Update on Safety Codes
National Electrical Safety Code (NESC)
California GOs-95, -165

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Contact:

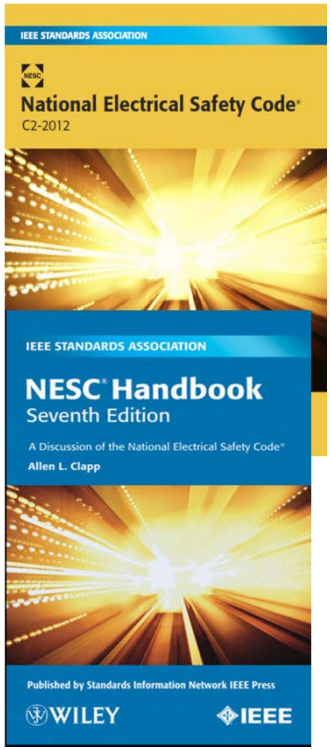
Trevor N. Bowmer, Ph.D.
Senior Analyst - Ericsson
Telcordia - Network Infrastructure Solutions (NIS)
Trevor.Bowmer@Ericsson.com
Ph. 732.699.3341

- **Code Overview** 
  - Codes - NESC…GO 95…NEC….OSHA….
  - Best Practices – Personal Safety & Facilities Reliability
  - Engineering Design for Efficient & Reliable Operation

- **Issues (active)**
  - Bonding & Grounding
  - Congestion – on Poles and in Buried locations
  - Scope Boundaries of NESC/NEC
  - Work Rules - Tests and Inspections
  - Clearances
  - Pole Loading and Strength

- **Plans and Paths Forward - 2014/2015**
  - NESC Preprint
  - Blue Book Revision (Issue 6)

Adventures in Code Land



IEEE
Advancing Technology for Humanity

National Fire Protection Association
The authority on fire, electrical, and building safety

California Public Utilities Commission

Overhead Electric Line Construction

Prescribed by the
PUBLIC UTILITIES COMMISSION

- **IEEE – NESC**
- NFPA -- NEC
- GO-95.. GO-165
- OSHA
- 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**

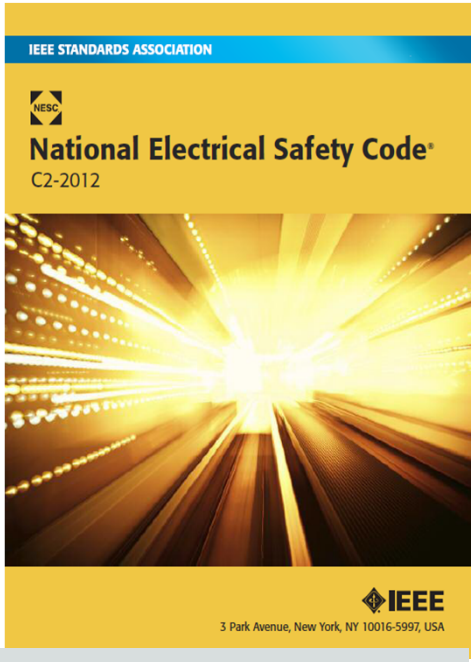
National Electrical Safety Code

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

- Contains the basic provisions that are considered necessary for the safeguarding of the public, utility workers and utility facilities under the specified conditions.

Scope: The NESC covers supply and communication facilities and associated work practices employed by a public or private electric supply, communications, railway, or similar entity in the exercise of its function as a utility.

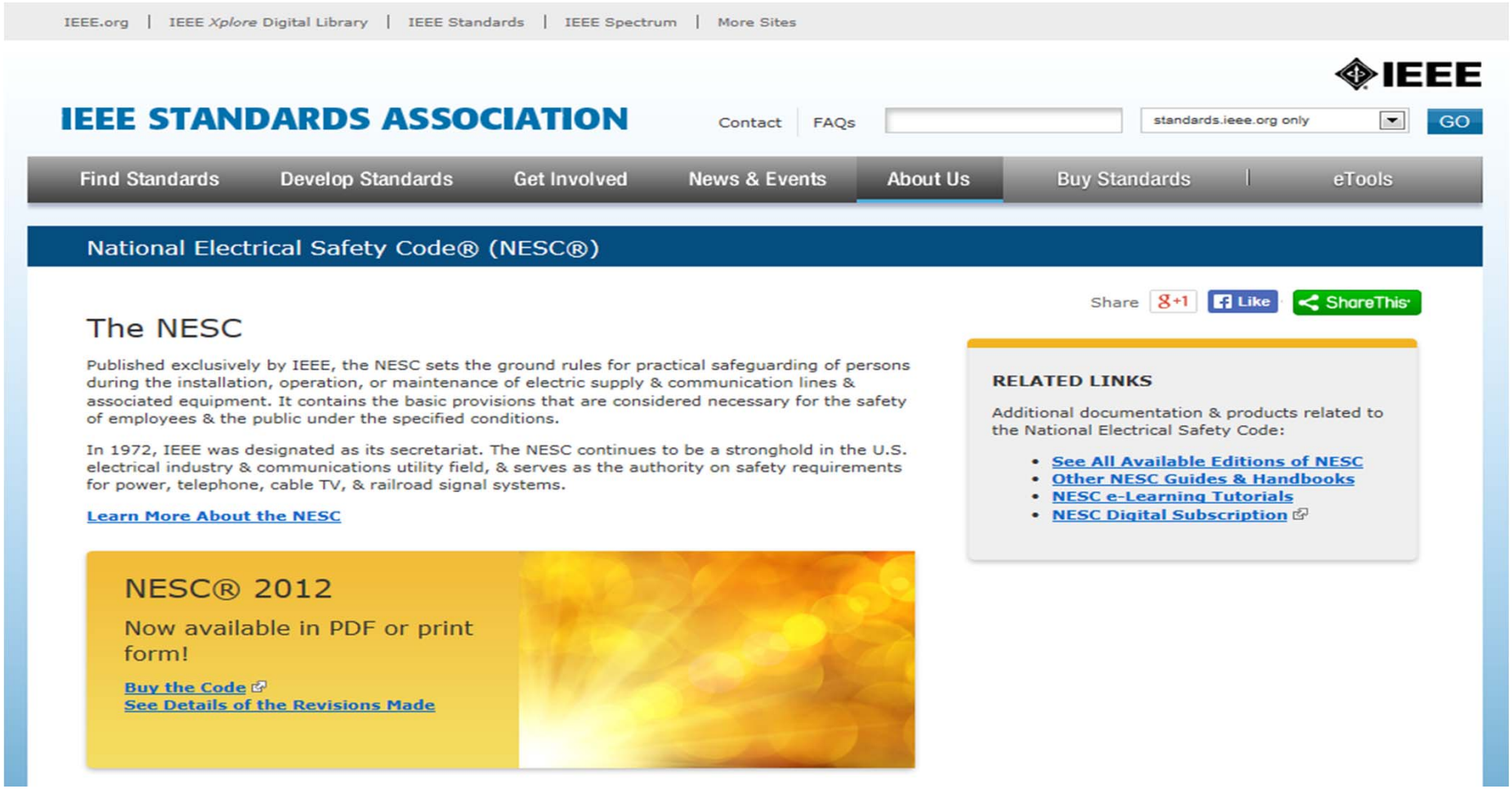
- Facilities = lines, equipment, and specified infrastructure
  (e.g., poles, sub-stations, vaults…)
- The NESC covers similar systems under the exclusive control of the utility and being worked by qualified persons, such as those associated with an industrial complex or utility interactive system.



2012 (current) -- → -- →-- 2017 Code

National Electrical Safety Code

- NESC is not intended as a design specification or as an instruction manual – http://standards.ieee.org/about/nesc
- The implicit assumption exists that regular operational cooperation as well as formal joint-use agreements (JUAs) exist between all power and telecom utilities sharing a pole, underground vault, location or area.



