



PROTECTION
ENGINEERS
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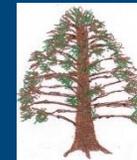
HUNTSVILLE, AL - MARCH 13-15, 2018

National Electrical Safety Code (NESC) Update

Presented by:

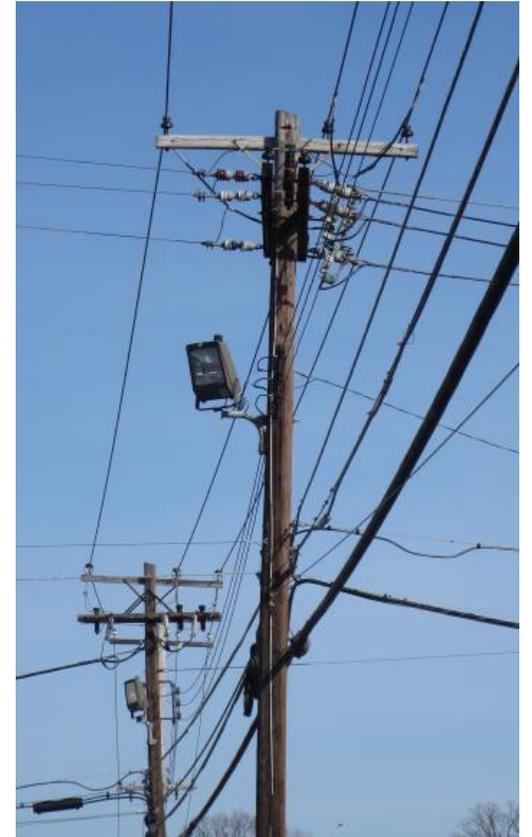
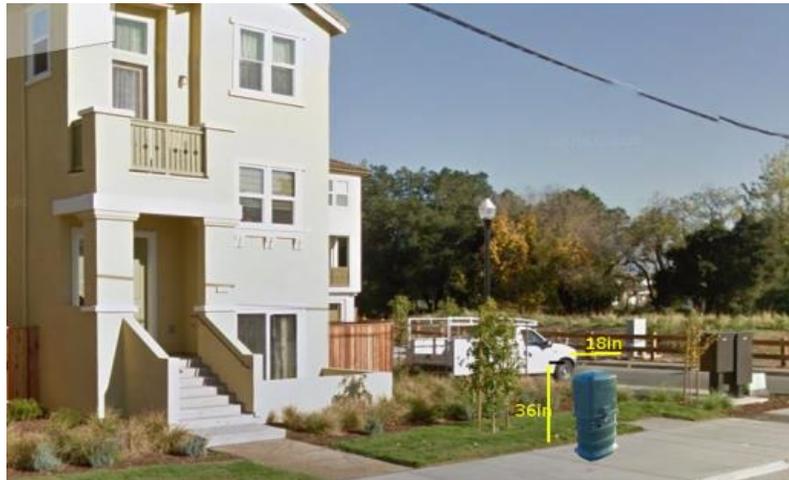
Trevor N. Bowmer, Ph.D.

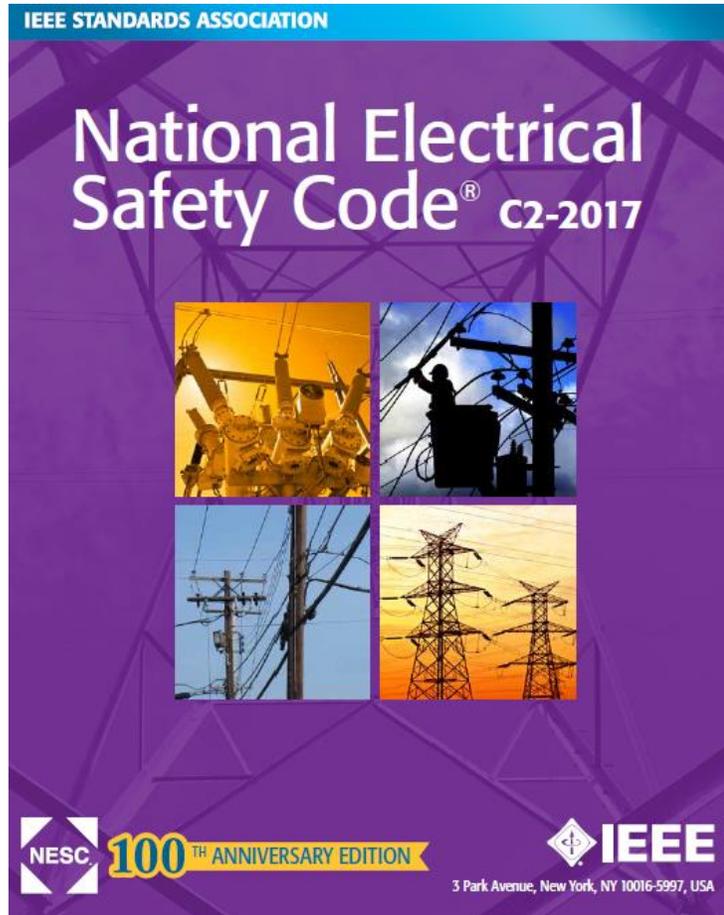
*Principal – Bunya Telecom Consulting LLC
for Telcordia-NIS (Ericsson)*



tnbowmer@gmail.com

- **NESC Overview**
- **2017 NESC Code – Reprise of Changes**
 - **Construction Blue Book – March 2017 Issue 6 (SR-1421)**
- **Code Making Process for 2022 Code**
- **Most Active Areas of Interest & Discussion**





Overhead Electric Line Construction



Prescribed by the
PUBLIC UTILITIES COMMISSION

IEEE – NESC

- NFPA -- NEC
- GO-95....GO128....GO165
- OSHA 1910.268/269
- Internal M&Ps
- GRs and UL Listings
- Joint Use Agreements (JUA)
- UL
- GRs/SRs
- ATIS
- etc.....

