

Table of Contents

1 General

1.1 Scope and Purpose	1-1
1.2 Safety, Design, Reliability and Resiliency	1-1
1.3 Coordination Between Codes, Standards, and Other Agreements	1-3
1.4 SR-1421 History	1-4
1.5 Company Terminology	1-6
1.6 Blue Book Structure	1-7

2 General Safety Precautions and Guidelines

2.1 Working in the Vicinity of Power Conductors	2-1
2.1.1 Job Plan or Job Briefing	2-2
2.1.2 Made-Safe (or Make-Safe)	2-3
2.1.3 Minimum Approach Distances (MADs)	2-7
2.1.4 Use of Rope	2-8
2.2 Identifying Power	2-10
2.2.1 Powering of Communications Equipment and Smart Grid Devices	2-11
2.2.2 Electric Safety of Communications Circuits - Arc Flash and Electric Shock	2-12
2.2.2.1 Telecommunications Circuits are Inherently Safe	2-13
2.2.2.2 Routine Work of Communications Worker	2-14
2.2.2.3 Communications Worker in Substation	2-17
2.3 Using Truck-Mounted Equipment Near Power	2-18
2.4 Placing or Removing Poles Near Power	2-20
2.5 Placing or Removing Suspension Strand and Cable Near Power	2-21
2.6 Visual Pole Inspection	2-22
2.7 Conditions Requiring No Testing or Supplemental Support	2-23
2.8 Buried Plant Precautions	2-24
2.9 Depth of Buried Plant	2-26
2.10 Separation from Gas and Other Fuel Lines	2-27
2.10.1 Steam Lines	2-27
2.11 Safety Considerations	2-28
2.12 Manholes	2-30
2.13 Fiber Optics	2-30
2.14 Wireless Facilities	2-31
2.15 Inspection Checklist	2-31
2.16 Make-Ready Survey Checklist	2-33
2.16.1 Internet and NESC Resources	2-33
2.17 Personal Protection Equipment (PPE)	2-35

3 Clearances

3.1 General	3-1
3.2 Clearances Between Communications Facilities	3-2
3.2.1 Hierarchy on Pole	3-5
3.3 Clearance Between Power and Communications Facilities	3-6
3.3.1 Congestion on Poles	3-6
3.3.2 Clearances Between Power and Communications Facilities	3-7

3.3.3 Supply Equipment in Communications Space	3-11
3.4 Clearance Between Power and Communications Cables on Different Poles	3-12
3.5 Clearance Between Power and Communications Conductors Along Span	3-14
3.6 Clearances Above Roadways, Rails, and Other Structures	3-17
3.6.1 Clearance Example	3-18
3.7 Communications Antennas	3-20
3.7.1 Basic Clearances	3-21
3.7.2 Placement Concerns for Antenna and Associated Equipment	3-22
3.7.3 Clearances for Antenna Structures, Cables, and Associated Closures	3-23
3.7.4 Radiation Emissions	3-24
3.8 Clearance of Supporting Structures (Poles) from Other Objects	3-24
3.8.1 Pole Placement Along Roadways	3-25
3.8.2 Reflector Markers and Strips	3-27
3.9 Climbing Space	3-27
3.10 Service Drop Clearances and Separations	3-28
3.10.1 Service Masts	3-30
3.10.2 Vegetation Management	3-32
3.11 Current Trends Concerning Clearances and Separations	3-33
3.12 Normative and Informative References Related to Clearances	3-34

4 Strand - Description and Stringing Tension

4.1 General	4-1
4.2 Strand Description	4-2
4.3 Stringing Tension	4-3
4.4 Methods of Obtaining Stringing Tension	4-4
4.5 Tensioning and Sagging of Cable Strand	4-5
4.6 Strand Choices	4-6
4.6.1 Suspension Strand Choices for Optical Fiber	4-6
4.6.2 Coastal Zones	4-7
4.6.3 Strand Size Considerations - 6 M Versus 6.6 M	4-8
4.7 Normative and Informative References Related to Clearances	4-11

5 Pole Line Hardware - Description and Use

5.1 General	5-1
5.1.1 Hardware Functional Requirements	5-1
5.1.2 Hardware Categories	5-2
5.2 Suspension Clamps	5-3
5.3 Suspension Bolts	5-5
5.4 Suspension Screws	5-7
5.5 Reinforcing and Support Straps	5-9
5.6 Reinforcing Links	5-12
5.7 Table of Hardware for Attaching Suspension Strand	5-15
5.8 Guy Hooks	5-16
5.9 Thimble Eye Bolts	5-19
5.10 Guy Straps	5-22
5.11 Guy Clamps	5-22
5.12 Guy Grips ("B" Strand Grips)	5-25
5.13 Strandvises	5-28
5.14 Pole Attachment Illustrations	5-29
5.15 Non-Wood Poles	5-33