NESC Status and Process

A. Aug 2011 – 2012 NESC Published

B. July 2013 – change proposal deadline for changes to 2012 Edition

C. Sept.– Oct. 2013 -- NESC Subcommittees met to consider change proposals and prepare recommendations for 2017 Edition (the pre-print).

We are here → WGs, Review of Preprint, New Comments

D. Sept. 2014 - Preprint of proposed 2017 Edition released → Opens the public comment period until to May 2015

E. May 1, 2015 – Final comments received on 2017 Draft

F. Sept.– Oct. 2015 -- Subcommittees and their Working Groups consider all comments and recommendations.

G. 2016 - 2017

- New NESC submitted to Accredited Standards Committee and to ANSI for recognition → ANSI approval (~June/July)
- August 2016 -- Publication of 2017 NESC → Effective no later than 2/1/2017

Main Drivers for NESC Changes

PRIMARY = REACTIVE

- Problems, issues and conflicts revealed during active use of NESC
  - Problems during Engineering/Design/Planning activities
  - Joint-Use Agreement Conflicts
  - Regulatory Inspections - OSHA and AHJ Compliance
  - Regulatory Harmonization and Feedback
    - FCC, Public utilities – Boards and Commissions
  - Field incidents, accidents, and legal cases

SECONDARY = PROACTIVE (5 year code cycle limits reaction time)

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

Underlying Concerns & Issues -1

- **Bonding and Grounding (Rule 96C, 097, 097G, 099, 384)**
  - Different stakeholders have different purposes and objectives
  - Delineate purpose of grounding and bonding
  - Protect people and equipment from effects of lightning, power fault, stray current and induced voltages
- **Congestion on Poles and in Buried locations (Sections 2 and 3)**
  - Multiple joint users and competing users for available space on pole and under the ground
- **Scope Boundaries of NESC/NEC - Codes Inter-Relationship - NESC…NEC…GO95**
  - Competition for AHJ control of areas – safety, permits, control and economics ($$)
  - Alternative and distributed generation systems:
- **Risk Management - Work Rules - Worker & Public Safety (Part 4 - Work Rules)**
  - Work Skill/Experience/Training ….M&Ps….Engineering Controls
  - Contact Avoidance…Minimum Approach Distance - IEEE 516/OSHA
  - PPE - Voltage detectors, clothing, equipment
  - Emergency restoration Vs. standard work operations (Applicable Construction Grade)
  - Regulatory and Legal – inspections, documentation & records
    - Conditions versus Defects
    - Extraordinary threats versus “expected” stresses

Underlying Concerns & Issues - 2

- **Clearance and Separation**
  - Avoiding conflicts - field problems and failures
  - Clarification of code – consistency of interpretation and calculation
  - Failure at times of emergency → power outage and service loss at most inconvenient time
- **Pole Loading and Strength**
  - Accurate prediction of pole performance under “all” expected conditions
    - Normal circumstances - loadings of cables and equipment – for many decades of use
    - Regular variations – winter to summer, rain storms to snow/ice to wind
    - Extreme events – 50 year ….100 year event ….?
  - Fair and Consistent application of safety factors -
    - Load & Resistance Factor Design (LRFD) Vs. Allowable strength Design (ASD)
  - Regulatory – “will not fail” …..high reliability objectives
  - Safety Factors

Competing Views from

Engineers (Design/Plan) --- Statisticians – Meteorologists – Regulators --- AHJs

- Code Overview and Background
  - Codes - NESC…GO 95…NEC….OSHA….
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  - Engineering Design for Efficient & Reliable Operation

- **Issues (active)** 
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  - **Congestion – on Poles and in Buried locations**
  - **Scope Boundaries of NESC/NEC**
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GROUNDING AND BONDING

Key NESC Rules

Rule 097 - *Separation of Grounding Conductors*

Rule 099 - *Additional Requirements for Grounding and Bonding of Communications Apparatus*

Why Bond And Ground?

Appropriate Bonding and Grounding Helps to Ensure the Safety of the Outside Plant Network, Employees and Public

SAFETY

- Reduce the hazard of electric shock to employees and the public from unintentional contact with power faults and power crosses
- Limits the extent and minimize the damage caused by lightning (but cannot prevent damage entirely)
- To reduce corrosion and subsequent deterioration of hardware/anchors that could put a pole line's integrity in jeopardy.

QUALITY OF SERVICE To reduce noise in telecommunications circuits

INTEGRITY OF THE NETWORK -- To mitigate

- Effects of power surge voltages and currents in telecom facilities -- it is important to establish and maintain continuity of the cable shield
- Electrolysis which can cause corrosion of shield, strand, and anchor
- Damage to electronic equipment and telephone plant caused by power & lightning surges

Grounding and Bonding Issues

- **"Effective Grounding" –** New definitions in and use throughout code to help delineate the purpose of grounding and bonding
- **Grounding system** needs sufficiently low impedance or resistance to:
  - Enable protection circuits for the power system to operate rapidly and efficiently
  - Drain unwanted, foreign voltages or currents to earth (ground) thereby minimizing hazards to workers and equipment.
- **Intersystem grounding and bonding** – Where and when to bond or not to bond (Rules 096, 097G, 344, 354, 384C)…
- **Grounding Conductor -** Alternative conductor design 30% vs.. 40% conductivity
- **Long Spans –** Change to Rule 096C to allow not require opening of jacket sheath to only ground the shield (Rule 096C)

Baseline Guidance - Aerial Plant

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Bond

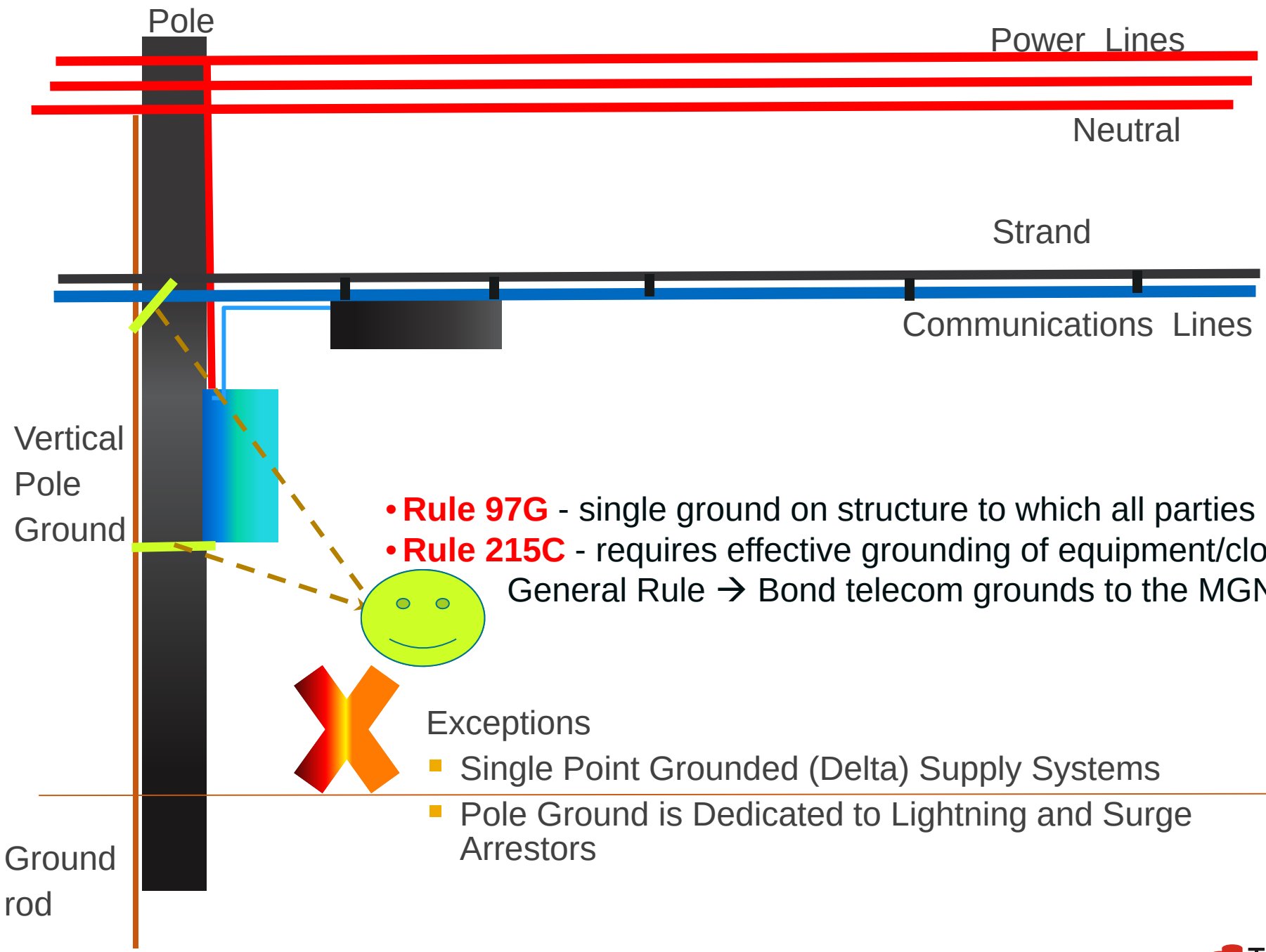
- Copper cable shield to strand at least every ¼ mile
- Strands of separate copper cables on same pole together every ¼ mile.
- Attachments to strand dead ends.
- Communications attachments to communications grounds where they exist.
- Strands that intersect from different copper cable leads (crossover poles)