- Industry Safety Codes and Standards
- Regulatory Rules..... Legal Mandates
- Internal Practices.....Engineering Design

Purpose = The practical safeguarding of persons, utility facilities, and affected property during the installation, operation, and maintenance of electric supply and communications facilities.

Scope - covers supply and communication facilities and associated work practices employed by a electric supply, communications, or railway in the exercise of its functions as a utility.

- Facilities = lines, equipment, and specified infrastructure (e.g., poles, vaults...)
- The NESC covers similar systems under the exclusive control of the utility and being worked by qualified persons, such as those associated with an industrial complex or utility interactive system.

“NESC is Not a Design Guide or Instruction Manual “

However, the code is used as defacto minimum baseline to build off for design/engineering calculations. Extra safety factors and clearances are added to provide the highly reliable and resilient networks desired. A network designed to just or only meet minimum safety, clearance and strength rules is not wise planning or design for service reliability or network facility resiliency.

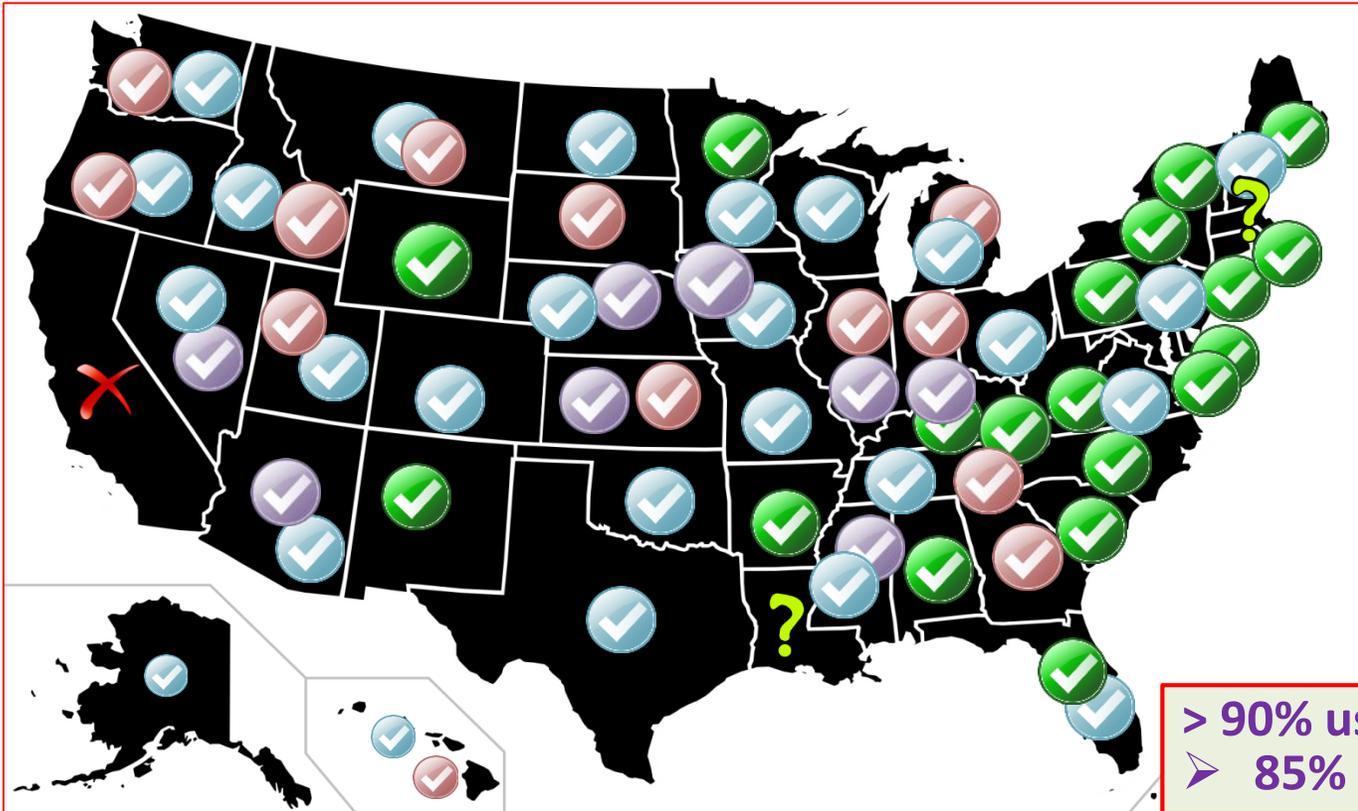
NESC - Adopted by most States and municipalities through legislative and/or regulatory (PUC) process after a review

- Automatic use of latest edition.
- Adoption of specific issue/date usually after review
- Some do piecemeal adoption (e.g., Washington State, Michigan and Iowa do not adopt Part 4 in its entirety)
- Some States have separate independent codes (e.g., General Orders 95, 128.... in California)
- Utilities within States often use NESC as basis for Joint use Agreements and regulatory practices

Contractual Basis of Joint-Use and Pole Agreements & Inter-Company Contracts.