- 5.15.1 Concrete Poles 5-33
- 5.15.2 Steel Poles 5-33
- 5.15.3 Fiberglass or FRC Poles 5-33
- 5.15.4 Hardware for Non-Wood Poles 5-34
- 5.15.5 Guys 5-35
- 5.15.6 Holes and Drilling 5-37
- 5.15.7 Lag Screws and Support Straps 5-37
- 5.15.8 Banded Hardware Attachments 5-38
- 5.16 Normative and Informative References Related to Pole Hardware 5-40

6 Guying

- 6.1 General 6-1
- 6.2 Types of Guys 6-1
- 6.3 Determining Lead and Height 6-7
- 6.4 Determining Pull 6-9
- 6.5 Pull Finder Description 6-10
- 6.6 Pull Finder Use 6-10
 - 6.6.1 To Measure Pull 6-10
 - 6.6.2 To Bisect the Angle 6-11
- 6.7 Determining Guy Strand Size 6-13
 - 6.7.1 Dead-End Poles 6-16
 - 6.7.2 Corner Poles 6-19
 - 6.7.3 Sidewalk Anchor Guys 6-21
- 6.8 Grounding and Bonding of Guys 6-24
- 6.9 Non-Wood Poles 6-24

7 Insulating Guys

- 7.1 General 7-1
- 7.2 Sizes and Ratings of Strain Insulators 7-2
- 7.3 Locating Insulators 7-3
- 7.4 Methods of Installing Strain Insulators 7-8
- 7.5 Normative and Informative References Related to Pole Hardware 7-12

8 Anchors and Guy Rods

- 8.1 General 8-1
- 8.2 Field of Use 8-2
 - 8.2.1 Average Soils 8-2
 - 8.2.2 Rock Formations 8-2
 - 8.2.3 Swampy Areas 8-2
- 8.3 Description of Guy Rods (With Expanding Anchors) 8-3
- 8.4 Expanding Anchors 8-4
 - 8.4.1 Installation 8-5
- 8.5 Screw Anchors 8-8
- 8.6 Soil Classes 8-12
- 8.7 Toggle Anchor and Guying System 8-12
- 8.8 Adding Eye to Existing Guy Rod 8-15
- 8.9 Anchor Strength Verification 8-16
- 8.10 Removal of Anchors and Guys 8-17
- 8.11 Normative and Informative References Related to Anchors 8-17

9 Suspension Strand - False Dead-Ending and Slack Span Construction

9.1 General	9-1
9.2 Wrap-Type False Dead-End	9-1
9.3 False Dead-End Strandwise	9-3
9.4 Guy Clamp False Dead-End	9-5
9.5 Strandwise and Guy Clamp False Dead-End	9-6
9.6 Strand String Tension	9-8
9.7 Constructing the Slack Span	9-9

10 Bonding and Grounding for Aerial Plant

10.1 Background	10-1
10.1.1 Changes in 2017 Edition of NESC	10-2
10.1.2 Basic Precautions	10-3
10.2 General	10-4
10.3 Methods of Bonding and Grounding	10-6
10.4 Grounding Guys	10-13
10.4.1 Self-Supporting Cable	10-14
10.4.2 Guys Not Electrically Connected Through Guy or Suspension Bolt	10-16
10.5 Bonding and Grounding Where There Is No Access to the Power MGN System	10-17
10.5.1 Bonding and Grounding Where Access to Power MGN System Is Denied	10-19
10.6 Bonding Metallic Components of Optical Cable to Support Strand	10-19
10.7 Grounding and Bonding on Metallic Poles	10-20
10.8 Informative References for Bonding and Grounding of Aerial Plant	10-21

11 Identification Markers for Aerial Cable, Guys and Equipment

11.1 General	11-1
11.2 Cable and Equipment Identification Markers	11-1
11.3 Installation of Cable and Equipment Markers	11-4
11.4 Guy Markers	11-4
11.5 Informative References	11-5