Ground

- Strand dead ends
- Supporting messenger (strand) every 1320 feet (1/4 mile) with Ground Bed

Telcordia

Intersystem Bonding: Pole MGN



- **Rule 97G** - single ground on structure to which all parties bond
- **Rule 215C** - requires effective grounding of equipment/closures

General Rule → Bond telecom grounds to the MGN

Exceptions

- Single Point Grounded (Delta) Supply Systems
- Pole Ground is Dedicated to Lightning and Surge Arrestors

Intersystem Bonding to Power

Function of Power System Grounding Scheme

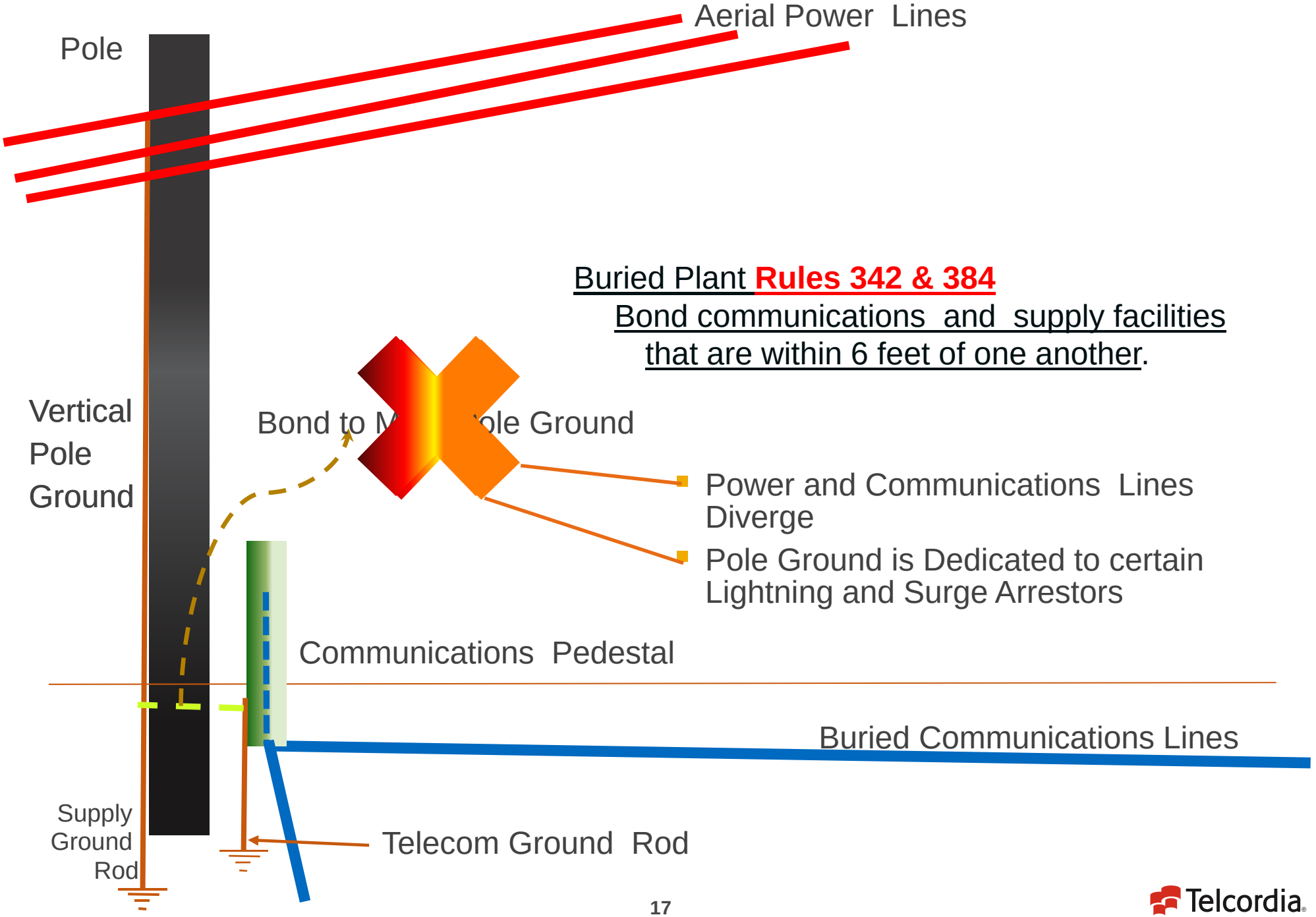
- Multi Ground Neutral (MGN) Systems
- Delta and Wye grounding schemes

- MGN connection is the preferred method to help ensure parallel communications network is properly grounded.
- Many major power utilities in the southern and western USA(*), regardless of grounding type, deny permission to telecom to attach to their grounds.

  (*) Mainly in California where 42 different power companies deny permission; but also increasing resistance to MGN bonding is found in North Carolina, Texas, Oklahoma, Louisiana, other States in the western and southern portions of the USA.

- Possible current in vertical pole grounds from unbalanced loads, surges and faults (lightning or power supply problems) can pose threat to telecommunications circuits if energy is dispersed more through the telecom equipment then to earth
  - NEETRAC study suggests in is better to not bond pole ground directly to adjacent pedestal ground to avoid introducing damaging current/voltage into telecom circuits

Buried—Aerial : To Bond or Not to Bond?



Buried Plant **Rules 342 & 384**

Bond communications and supply facilities that are within 6 feet of one another.

Rule 097 - Separation of Grounding Conductors

Rule 097 has seven (7) individual interlocking sections with connections to other rules (e.g., 096, 224, 344, 354 and 384) applicable to intersystem bonds

- Rule 097A requires separate grounding conductors except as permitted by 097B providing 097C (4 grounds/mile)is met.
- 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.
  - The combination of Rule 097B with 097C is the basis for the practice of bonding communications to the vertical pole supply ground in MGN systems with a 6AWG conductor and approved connector. It is highly desirable to maintain and encourage this practice with an intersystem bond between power and communications systems as the first choice if practical.
- Rule 097C - 4 grounds/mile criteria for an effective ground
- Rule 097G requires a single grounding conductor on structures except as required by Rule 097A
  - One objective of Rule 097G is to distinguish between intersystem bonding necessary in cases of MGN power systems as opposed to ungrounded or single grounded systems.

Rule 097G Proposals

Ericsson

Current 097G

G. Bonding of communication systems to electric supply systems

Where both electric supply systems and communication systems are grounded on a joint use structure, either a single grounding conductor shall be used for both systems or the electric supply and communication grounding conductors shall be bonded together, except where separation is required by Rule 97A. 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.