Adoption & Use – 2016 View

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY



Automatically adopts latest NESC	Adopts current NESC after review	Currently use old Edition or part of NESC
		
Uses NESC to develop internal code	Does not use NESC	NESC Status Unclear
		

- > 90% use in some form
- 85% use current or near current version

- 5-year revision schedule – plans in progress to enable accelerated changes
- Administered by IEEE - Institute Electrical & Electronics Engineers
- Technical decisions made by Subcommittee (SCs) based on proposals
- Correlation/Coordination – SC1, Main, Exec Committees, Standards Committee
- 2017 Edition (released August 2016 → effective Feb 2017)
- Public change proposals (CPs) → due by July 16, 2018 
 - NESC Working Groups and industry discussions already underway
- SC action on proposals on Sept/Oct 2018 → 2022 Preprint published – 1st July 2019 
- Public Comments (PCs) on Preprint → March 1st 2020 → action on PCs during Sept/Oct 2020
- Review by Main & Exec. Committees → Jan-through May 2021
- Final Draft of 2022 NESC released May 2021 -> ANSI Approval
 - → Release of 2022 Code scheduled for August 1st 2021
- Applies on adoption by PUC, State legislative or local AHJ bodies

Open Process - Multiple Public & Internal Review Steps

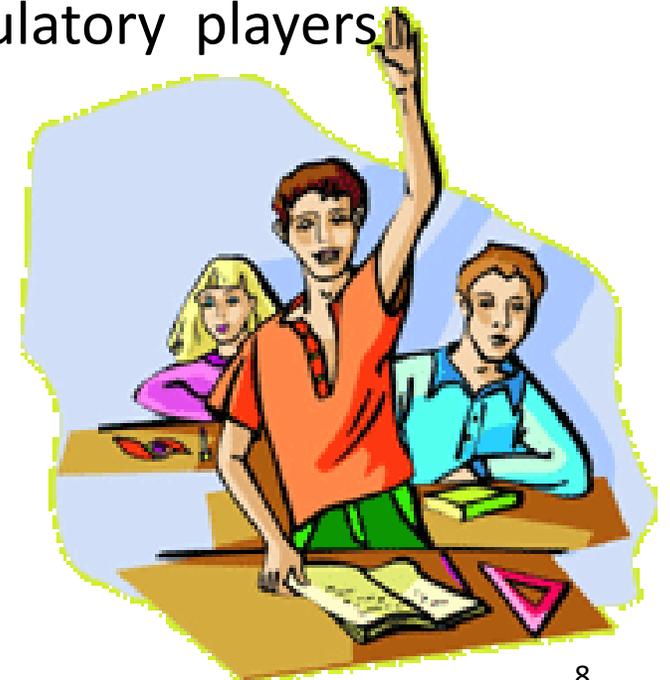
Active outreach efforts (IEEE) underway to add input

- Alternative energy generation and storage industry players
- Regulatory commissions (PUCs) and governmental/regulatory players
- Users and Stakeholder Communities
- Working Groups – Industry and SC/IEEE driven

Initial Public Inputs set tone and likely directions for code development → encourages early input

Appeals Process (rare event)

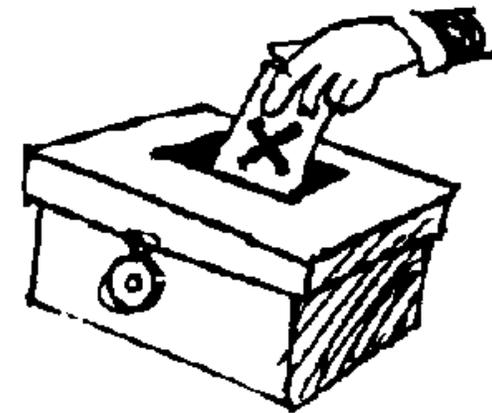
Adoption Variations – State by State, PUC..



Main and Executive Committees plus

5 of the 7 NESC Technical Subcommittees (not on Substations SC 3 or SC1)

- **SC1** – Purpose, Scope definitions
- **SC 2** – Grounding (Rules 09)
- **SC3** – Substations
- **SC 4** – Aerial Clearances (Rules 20-23)
- **SC 5** – Strength/Loading (Rules 24-26)
- **SC 7** – Underground/Buried (Rules 30-34)
- **SC 8** – Work Rules (Part 4 - Rules 40-44)
- **Main and Executive** Committees



Numerous clarifications and refinements with general objectives to improve the practical and consistent implementation of code and harmonize rules with industry best practices and work rules

- **Definitions** - power and communications equipment & adding definitions for their normal allocated spaces on a pole
- **Grounding & Bonding** – Rule 094 on ground rods, Rule 096 on allowed grounding exceptions, and Rules 097 (097G) & 384 pertaining to intersystem bonds
- Reorganization of rules (215 & 279) dealing with placement of **Guys and Insulators** to better protect public and workers
- **Grades of Construction** (Section 24 → Table 242-1)
- **Part 4 Work Rules** – alignment/harmony with 2014 OSHA Rules
 - Arc Flash..... MAD distances..... Fall protection....