12 Pole Testing and Inspection

12.1 Pole Testing Prior to Work Operations	12-1
12.1.1 Congested Poles	12-3
12.2 Conditions Requiring No Physical Testing or Supplementary Support	12-4
12.3 Physical Testing Techniques for Examining Poles	12-5
12.3.1 Sound Test	12-5
12.3.2 Prod Test	12-6
12.3.3 Prod Test - Below Groundline Inspection	12-6
12.3.4 Hand Line or Pike Test	12-7
12.3.5 Consequences of Physical Tests	12-7
12.4 Measuring Extent and Effect of Decay	12-8
12.4.1 Internal Examination of Pole - Hook Probe in Drilled Hole	12-8
12.4.2 Wood Pole Decay Patterns	12-9
12.4.3 Deductions for Defects	12-10
12.4.3.1 Advanced Internal Decay	12-10
12.4.3.2 Enclosed Pockets	12-12

- 12.4.3.3 Exposed Pockets 12-13
- 12.4.3.4 Woodpecker Holes and Similar Damage 12-14
- 12.4.4 Critical Pole Section and Required Circumferences 12-14
 - 12.4.4.1 Critical Pole Section 12-15
 - 12.4.4.2 Minimum Circumference 12-16
- 12.4.5 General 12-17
- 12.4.6 Tag Descriptions 12-17
 - 12.4.6.1 Other Pole Markings and Tags 12-18
- 12.5 Wooden Pole Inspection Programs 12-19
 - 12.5.1 Basic Training 12-21
 - 12.5.2 Specialized Training 12-21
 - 12.5.3 Visual and Physical Tests 12-23
 - 12.5.4 Documentation 12-24
- 12.6 Non-Wood Poles 12-26
 - 12.6.1 Visual Inspection 12-26
- 12.7 Informative References for Utility Poles 12-27

13 Pole Loading and Strength Requirements

- 13.1 General 13-1
- 13.2 Wood Pole Class Loads (ANSI O5.1) 13-2
- 13.3 NESC Storm Loading Requirements 13-3
- 13.4 Load Factors and Strength Factors 13-6
- 13.5 Grade of Construction 13-7
- 13.6 Application 13-9
- 13.7 Depth of Set 13-10
- 13.8 Conditions of Potential Concern 13-12
- 13.9 Non-Wood Pole Factors 13-12
- 13.10 Normative and Informative References Related to Pole Hardware 13-14

14 Supply Equipment In or Near the Communications Space

- 14.1 General 14-1
- 14.2 Power Supplies 14-3
 - 14.2.1 Power Supply Grounding 14-3
- 14.3 Locations of Amplifiers Serving Coaxial Networks 14-10
- 14.4 Communications Antenna and Associated Wireless Equipment 14-11
- 14.5 Supply Facilities in Locations Near Communications Space 14-12

15 Wireless Facilities on Utility Poles and Similar Structures

- 15.1 General Overview 15-1
 - 15.1.1 Network Components (or Elements) 15-4
 - 15.1.2 Regulatory Perspective 15-5
- 15.2 Radio Frequency (RF) Exposure 15-6
 - 15.2.1 FCC Exposure Guidelines 15-7
 - 15.2.2 OSHA Exposure Regulations and Guidelines 15-8
 - 15.2.3 Radio Frequency Safety Programs (RFSP) 15-9
 - 15.2.4 RF Exposure Analysis 15-10
- 15.3 Pole Marking and Product Requirements 15-12
 - 15.3.1 Pole Markings 15-13
 - 15.3.2 IEEE C95 Practices and Guidelines 15-14

15.4 Mechanical, Electrical and Spatial Concerns	15–17
15.4.1 Ground Clearances	15–18
15.4.2 Separation from Supply and Other Communications Lines	15–19
15.4.3 Other Clearances and Separations	15–20
15.4.4 Climbing Space	15–22
15.4.5 Working Space	15–23
15.4.6 Heat Dissipation	15–25
15.4.7 Powering and Grounding	15–25
15.4.8 Cables and Attachment Hardware	15–26
15.4.9 Attachment Structures	15–26
15.5 Location Choices for Antenna/Wireless Equipment	15–28
15.5.1 Antenna Placement on Light Poles	15–29
15.6 Summary	15–32
15.6.1 General Guidelines	15–32
15.6.2 Grounding and Bonding	15–34
15.6.3 Pole Loading Considerations	15–34
15.6.4 Attachment Hardware	15–35
15.7 Normative and Informative References Related to Wireless Facilities	15–36