Change accepted as follows –

G. Bonding of communication systems to electric supply systems

Where both electric supply systems and communication systems are to be grounded on ~~a~~ the same joint use structure, either a single grounding conductor shall be used for both systems or the electric supply and communication grounding conductors shall be bonded together, except where separation is required by Rule 097A. 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.

Telcordia supported this actions as the best interim measure with the following affirmative comment in ballot :

"These accepted changes to Rule 097G help clarify the rule. However, the last sentence of revised Rule 097G requires work to better clarify when, and when not, a bond is appropriate between communications grounds and supply grounds in single-point grounded systems and cases where isolation is being used in power system. Further work on a revision to the last sentence of Rule 097G should be considered."

Telcordia

Alternative Rule 097G - Planned as a Submission as a Comment to Preprint

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1. *Ungrounded or single-grounded systems*

   The communication system ground shall be connected only to the secondary neutral's grounding conductor

2. *Multi-grounded systems*

   The communication system ground shall be connected only to the primary grounding conductor.

Telecom Grounding Preferences/Choices

1. MGN - Connect to an MGN
2. *Manhole Grounding System*
   - *Ground ring or ground bed*
3. *Telecom Ground Bed –*
   - *Three x 8-feet long (*) ground electrodes (ground rod)*
   - *Minimum of 8 feet apart and strapped together with a #6 AWG bare copper ground wire.*
   - *Each rod is solid corrosive-resistant copper.*
4. *Counterpoise Ground – Ground wire in an open trench to a handhole, pedestal, or manhole.*

(*) 8 foot in network….5 foot allowed at residence

Buried Plant

Bond cable shield to power neutral ground at

- At least every other terminal not to exceed 1000 feet
- At terminal nearest each transformer
- At all aboveground terminals, apparatus cases, and cable closures which are within 6 feet of any above ground power apparatus

Since in many or most cases, no access to power bonding & grounding source is available.

- Place a ground bed
- Place ground at the beginning and end of the laterals and major branch splices
- Bond cable shields
  - Within 500 ft of first transition point (e.g., pedestal, crossbox)
  - Within 500 ft of the CO side of any new buried cable pulling off from an existing route (branch location).
  - At least every other terminal so as not to exceed 1000 ft to a ground bed.
  - Within 500 ft of the end of the cable route, no additional ground rods are required.

Long Span Exception (Rule 096C)

Change to Rule 096C accepted to add an exception

Do not need to open jacket sheath to only ground the shield (Rule 096C)

Long spans with limited access and reduced exposure

- Long underground runs with no splices or connection points (closures)
- Water crossing or canyon crossing spans with no logical access or splice points

Bonding/grounding required at next convenient pedestal or splice

- Grounding to Earth
- Intersystem bonding between telecom and power grounds


CONGESTION

Congestion

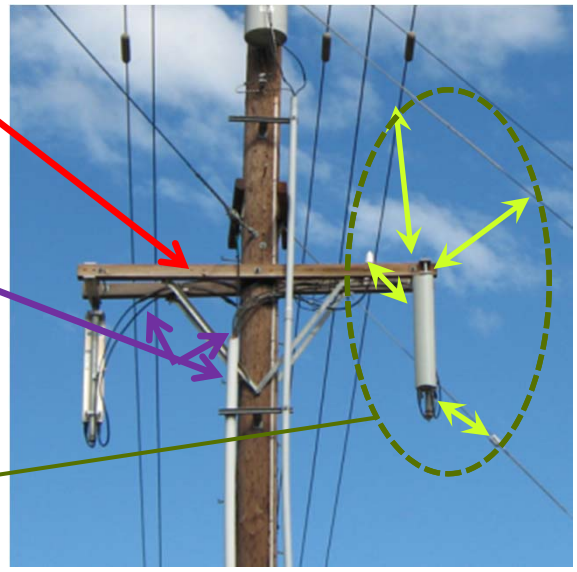
- On Poles
- In Buried Locations
- In Underground Facilities

  (ducts, conduits, vaults…)

  - Urban versus rural areas
  - Power, water, …. other utilities
    - A broad definition of “joint use” includes facilities near, adjacent, and in the vicinity of the telecom plant
  - Drive for new technologies – wireless, broadband, new builds and so forth → helps increase density of interconnected devices and facilities

    Smart grid devices, Wireless – antennas, power supplies etc…, Security devices for control and surveillance, Traffic lights, Luminaries, Light rail and so forth
  - Depths and Order of Buried Plant

WIRELESS ANTENNAS ….



Strength of Support Elements

Vertical Conductor Protection

Obstructions to Working Space

RF Radiation Hazards

Clearance from Supply Line Conductors

Code Scope and Demarcation

Harmonization, Demarcation, and Competition, Between Codes

Joint Use
Competition -- Cooperation

Code Scope Boundaries

- Supply Equipment in Communications Space
- Definitions
  - “Supply” and “Communications” equipment
  - Communications Worker Safety Zone (CWSZ)
- Limits for communications plant
  - Power limited circuits
- Wind and Solar panel farms

Themes and Trends

- **Demarcation between Codes and Standards - NESC/NEC/GO95…local codes**
  - Codes are not in significant technical conflict over general objectives and intent – However the “Devil is in the Details”
  - Local interpretations vary greatly between inspectors, local authorities, and individual utilities → generate conflicts
  - Other (Hidden) Agendas – Business and Economic Drivers, Regulatory and Local /State/Federal Political Factors
- **Ongoing Refinements to make code practical and usable**
- **Conflicts around Congestion Issues**
- **Communications (Lack of ?) Between Stakeholders**
  - Cooperation between all Joint users of structure and Right-of-Ways

Demarcation Between Codes

Electrical Supply …….. Telecommunications

Service Points ……Network Interface

****Utility Defined Demarcation Point****

- Residence
  - Outside of house – Network Interface Device (NID)/Optical Network Unit (ONU)
  - 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

Other Codes and Regulatory Influences e.g., California GO 95 …… FCC ....)

- **Multiple Purposes of Codes**
  - Safety to Workers and Public
  - Regulatory and Legal Compliance – Risk Management
  - Engineering – help ensure practical and useful rules to facilitate safe Joint Use installations and work rules
  - Continued communications in times of disaster and emergency
- **LRFD versus ASD Engineering designs**
  - Safety Factors
  - Load Calculations
  - Worst case situations Vs. “Expected” stress
- “**Will Not Fail**”
  - Precision of Legal/Regulatory Language
  - Engineering Reality
- **Continuity of Communications including Cellular Service**
  - → Backup reserve power
  - → Duplicate routes
  - → During/after Wild Fires

Risk Management

Inspections
Tests
Responsibilities

(Legal, Regulatory, Service Availability)

Risk Management - Work Rules

- Tests and Inspections (Rules 214 & 313)
  - Conditions versus Defects
  - Routine inspections during other work vs. separate program
- Maintenance and Activity around Batteries
- DC Circuits - Arc Flash Risks, Protection and PPE
- Aerial Lifts
- Clearances, separations, buried depths,

Operational Concerns in Legal Cases

- Inspections
  - Incidental to Regular Work Activities
  - Separate Inspection Programs (Frequency?)
  - Can be Regulatory or legally driven
- Documentation and Records
  - Trouble Report Calls - Response times and Access to Data
  - Installation/Maintenance/Repair
  - Engineering and Design Records - Pole Loading Analysis
- Practices
  - Routine inspections for safety of workers and public
  - Corrections of Defects and Reporting of Conditions
  - Differences in Operations between utilities – e.g., use of metallic versus dielectric buckets on truck

Batteries -- Rule 420G activity

Ericsson

G. Liquid-cell batteries

1. Employees shall ascertain that battery areas are adequately ventilated before performing work.
2. Employees should avoid smoking, using open flames, or using tools that may produce sparks in the vicinity of liquid-cell batteries.
3. Employees shall use eye and skin protection when handling an electrolyte.
4. Employees shall not handle energized parts of batteries unless necessary precautions are taken to avoid short circuits and electrical shocks.