Blue Book – Manual of Construction Procedures

Chapter 1	Overview
Chapter 2	General
Chapters 3 to 14	Aerial Plant
Chapter 15	Wireless Facilities (NEW)
Chapter 16 to 20	Underground Plant
Chapter 21 to 24	Buried Plant
Chapter 25	Bonding & Grounding – Customer Locations
Chapter 26	Cable Guards
Chapter 27	Fiber Optic Facilities (FTTX) - Deployment
Chapter 28	Symbols – Grid and Mapping Diagrams
Appendices	Informational Commentaries



Issue 6 Improvements

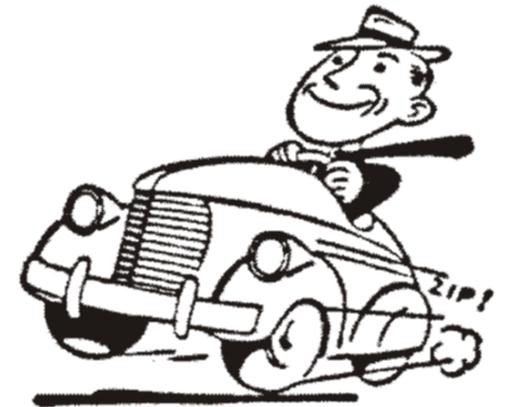
- 1. Updated and harmonized with 2017 NESC and NEC**
- 2. Size - 500+ pages = 38% increase in size**
- 3. Commentaries and clarifications added based on field problems, issues, and concerns over previous 6 years.**
- 4. New Wireless Chapter (Chapter 15) and incorporation of wireless facilities information in other chapters**
- 5. Updated Fiber Optic network (FTTX) - Chapter 27**
- 6. Expanded guidance and details on Grounding and Bonding issues – primarily in chapters 10 and 25**
- 7. Added commentaries on relationships between safety codes, product specifications and design/engineering choices to attain the desired network characteristics of quality, resiliency, and reliability**

PRIMARY = REACTIVE

- Problems, issues and conflicts revealed during active use of NESC
 - Joint-Use Agreement Conflicts – Wireless, Wireline, Power, Light Rail....
 - Problems during Engineering/Design/Planning activities
 - Regulatory Inspections – FCC, PUC, OSHA and AHJ Compliance
 - Tests & Inspections – part of routine work, planned, documented
 - Field incidents, accidents, and legal cases

SECONDARY = PROACTIVE (5 year code cycle can limit reaction time)

- Mismatch of new technologies to practices based on traditional codes
 - Alternate/hybrid sources and storage of energy – wind, solar, batteries, etc....
 - Smart Grid Devices – joint power and communications functions
 - Wireless Antennas – Growth into Femtocells and DAS systems
 - Intersystem Grounding & Bonding



- 1) Distributed Generation Power (DGP) – Solar (PV), Energy Storage (Batteries), etc...
 - Work Rules- In and around power generation and storage sites
 - Communications companies need to serve these sites – monitor, alarm, control
- 2) 5G – Wireless facilities and associated Joint Use Issues
 - Congestion - Management of multiple users
 - Working Space....Clearances....Wireless antennas ... FTTX Build-Outs
- 3) Powering the Internet of Things (IoT) /Wired Ethernet
 - NESC/NEC – Demarcation & Conflicts
- 4) Pole Loading Calculations
 - 60ft exemption... k factor....wind/ice loadings
- 5) Code process - Need to make NESC more flexible and responsive – FAST-TRAC



1) Distributed Generation Power – Energy Storage Batteries

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY

- Rule 420G – Liquid cell Batteries** – (Section Distributed Generation Power 14)

- Keeping up with new battery technologies → Liquid ?
- Lead-Acid, Lead-Calcium VRLA type systems Lead-Selenium
- Ni-Cd (Nickel-Cadmium) ... Ni-MH = Nickel Metal Hydride
- Na-Ni-Cl = Sodium Metal Hydride, sodium-sulfur
- Zn-Br, Zn-air, Li-ion – lithium ion technologies – variety of chemistries

