A draft of the final respective subcommittee recommendations is issued to the subcommittees for a letter ballot. Once these letter ballots are completed, the complete draft document is submitted to the Main Committee for a final vote. Any issues at this point are resolved by the Executive Subcommittee.

The document is then submitted to ANSI for final approval and subsequent publication by IEEE on August 1st with an effective date of 180 days following the date of publication, February 1st, of the following year.

Adoption

The NESC is adopted individually by states. Each state has a Public Utility Commission or Public Service Commission which is responsible for determining if the NESC will be adopted, by what mechanism, and for which edition. In many cases, a state commission will have an automatic adoption process to adopt each new edition; in other cases, a rulemaking proceeding will take place.

For further information on individual state adoptions, visit the website of the National Association of Regulatory Utility Commissioners (NARUC) at www.naruc.org or the websites of the individual state regulatory commissions.

Some of the resources available to you include:

An interpretation request, which may be submitted when the wording of a specific rule or set of rules appear ambiguous or incomplete.

A Tentative Interim Amendment (TIA) to the National Electrical Safety Code may be proposed if it significantly affects the safeguarding of persons, utility facilities, and affected property and requires interim action prior to the approval of the next edition of the NESC.

Conclusion
This brings us to the conclusion of the first NESC Open Course. Over the weeks we have discussed the role of the NESC related to the grid and how the committee is organized.

We saw how each technical subcommittee has a specific focus like grounding or clearances and makes recommendations about change proposals received during the revision cycle every five years.

Celebrating the 100 year anniversary of the NESC in 2015 led to both an interesting look back at the early years of development and history along with a look forward to the code of the future. And remember, the public has ample opportunity to participate in the code development process.

On behalf of IEEE, this is Nelson Bingel thanking you for joining us on this journey.