Concerns raised during NESC discussions → with Working Group at moment

1. The battery rules Rule 420G and Rule 140 need updating
2. DC Arc Flash risk needs NESC reference

- Current 420G rules are appropriate and adequate
- Could revise title of Rule 420G to read one of the following
  - "Flooded, Absorbed electrolyte and Gel-Electrolyte Batteries"
  - "Liquid-Cell and Gel-cell Batteries"
  - "Batteries".
- One could add an informational note in Rule 420G pointing the user to Rule 140 for appropriate rules covering "large flooded type cells; e.g., Lead-Acid Round Cells".

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Telecom Batteries

Flooded CO Batteries

- Require watering and maintenance.
- Rule 140 criteria are appropriate for theses cells and usually met through the internal and normal work practices and procedures
- The power rooms have controlled access and ventilation

VRLA Batteries in OSP (huts and cabinets)

- Controlled access (doors) to huts and battery spaces
- Plastic shields prevent accidental contact with terminal posts. These barriers also provide a guard/cover in the unlikely instance that gas or liquid is vented from the VRLA (Lead-Calcium) type batteries.
- Designed to require minimal maintenance – incidental inspection with visual monitoring for any signs of leakage, and measured for their state of charge.
- Any problems found are referred to battery maintenance personnel with appropriate training and tools (including PPE) to replace the batteries if needed.

Other Battery Types

- VRLA (TTPL = Thin Plate Pure Lead), and gel cells
- Ni-Cd (Nickel-Cadmium) or NiCad
- NiMH = Nickel Metal Hydride – Na-Ni-Cl = Sodium Metal Hydride
- Li-ion – lithium ion technologies - LCO, NCA, LFP, Lithium Cobalt Oxide

DC Arc Flash Risk

Rule 410A3 – focus on AC and power worker risks (e.g., live work - hot stick work, changing power meters)

- Requires arc flash risk assessment
- Defines appropriate PPE (arc flash clothing, eyewear, etc…
- Based on extensive testing

DC Circuit Risks – accidental short circuits

- Dropped wrench on battery terminals
- Contact with Bus

Current Operational Controls in Place

- Low power in individual telecom circuits (< 100 V A)
- Plastic shields prevent accidental contact with terminal posts in OSP facilities.
- Maintenance programs to help avoid thermal runway or low electrolyte problems – measure float voltages, discharge tests, thermal measurements of cells, visual inspections….

Issues

- DC fault detection
- Protection Devices for DC circuits

Aerial Lifts

Issue = Continued incorrect contention that metallic lifts are more dangerous then “all dielectric” lifts → proposal to prohibit these metallic lifts was defeated but the issue will return.

Operational Facts

(a) Contact between the person and live energized line/equipment is the danger and the conductivity of the bucket infrastructure is not a critical factor,

(b) Buckets with fiberglass/dielectric coverings still have underlying metallic superstructure with electric controls in bucket (i.e., the bucket is not electrically isolated), and

(c) Contact occurs because the worker has not followed industry rules and best practices for safe operations.

(d) Lift telescopic boom design (contracts in and out in a linear fashion) improves safety factor - boom always below the aerial lift in contrast of some older fiberglass buckets designs.

(e) Many fiberglass buckets not as sturdy or resilient as the steel buckets

(f) Telecom aerial lifts usually need 110/120 V outlets to operate tools – any bucket with electrical outlet can not be considered “insulated from power”.

.

Why metallic buckets are preferred: 40+yrs experience

Ericsson

Metallic buckets have the necessary strength required for best construction work practices.

Construction line operations require a sturdy constructed truck to perform heavy line operations often while worker is in bucket and truck is moving from pole to pole :

- Placing strand under tension
- Placing self-support cable under tension
- Placing cable using direct cable lasher method.
- Performing pole transfers – moving cable plant from old pole to new

The aerial lift is often used as a tool to help operator perform work - e.g., a rope winch line is operated from the lift help pull lashers while placing cables.

When following usual operational safety rules and work rules, the metallic buckets are safe. Mandatory rules for use of communications lifts that apply regardless of the aerial lift type include:

- Mandated use of safety harness with double locks for bucket doors
- Use of insulated gloves when working near foreign power
- Stay outside of MAD and safe working distances from supply equipment
- Double chuck rear wheels to prevent the truck from rolling
- 2-way communications link between the driver and the person in the bucket

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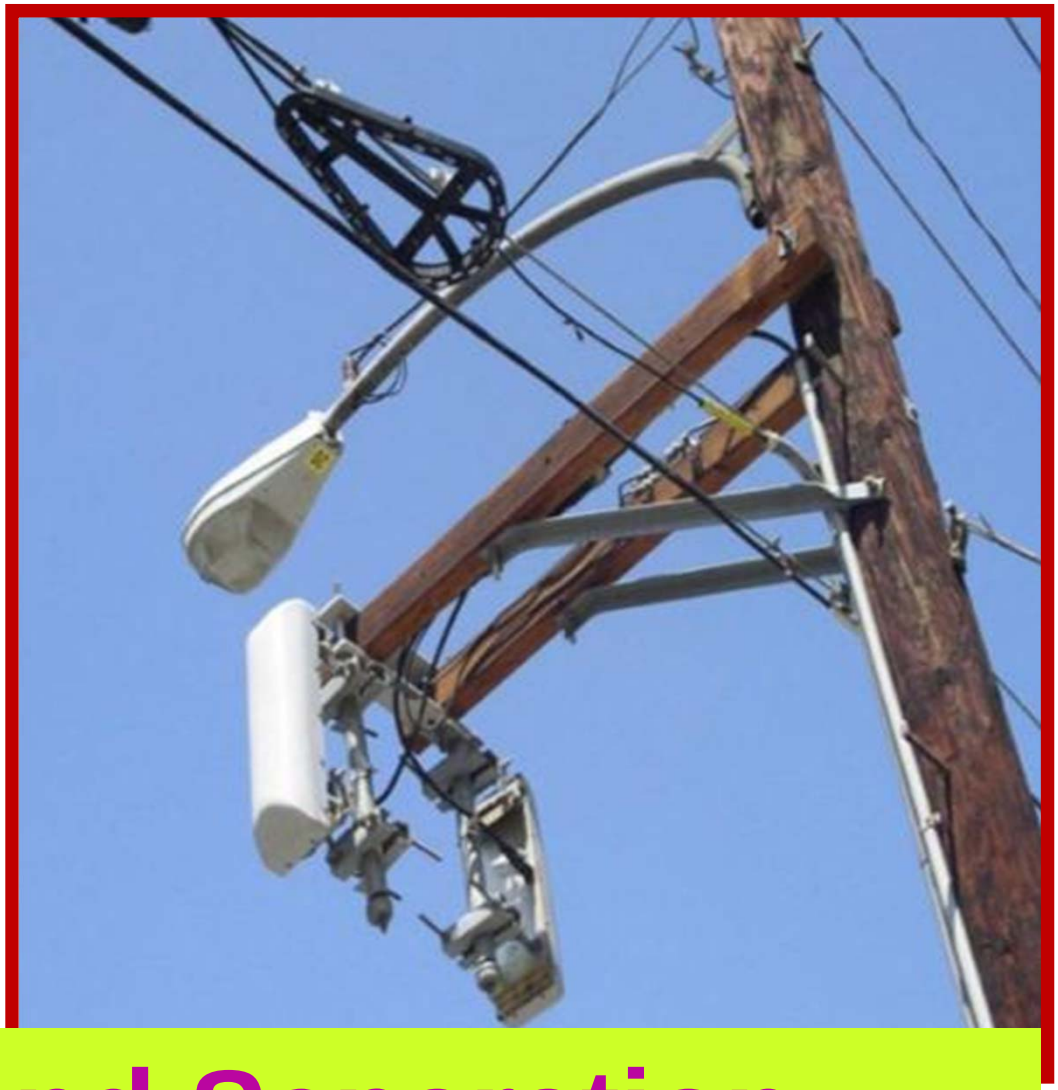
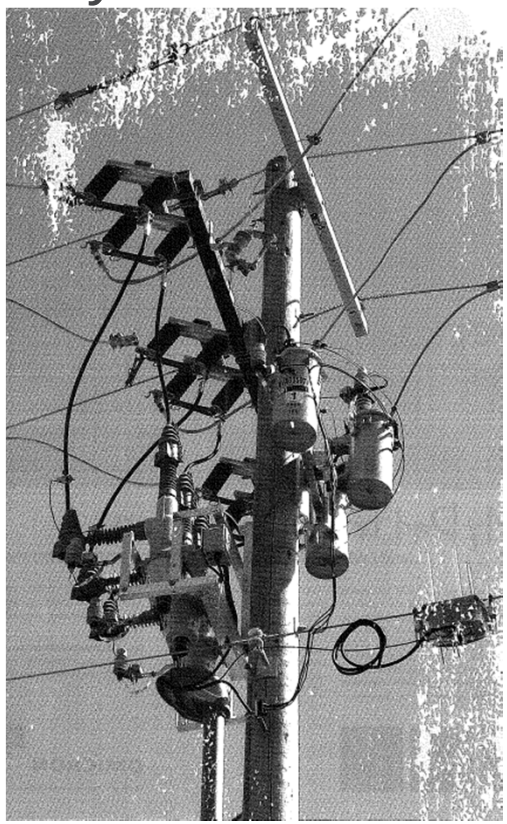