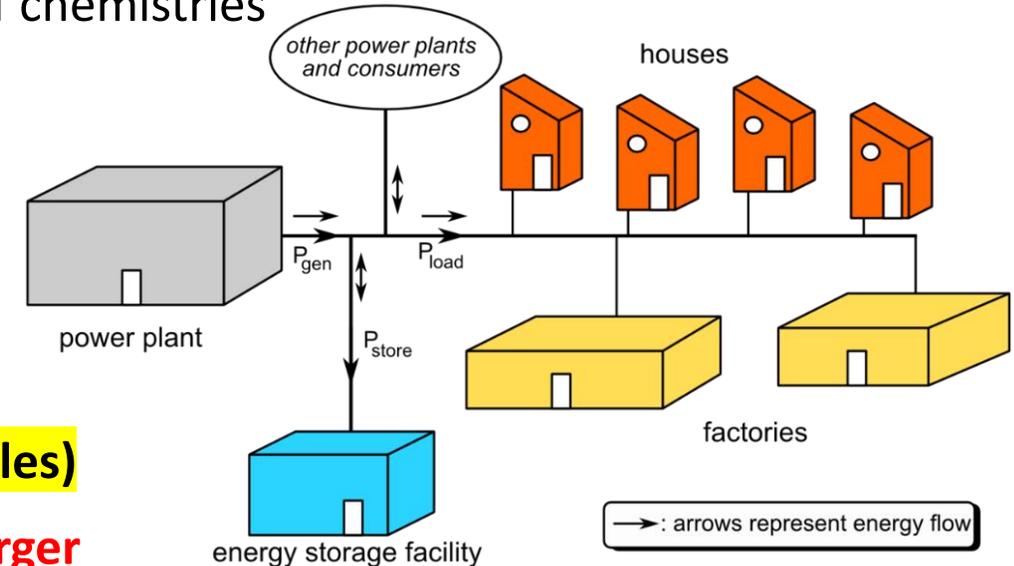
Growing varieties



- Related Issues for **Part 1 (Substations) & Part 4 (Work Rules)**

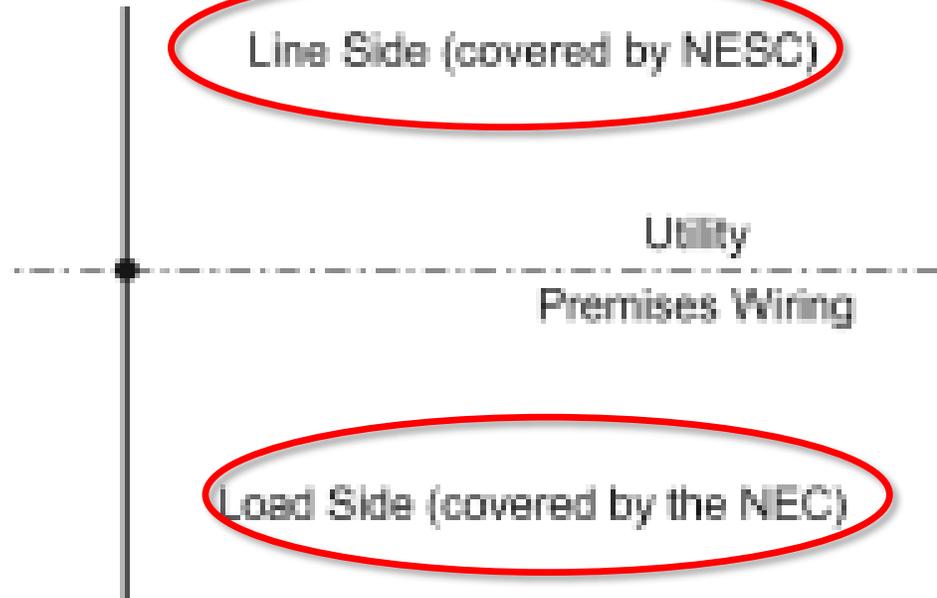
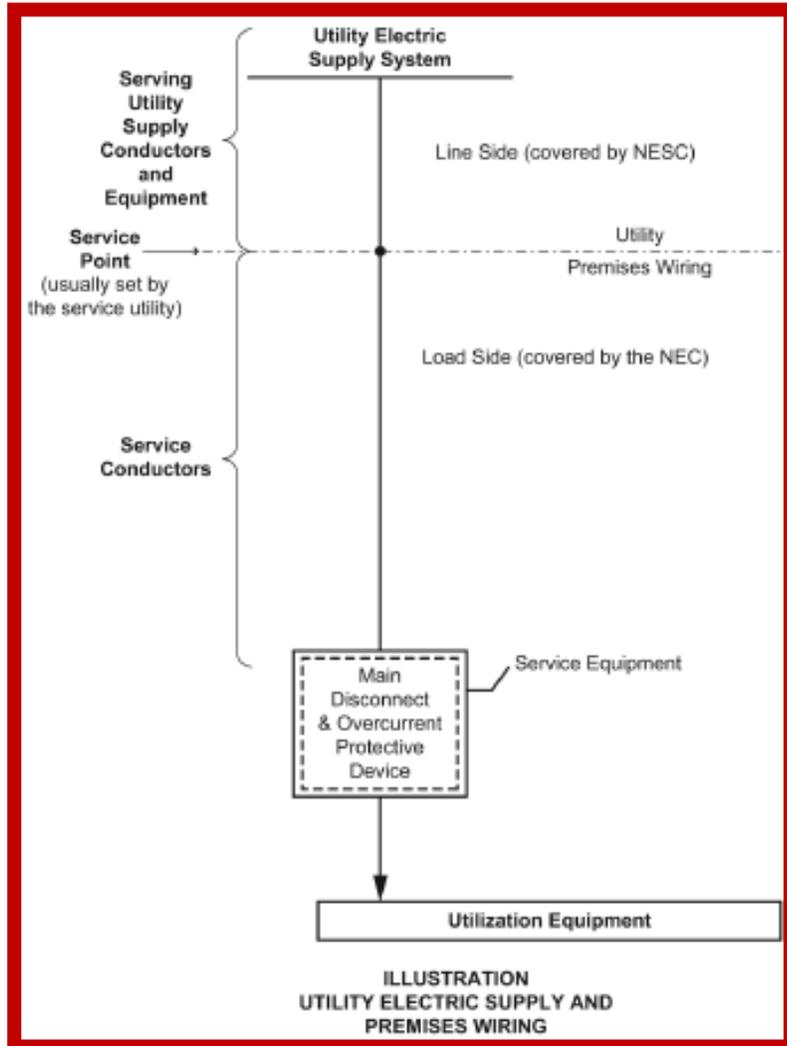
- Distributed power and alternate energy sources
- Solar and Wind Farms, Microgrids, fuel cells, etc...