16 General Precautions and Work Rules for Manholes

16.1 General	16–1
16.1.1 Handholes and Other Vaults	16–1
16.2 General Precautions and Work Rules	16–2
16.2.1 Corrosion in Manholes	16–3
16.3 Normative and Informative References Related to Manholes	16–5

17 Testing Manhole Atmosphere and Ventilating Manhole

17.1 General Precautions	17–1
17.1.1 Tents	17–1
17.1.2 Open Flames and Furnaces	17–2
17.1.3 Fusion Splicing Fiber Optic Cable in Cable Entrance Facilities (CEFs) and Manholes	17–2
17.1.4 Radon in Manholes	17–2
17.2 Gas Indicators and Monitors	17–3
17.2.1 Non-Continuous Gas Indicators (Hand-Aspirated)	17–4
17.2.2 Continuous Gas Monitors	17–5
17.3 Blowers	17–6
17.3.1 Blower Capacities	17–6
17.3.2 Blower Maintenance	17–6
17.4 Setups for Testing and Purging Manholes	17–7
17.4.1 General	17–7
17.4.2 Conventional Manholes	17–7
17.4.3 Irregular-Shaped Manholes	17–9
17.4.4 Offset-Access Manholes	17–10
17.4.5 Deep-Neck Manholes	17–12
17.5 Purge Times	17–15
17.5.1 Alignment Charts	17–15
17.5.2 Determining Purge Times	17–18
17.6 Testing, Purging, and Ventilating Manholes	17–19
17.6.1 General	17–19

- 17.6.2 Initial Test Prior to Entry 17-19
- 17.6.3 Tests at Entry 17-21
- 17.6.4 Tests and Precautions During Work Operations 17-21
- 17.7 Testing Cable Entrance Facilities (CEFs) for Combustible Gas 17-25
 - 17.7.1 General 17-25
 - 17.7.2 Test Procedures 17-25
- 17.8 Testing Unattended Buildings for Combustible Gas 17-26
- 17.9 Water Discharge from Manhole 17-26

18 Bonding Cables in Manholes and Handholes

- 18.1 General 18-1
- 18.2 Location of Bonds 18-1
- 18.3 Placing Bonds 18-2
- 18.4 Connection to Ground (Earth) 18-2
- 18.5 Bonding in Handholes 18-3

19 Identification Markers for Underground Cable

- 19.1 General 19-1
- 19.2 Description 19-1
- 19.3 Cable Tag Location 19-2
- 19.4 Method of Installing Tags 19-2
- 19.5 Other Identification Markers 19-5
- 19.6 Locating Technologies for Buried and Underground Plant 19-5

20 Sealing Conduits and Ducts

- 20.1 General Definitions 20-1
- 20.2 General Sealing 20-2
- 20.3 Where Seals Are Required 20-5
- 20.4 Rubber Duct Plug - Description 20-6
 - 20.4.1 Rubber Duct Plugs for Multiple Cables in a Conduit 20-11
- 20.5 Installing Rubber Duct Plugs 20-11
- 20.6 Removing Rubber Duct Plugs 20-14
- 20.7 Description of Caulking Materials 20-17
- 20.8 Installing Caulking Material 20-18
- 20.9 Installing Plastic Duct Seals 20-20
- 20.10 Wooden Duct Plugs 20-20
- 20.11 Plastic Conduit Plugs – Description and Use 20-20
- 20.12 Duct Plugs Using Foams 20-22
- 20.13 Ductliner (Innerduct) 20-24
- 20.14 Microducts 20-24
- 20.15 References Related to Conduits, Ducts, Sealants and Encapsulants 20-25

21 Buried Plant Construction - General

- 21.1 Construction of Facilities - General 21-1
- 21.2 Construction Specifications 21-2
 - 21.2.1 Random Separation of Communications Cables 21-3
 - 21.2.2 Random Separation of Communications and Power Cables 21-4
 - 21.2.3 Planned Separation of Cables 21-6
 - 21.2.4 Bonding and Grounding 21-7