Clearance and Separation

Supply Equipment in Telecom Space

Safety Code Requirements = Baseline or Minimum Level

- Adequate bonding and grounding to help prevent induced and fault voltages/currents on the communications circuits.
- Identification and marking rules to provide equipment or contact information to help identify responsible party.
- Adequate Ground clearance rules.
- Providing sufficient climbing space
- Provide sufficient working space around communications lines and facilities
- Keep minimum clearances as per the NESC to help maintain the integrity of the CWSZ around communications facilities.



Clearance and Separation

NESC are safety driven guidance rules (minimum)

- On congested Poles - Business and regulatory driven considerations for growth
- Clearances over specific cases
  - Driveways – service drops to “low” roofs
  - Water bodies
  - Roads where newer and larger harvesters and vehicles may pass under
  - Long spans across roadways where ice loading may be problem (WG)
  - Fences with overhanding aerial facilities from adjacent or nearby poles
- Simplify and clarify calculation of minimum separation between adjacent or crossing communications lines (Rule 235H and 235I)
- Separation from rail beds, railroad right-of-ways, agricultural areas, irrigation zones, ….
- In joint use applications
  - Urban congested environments – microtrenching and microducts

Pole Loading and Strength

Safety Factors

and

Design Principles

Pole Loading and Strength

- Pole Strength and Loadings – GO-95 Vs. NESC approaches
- Load & Resistance Factor Design (LRFD) Vs. Allowable Strength Design (ASD)
- Load and material strength factors along with load duration effects
- Extreme Wind methodology and Ice Loading Factors
- Correlation with ANSI O5.1 & ASCE (ASCE 7)
- Engineered materials; e.g., Fiber-reinforced polymer & concrete structures
- Engineering Reality Vs. Regulatory/Legal Language - "..will not fail…"
  - Design Pole strength for heavy loads – weather events (ice/storm/..)
    - 50…100 year storm or event
  - Increased reliability (perceived) by over-building poles through
    - Increased safety factors
    - Increase replacement criteria (67---75—85—95% strength retention)
  - Design options and approaches do not necessarily match threats
    - Ice….wind…fire…termites…
    - Engineering Analysis & Theory versus real world data and experience

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  - Codes - NESC…GO 95…NEC….OSHA….
  - Best Practices – Personal Safety & Facilities Reliability
  - Engineering Design for Efficient & Reliable Operation

- **Issues**
  - Bonding & Grounding
  - Congestion – on Poles and in Buried locations
  - Scope Boundaries of NESC/NEC
  - Work Rules - Tests and Inspections
  - Clearances
  - Pole Loading and Strength

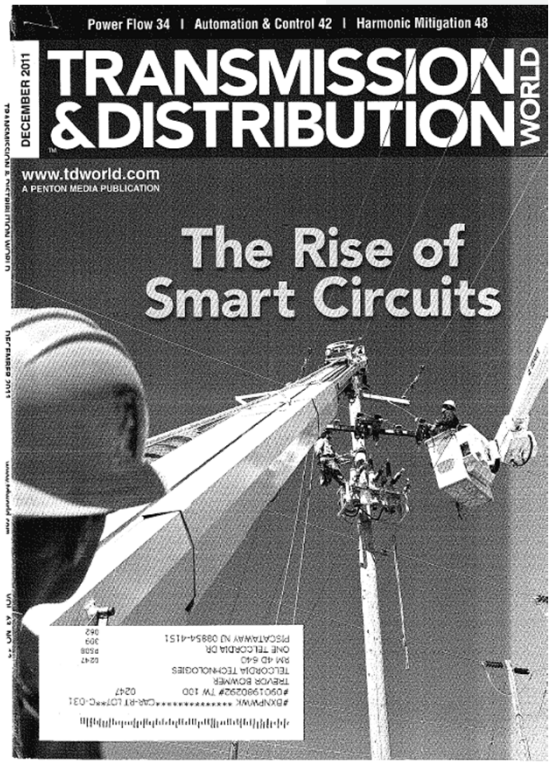
- **Plans and Paths Forward - 2014/2015**
  - **NESC Preprint**
  - **Blue Book Revision (Issue 6)**

Network and Business Drivers

- More connected and interconnected devices
  - Smart grid, distributed power systems, antennas, …
- More Wireless - More DAS systems'
- Higher voltages and power
- More joint use in broadest terms – near, adjacent, in close proximity, same pole, trench ort duct
  Facilities served by both telecom & power lines

Resulting Concerns

- Bonding and Grounding
  - Protection – primary, secondary, tertiary….
  - Harmonization/coordination of multiple protection devices and strategies
- Safety
  - Equipment
  - Workers and public
- Equipment Performance (S/N and Interference)



Crews performing the first recloser test install in 2010.