Larger Facilities



Demarcation

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY



Electrical Supply Telecommunications
Service Points Network Interface
 Utility Defined Demarcation Point

- At Residence – Network Interface Device or Unit (NID or NIU)/Optical Network Unit (ONU)
 - Outside of house..... AC Panel inside house
- Commercial Building
 - Building Entrance Terminal (BET – inside or outside) Telecom Closet or Room
 - AC Panel or power Room inside building
- Communications Nodes - Electronic Hut or Cabinet or Active Fiber Hub
 - Closure Inside Hut
 - Distinct AC compartment in cabinet or separate adjacent box
- Lighting for Parking Area
- Long Rural line serving Remote Farm or Residence
 - At Main Road.....At Property Boundary.....At Buildings
- Distributed/Alternate Power– Solar/Wind farms, Microgrids....
 - Interconnection to power Grid Smart Grid Devices
- Line and span powering



2) 5G – Wireless Facilities & FTTx

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY

- A. Congestion
- B. Management of Multiple Users – Joint Use
- C. Clearances - from Power, Guys, other Communications Lines and Equipment
- D. Working and Access Space
- E. Wireless Antennas - RF Levels



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

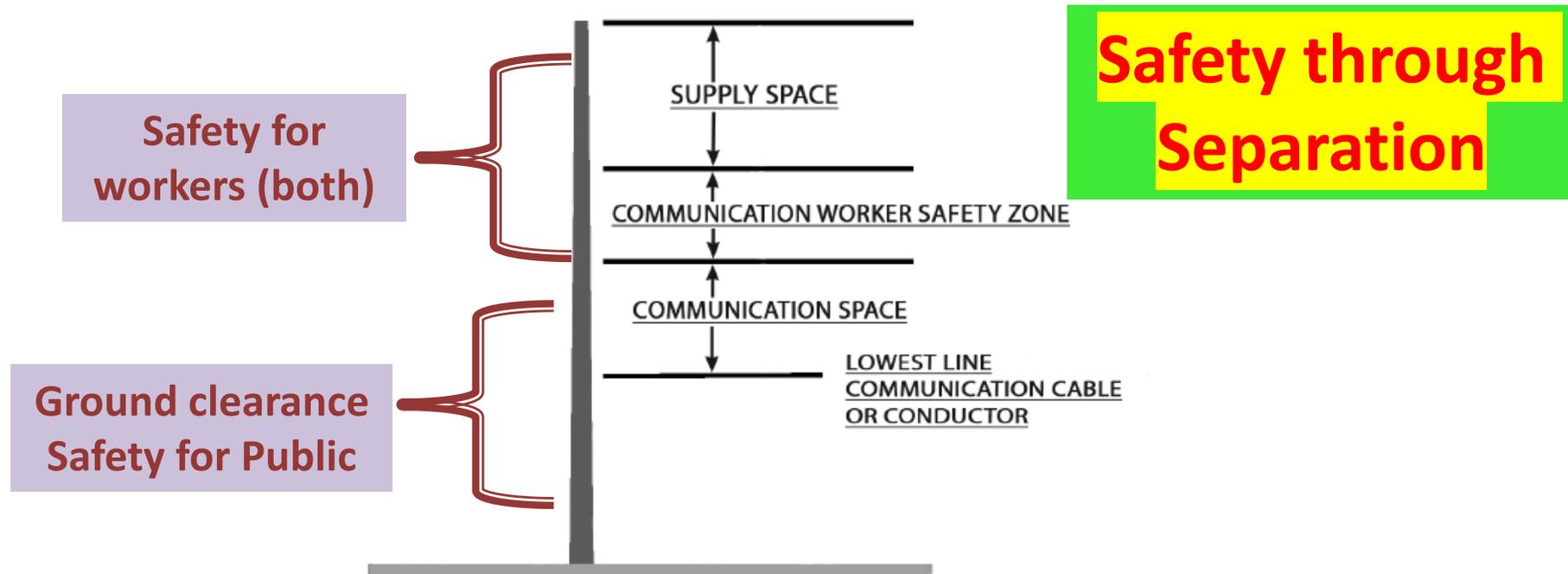
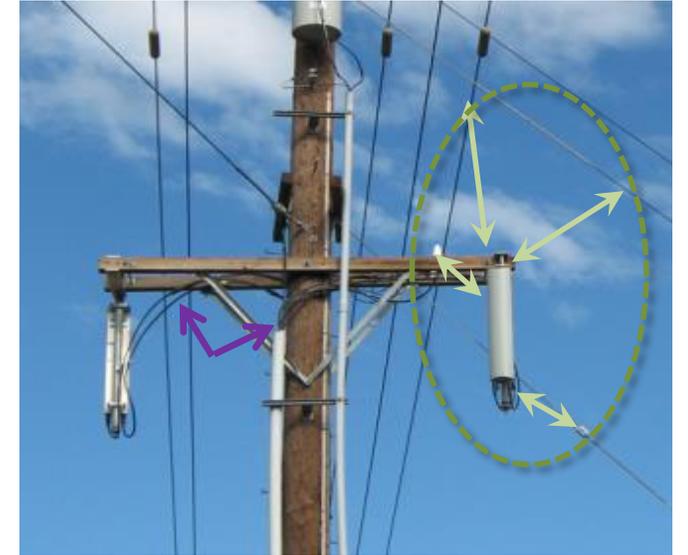


Figure D-1

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

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

- **Space Definitions (previous discussions)**
- **Clearances between communications lines Rule 235H**
 - 12 inch minimum separation at support
 - 4 inch minimum anywhere in span (spacers?)
 - Under all ambient conditions (all expected conditions)
 - Wording of rule expected to change in next cycle
- **Wireless (Antenna) Attachment – Rule 235I clarified**
 - All other clearances need to be met as facilities are attached to congested poles with multiple communications and power facilities
 - Engineering designs and configurations → Blue Book + other design and engineering guidance documents.
- **Clearance between communications and supply facilities – Rule 238**
 - Encourages grounding of supply equipment by having larger (40 inch) separation for ungrounded supply equipment





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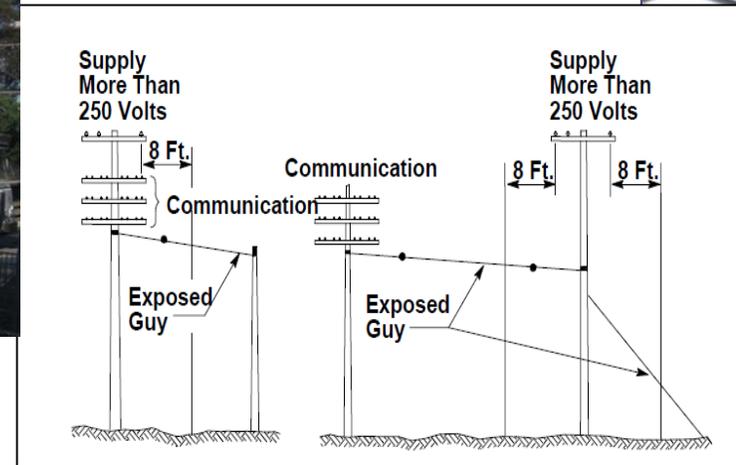
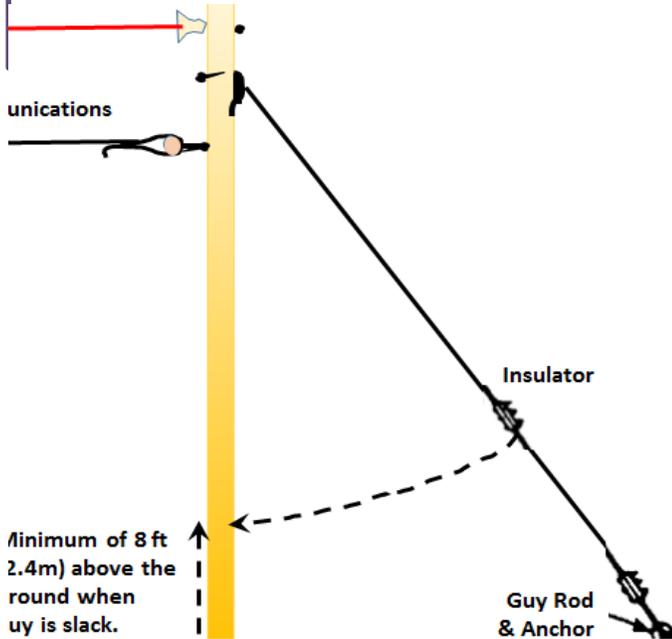
Clearance & Separation

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY



■ **Rule 215 - Guys and Guy insulators**

- Effectively grounded.....Connections through hardware
- Objective is that if guys are slack or broken, the guys do not create hazard to public.....Reference height is 8+ ft
- Protect both Public on ground and workers in aerial plant



Within the context of the NESC, Telecommunications Circuits are inherently safe based on the voltage/current limitations and descriptions found in GR-1089 and ATIS 0600315 industry.

- A. NESC Rule 224B for aerial plant
- B. NESC Rule 344 for underground/buried plant
- C. Section 2 – Definition of “**Communication Lines**” – provides considerable flexibility
 - a. located in the communication space. The conductors and their supporting or containing structures, equipment, and apparatus that are used for public or private signal or communications service, and which operate at potentials **not exceeding 400 V to ground or 750 V between any two points of the circuit**, and the transmitted power of which **does not exceed 150 W**. When operating at not more than 90 V ac or 150 V dc, no limit is placed on the transmitted power of the system. Under specified conditions, communication cables may include communication circuits exceeding the preceding limitation where such circuits are also used to supply power solely to communications equipment. Fiber-optic cables are considered as communication lines, regardless of whether they are installed in the communication space or supply space in accordance with applicable rules,
 - b. located in the supply space. Communication lines located in the supply space and meeting Rule 224A may (a) **operate at any voltage**, (b) include supply circuits of any voltage, or (c) be included within a supply conductor or cable operating at any voltage.

Modern communications cables can include power supply circuits for Power-over-Ethernet (PoE), span/line powering applications and to provide for other communications devices (e.g., antenna). Requiring each conductor of a supply circuit used exclusively to power communications devices to be *“individually enclosed with an effective shield”* is not necessary. Having additional shields around each individual conductor does not add significantly to the safety of the circuit or cable configuration.

- **2017 changes to Rule 224B2(a) – Aerial cables**

- a. Such cables shall have a conductive sheath or shield that is effectively grounded, and each such circuit shall be carried on conductors that are individually enclosed with an effectively grounded shield.

- **2017 changes to Rule 344A1– Underground/Buried Cables**

1. Such cables shall have a conductive sheath or shield that shall be effectively grounded, and each such circuit shall be carried on conductors that are individually enclosed with an effectively grounded shield.

EXCEPTION: The requirements of Rule 344A do not apply to communication circuits where the transmitted power does not exceed 150 W.



This is an older hybrid cable design that is a power cable which had 480 V power on the 1/0 AWG conductors as well as some communications conductors in the center portion.

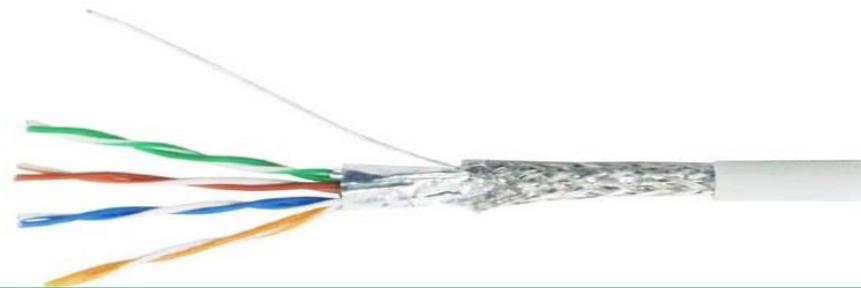
The safety concerns on the use of this type of hybrid power cable was the reason that this 224B and 344 rule was first created.