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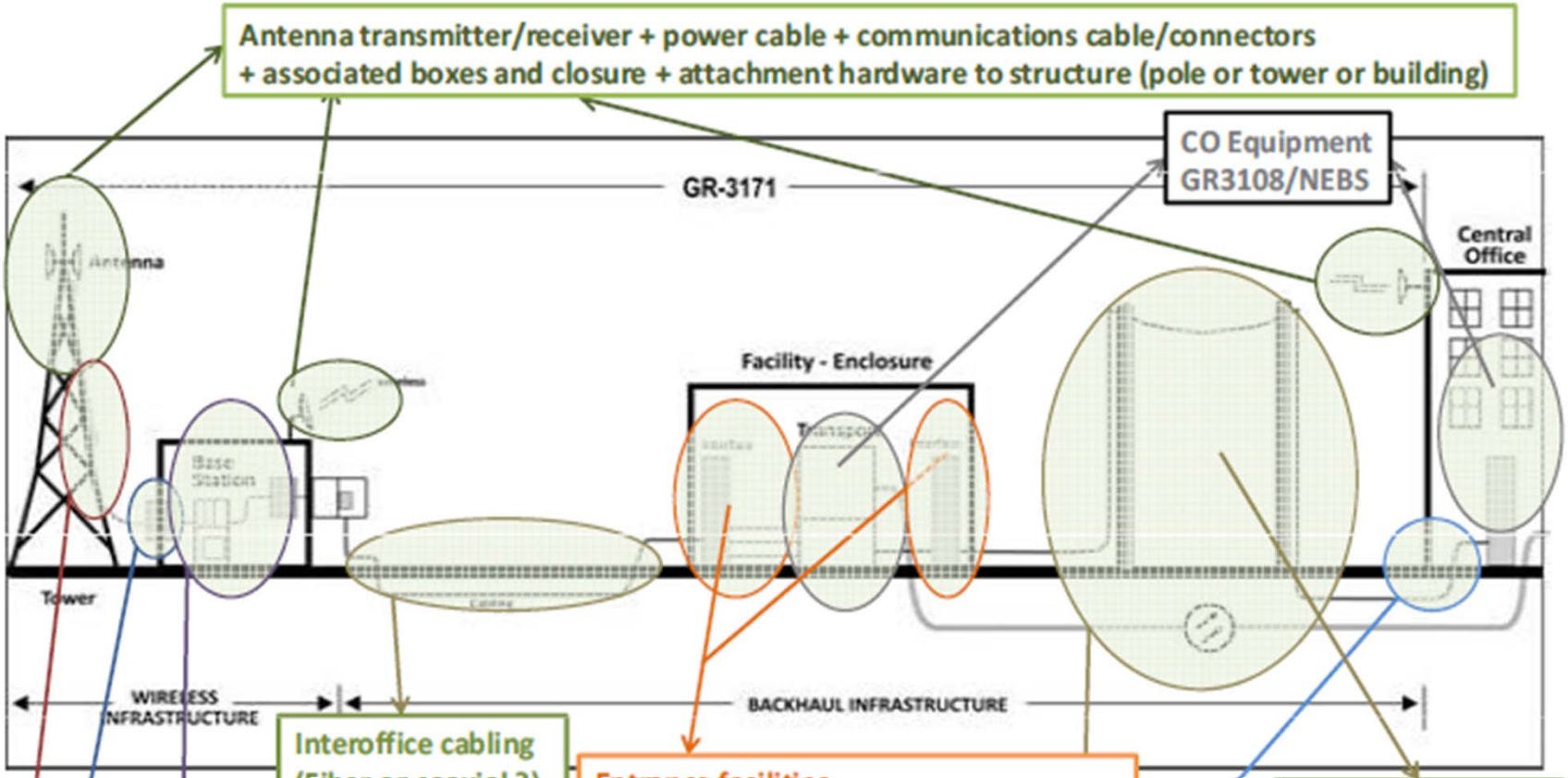
Expansion of Wireless Networks



From Telcordia GR-3171

Transition of Wireless Networks

Transition to Fiber-Fed Remote Radio Heads

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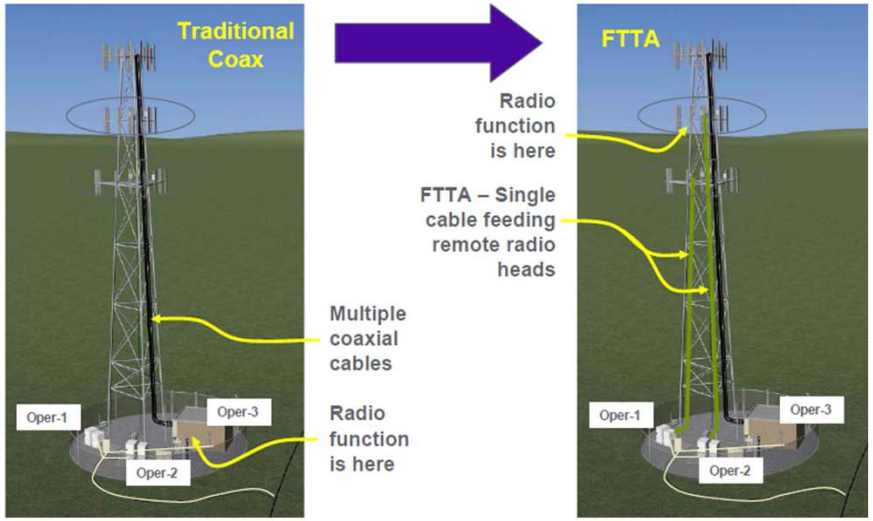
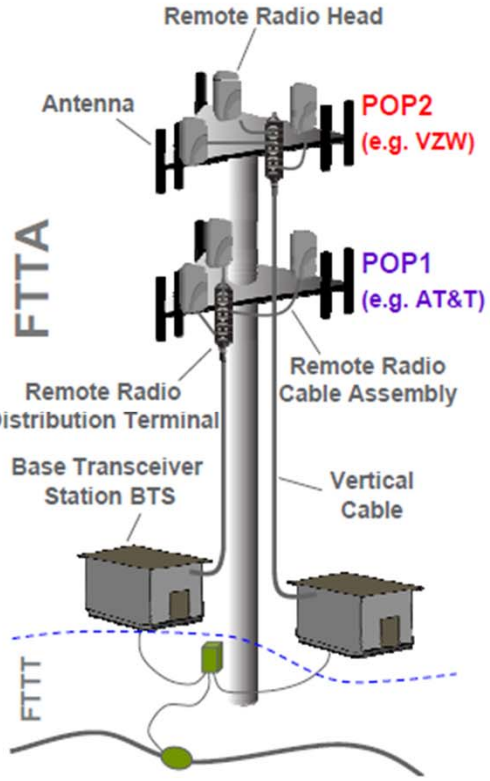


Joint Feeds to Antenna

- Power (AC/DC)
- Communications (Fiber/Copper)

Comparison of FTTA to Fiber to the Home (FTTH)

Fiber to the Antenna is different with new terminologies but some similarities



Fiber to the Antenna	Fiber to the Home
Point of Presence (POP) (wireless carrier at a cell site)	Home or Living Unit (LU) (wireline carrier at a residence)
Cell Site (cell tower, rooftop, etc.)	Neighborhood
Remote Radio Distribution Terminal (RRDT)	Network Access Point Terminal (NAP)
Remote Radio Cable Assembly (RRCA) (with Terminal and RRH connector)	Drop Cable Assembly (with Terminal Connectors)
Remote Radio Head (RRH) (electronics at top of cell site)	Optical Networking Terminal (ONT) (electronics on side of a home)
Terminal Installed (TI)	Homes Passed (HP)
RRHs Connected (RC)	Homes Connected (HC)

Antenna Locations

- Poles
- Towers
- Roof Tops
- Church Spire
- Walls
- DAS Indoor

From Telcordia GR-3171

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Paths Forward: Telecom Perspective -1

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A. Review NESC Pre-Print

- Review Consequences of Changes to Code such as
  - Definitions
  - Grounding rules 096C and 097G and 384
  - Buried Plant and Joint use rules 224B, 344, 354D
- Are reversal of proposed changes required or further comments and revisions needed?

B. Continue to review Incidents, Accidents and Current Practices for Operations, Personnel and Equipment Facilities

- Identify Root-Cause Problems
- Determine Areas for Changes or Improvements (Code or other)

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Paths Forward: Telecom Perspective -2

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C. Determine Best Solutions and Means to Improve Personal and Public Safety along with Better Equipment and Network Reliability

- **Product breaks or fails before its time → root cause analysis shows a design or materials issue then → Improve Product Functional Performance Criteria**
- **Develop, Educate and Train staff for best-in-class installation, repairs and maintenance practices**
- **Formalize Best Methods and Practice (M&P) in internal practice documents – e.g., Telcordia Construction Blue Book (SR-1421)**

D. Revision to Blue Book (Issue 6)

- **Harmonize with NESC changes (A above)**
- **Revised as result of real world incidents (B above)**
- **Create special reports or memorandum for other items of concern – e.g., Arc Flash Risk Assessment guidelines, Voltage detector tools use and capabilities, etc…**

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Safety Codes Alone Are Not Enough

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Baseline for Safety -- NESC…OSHA….NEC… GO 95

Limits of Safety Codes

- 5 year cycle → slow to respond to market/business initiatives
  - 3 year cycle like NEC ? Still too slow ?
  - TIA process? conservative process--takes time--requires >75% agreement
  - Develop local perturbations – Legislative, PUC, BPU, California GO95, etc…

A. Design, Engineering and Product Specifications

B. Operational M&Ps and Engineering Controls

Industry or Individual Company Driven

- ATIS – STEP, PEG … ATIS-0600333, etc…
- Telcordia GR-1089, SR-1421, GR-3171, etc…
- IEEE-516, IEEE-P487, UL-609590, IEC, …
- Supplier product specific engineering/use guidance

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Safety Codes Not Enough

- **Safety Codes…….Regulatory and Legal Mandates**
  - NESC…NEC..OSHA…GO 95….
  - Local and Regional Building and Fire Codes
- **Internal Practices**
  - Telcordia Construction Blue Book – Issue 5 (2011).., new issue in 2014
  - Service Providers - ATT..Verizon… Centurylink … RUS..
  - Manufacturer/Supplier provided instructions and guidance documents
- **Product Specifications and Functional Performance Criteria**
  - Poles & Hardware - GR-60 Wood, GR-3159 Non-Wood, GR-3174 Hardware
  - Equipment - Physical Protection -- GR-3108… GR-1089 EMC…..GR-63 and most recently GR-3171 - OSP Network Elements Used in Wireless Networks
  - Enclosures and Closures - GR-43 (Huts), GR-487 (Electronic Equipment Cabinets), GR-950 (ONUs), GR-902 (Handholes)
  - Cables, .GR-421, GR-3163, GR-3164, GR-137, GR-492, GR-20, etc.……
- **Design Engineering for Network**
  - Reliability and Long Lifetimes --- 20…..40 years
  - Quality and Availability of Services (99.999+%)

Internal Practices – e.g., Telcordia Construction Blue Book (SR-1421)

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General Scope
Chapters 1 and 2

- Scope, Purpose and List of Changes
- Coordination with Other Codes and Standards
- General Safety Precautions and Guidelines
  - Working in Vicinity of Power Conductors
  - Minimum Approach Distances, Arc-Flash…
  - Visual Pole Inspection.
  - Buried Plant Precautions and Manholes
  - Fiber Optics
- Inspection and Make-Ready Survey Checklists

Aerial Plant
Chapters 3 –to-14

- Clearances
- Strand
- Pole Line Hardware
- Guying
- Insulating Guys
- Anchors and Guy Rods
- Suspension Strand
- Bonding and Grounding
- Aerial Markers
- Pole Testing and Inspection
- Pole Strength
- Supply Equipment in/near Telecom Space

Underground & Buried Plant
Chapters 15 - to - 25

<u>Manholes</u>

- General Precautions
- Testing Atmosphere and Ventilating
- Bonding Cables
- Cable Markers
- Sealing Ducts and Conduits

<u>Buried Plant</u>

- General Construction
- High-Speed Blown Cable
- Direct Buried Duct
- Directional Drilling
- Bonding Drop Cable
- Placing Cable Guards

Chapter 26-27-Appendices

- FTTx Deployments
- Symbols for Grids and Mapping Diagram
- Appendices
  - Background on Ice-Wind Load Map used for Reliability-Based Design of Required Pole Strength
  - NESC 2012-2017 Cycle Schedule
  - NESC Active Issues – Working Groups (WGs)

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Blue Book Revisions and Updates
Formal Blue Book or Proprietary Reports - 1

1. Harmonize with changes expected to occur in **2017 NESC**
2. "**Make-Safe**"– defining and expanding on procedures around the term "make-safe" including items for cooperation and joint use agreements between telecom, power and other utilities. This will include guidance on desirable cooperation between local work center managers (the "responsible persons") versus a formal agreement or contract.
3. **Grounding and Bonding** – issues as covered here in this presentation
4. **Drop Plant Attachment, Separation and Clearance** – best practices for aerial and buried service wires to single residences, multi-dwelling (MDU) units, and appropriate use (if any) of telecom cables in conduit, air shafts, elevators shafts and other non-standard places.
5. **Antenna and Wireless Applications** – review and update aspects of this expanding plant regarding such **GR-3171** issues such as radiation hazards, working space & climbing space, locations (towers, poles, roof tops, belfries, Inside building), for DAS systems, inside CO areas
6. **Congestion** – what are the best practices and options for such situations as the develop on poles and below ground

Blue Book Revisions and Updates
Formal Blue Book or Proprietary Reports - 2

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7. **Excavation Hazards and Precautions** with discussions on - One call systems (**811**) , Working practices near marked lines, Hand work with shovel versus machine excavation – back-hoe, direction drilling, fiber placement - burial depth for safety and to minimize service disruption
   - **Civil Works** - excavation and structural issues near buildings and structures; e.g., appropriate trenching and separation requirements
   - **Manholes** – update sections for handholes/vaults (GR-902)
8. **Risk Management** – provide suggested and recommendation practices and processes in case of possible disputes – cooperation vs.. joint use agreements versus legal conflicts.. Include suggested minimum inspection frequencies for facilities
9. Revisions of **pole strength and loading** chapters
10. **Aerial Bucket** Practices – practices for using open metal basket vs.. closed covered bucket vs. “all dielectric” bucket aerial lifts
11. **Hardware Chapters** - update with guidance in GR-3174

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THANK YOU

Q & A

Contact:

Trevor N. Bowmer, Ph.D.
Senior Analyst - Telcordia
Network & Product Integrity
tbowmer@telcordia.com
Ph. 732.699.3341

Additional Information For Reference

Key Changes between 2008 and 2012 Code

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- **Scope (Sections 1--- 3)**
  - Extensive revisions to clarify applicability of NESC.
  - Not changes in scope but clearer statement reflecting 100-year history
- **Grounding (Sections 9)**
  - Effectively grounded – grounded for purpose
  - Directly embedded steel pole = acceptable ground electrode
  - 14 AWG (min) → 6AWG (min) for intersystem bonds for communications ground
- **Generation - Sub-Stations (Part 1 – Sections 10 ---19)**
  - Illumination and Fences – safety signs and environment (clarifications)
- **Aerial (Part 2 – Sections 20 --- 27)**
  - K-factors versus specific ice/wind loadings
  - Clarification of grounding rules for aerial plant – guys, strand, etc…
  - Improve of strength and loading calculation methods – define conditions better
- **Buried – Underground (Part 3 – Sections 30 --- 39)**
  - Inspections and Testing – conditions, defects …..
  - Refined clearances between different facilities to enhance safety
  - Limit intersystem bonding between vertical pole grounds and buried plant
- **Work Rules (Part 4 – Sections 40 --- 44)**
  - Arc-Flash Clothing Ratings – correlated to field data and laboratory testing
  - MAD (Minimum Approach Distances) – IEEE 516

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Grounding of Guys and Support Hardware

NESC Rule 215 requires a guy to be effectively grounded or isolated.

Intentions of Rules 215 & 233 is to make sure that if a line conductor or guy goes slack then fault current/voltage will not expose the public, supply/communications workers or equipment to power.

- Telecommunications guys are presently electrically bonded through their attachment hardware . The grounding path can include
  - Anchors
  - Strand
  - Through the pole attachment hardware
  - Vertical pole ground wires (MGNs) → 4 grounds in a mile (Rule 97)

The telecom equipment is "effectively grounded" since there is a permanent bond to the pole ground and supply neutral. A solidly attached guy forms a low resistance connection to earth through the attachment hardware, strand and MGN connections. The interconnected system meets the definition of effectively grounded since it is "*designed to minimize hazard to personnel and having resistances to ground low enough to permit prompt operation of circuit protective devices*".

Telecom Grounding Bed – Ground Rod System

- Note (1) defined by application and available space – 8 or more feet desired for 8 foot rods.
- Note (2) – crimped or welded connection using a 2-hole/lug ground connector is preferred
  - Crimp/weld → better electrical and mechanical bond
  - Screw-type → more easily reconfigured.
- Note 3 – Rods shall be 8 feet minimum length and 5/8-inch diameter for iron/steel, or ½ inch diameter of stainless steel or copper-clad stainless-steel.