This hybrid construction does require the individual shield/ground for each 1/0 AWG conductor for safety reasons.

The configuration to the right has individual shields and complies with 2012 NESC.



The objective for the NESC change was to permit the safe shielding variation shown below for span powering or line powering applications over small gauge twisted-pair (19-24 AWG) conductors. These are much lower voltage and power level circuits than the 480 V power cable shown to the left.



NESC Rule 097 has 7 interlocking subsections with implicit/explicit links to other Rules (e.g., 096, 224, 344, 354, 384) applicable to intersystem bonds (between grounding circuits of power and communications)

- Rule 097A -- separate grounding conductors
- Rule 097B – permits a bond to the power ground where a MGN system is being used and providing Rule 097C (i.e., 4 grounds/mile) is met.
- Rule 097C - 4 grounds/mile criteria helps define an effective ground
- **Rule 097G** requires a single grounding conductor on structures except as required by Rule 097A

- **Sets expectation that bond to vertical ground should be made unless explicit technical or safety reason exists not to bond**
- **Clarifies the relationship between 097G and other subsections of Rule 097 by placing the criteria in explicit Exceptions.**

Revisions for clarity were made in 2017 NESC that now reads -

G. Bonding of communication systems to electric supply systems

Where both electric supply systems and communication systems are grounded on a joint use structure and a single grounding conductor is present, the grounding conductor shall be connected to both systems. Where separate supply and communications grounding conductors are used, they shall be bonded together.

Exception 1: Where separation is required by Rule 097A

Exception 2: Where the electric supply utility is maintaining isolation between primary and secondary neutrals, the communication system ground shall be connected only to the primary grounding conductor if it complies with the requirements of Rule 097C.

4) Pole Loading Calculations

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY

NESC Sections 24, 25 and 26

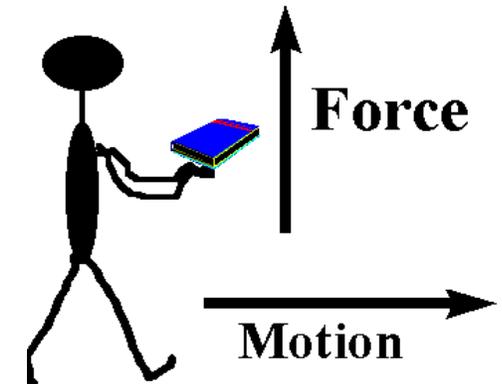
1) Pole Strength

2) Loading and Safety Factors

- 60 Foot Pole Exemption
- k Factor
- Appropriate & “Realistic” Wind/Ice Loadings
- Non-linear Factors



- **Construction Grades** – Reorganized & Clarified (Table 242-1) in 2017 code
 - More clearly define where and when each Grade is applicable
 - Grade N used for temporary emergency work, private rights of way and drops
 - Grade B = highest grades – for joint use & railroad crossings
 - Grade C = most often for communications poles
- **Open Issues with active discussions for Next Cycle**
 - “K additive constant” - Retained for present but
 - Appropriate & “realistic” **Wind/Ice Loadings**... ASCE
 - **60 foot exemption** – Retained in 2017...but
 - **Non-Linear Design Factors** – still in wings for future introduction
- **Communications Consequences** - May become more of an issue for communications companies as design/engineering negotiations with other joint users and pole owners for placement locations for 5G wireless and FTTX build outs in congested aerial spaces



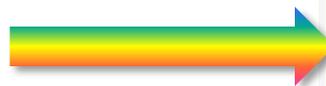
5) Code Process

IMPROVING NETWORK INFRASTRUCTURE RELIABILITY AND SUSTAINABILITY

- Need to make NESC more flexible and responsive to changes in technology
 - Wireless antenna and equipment – strand and pole mounted equipment
 - Line powering and other powering architecture
- Introduced a FAST-TRAC process to permit rapid temporary interim changes to the code during the 5 year lifetime of a NESC edition.
- Outreach Programs - On line tools, guidance and services - MOOCs (Massively Open Online Courses) --- main website for info = www.standards.ieee.org/about/nesc
- Code Events and Workshops to foster interest & input from public and interested stakeholders – includes power and communications companies, code regulatory officials (PUCs, state, municipalities ...)

- Changes for the Future : San Antonio TX - Oct 2016 – just after 2017 code finalized
- Main Committee : Charlotte NC August 2017

- **Change Development Workshop :**
Savannah GA April 10-11th, 2018



http://standards.ieee.org/events/nesc_change_proposal_development_workshop.html



- Distributed Generation Facilities → Scope, Part 1 (Substations), Part 4 (Work Rules)
 - Utility scale PV, wind and other facilities
 - Work rules in facilities
 - Battery and energy storage
- Wired Ethernet Evolution and Powering the Internet of Things (IoT)- Parts 2 & 3
 - Consequences (if any) of clearance, separation and work rules for actual and proposed powering options for communications networks including span powering and pulsed (interrupted) DC
- Evolution to 5G – Part 2 – Mostly Sections 20-23
 - Wireless facilities – necessary clearances for pole and strand mount options
- A National Approach to Joint Use – Code Process, Adoption & Regulatory Actions
- Pole Strength & Loadings - Scope and Section 24 through 27
 - Resiliency -- Reliability -- Storm Performance



***Thanks for
Your Attention***