21.2.5 Bonding and Grounding of Buried Fiber Optic Cable	21-8
21.2.6 Conduit Size	21-9
21.2.7 Depth of Buried Cable	21-11
21.2.8 Trench Bottom and Backfill	21-11
21.2.9 Trouble and Maintenance Procedures	21-11
21.2.10 Joint-Use Buried Networks - Buried Duct Networks (BDNs)	21-12
21.3 Cable Placing	21-13
21.4 Splice Point Excavations	21-14
21.5 Handholes	21-14
21.5.1 Applications	21-14
21.5.2 Installation	21-19
21.5.3 Bonding in Handholes	21-19
21.6 Backfilling and Ground Restoration	21-20
21.7 Permanent Markings	21-21
21.8 Informative References Related to Direct-Buried Plant	21-21
22 High-Air-Speed Blown Cable (HASB) Installation System	
22.1 General	22-1
22.2 Product Description	22-1
22.2.1 Principle of Operation	22-1
22.2.2 Equipment Description	22-4
22.3 HASB Method of Cable Placement	22-5
22.3.1 Preparation	22-5
22.3.2 HASB Set-Up	22-7
22.3.3 Cable Installation	22-8
23 Direct-Buried Innerduct Construction Guidelines	
23.1 General	23-1
23.2 Applications	23-1
23.3 Duct and Innerduct Types	23-2
23.3.1 General Considerations	23-2
23.3.2 Metallic Service Wire	23-3
23.3.3 Distribution	23-3
23.4 Innerduct Installation Methods and Practices	23-3
23.4.1 Planning	23-3
23.4.2 General Considerations	23-4
23.4.3 Trenching	23-5
23.5 Microtrenching in Urban Environments	23-5
23.6 Plowing	23-9
23.7 Directional Drilling	23-9
23.8 Informative References Related to Direct-Buried Applications	23-10
24 Horizontal Directional Drilling (HDD)	
24.1 General	24-1
24.2 Description	24-2
24.3 Preliminary Site Investigation	24-4
24.3.1 Existing Below-Ground Utilities	24-5
24.3.2 Surface Investigation	24-5
24.3.3 Subsurface Investigation	24-6

24.4 Safety During HDD Operation 24-6

24.5 Environmental Considerations 24-9

24.6 Regulations and Damage Prevention 24-10

 24.6.1 Locating and Marking 24-10

24.7 Product Pipe (Innerduct) - Placement Distances 24-12

24.8 Bore Path Layout and Design 24-13

 24.8.1 Bore Path Profile/Trajectory (Vertical Plane) 24-15

 24.8.2 Bore Path (Horizontal) Planar Trajectory 24-17

 24.8.3 Overall Bore Path Layout 24-17

24.9 Implementation 24-18

 24.9.1 Tracking and Locating 24-19

 24.9.2 Reaming 24-20

 24.9.3 Gripping and Pulling 24-21

24.10 Inspection and Site Cleanup 24-22

24.11 Informative References Related to Directional Drilling 24-23

25 Bonding and Grounding - Drop Cables and Service Wires

25.1 General 25-1

 25.1.1 Changes in 2017 Editions of NESC and NEC 25-1

 25.1.2 Changes in the 2011 NEC (from Issue 5) 25-3

 25.1.3 Grounding and Bonding Terminology 25-4

25.2 Purpose of Grounding (and Bonding) 25-5

 25.2.1 General Work Rules and Precautions 25-6

25.3 Bonding and Grounding at Customer Premises 25-9

 25.3.1 NEC Perspective of Grounding at Service Demarcations 25-9

 25.3.2 Grounding Electrode Choices 25-11

 25.3.3 Ground Rods – Recommended Materials, Designs and Diameters 25-15

 25.3.3.1 Current (2017) Concerns 25-16

 25.3.4 Grounding of Metallic Components of Fiber Cable 25-18

 25.3.5 Grounding of Antenna Lead-In and Other Components of Local
 Communications Antenna 25-19

25.4 Basic Grounding Methods and Procedures 25-22

 25.4.1 Ground Wires 25-24

 25.4.2 Grounding Clamps 25-25

25.5 Ground Tags 25-26

25.6 Grounding Requirements 25-27

25.7 Grounding NIDs in Detached Structures 25-28

25.8 Verification of the Grounding and Bonding Connections 25-28

25.9 Grounding at Mobile Homes and Trailers 25-31

 25.9.1 Overview 25-31

 25.9.2 Grounding in Mobile Home/Trailers - NID Placement
 Considerations 25-31

 25.9.3 Mobile Home and Trailers: Grounding Options 25-32

25.10 Examples of Grounding Configurations 25-33

26 Cable Guards and Vertical Risers

26.1 U-Type Cable Guards 26-1

26.2 Conduits for Vertical Risers 26-4

27 Fiber Optic Facilities (FTTX) - Deployment

27.1	General	27-1
27.1.1	Product Acceptance and Shipment	27-2
27.1.1.1	Polarization Mode Dispersion (PMD) measurements	27-3
27.1.1.2	Bend-Resistant Fiber	27-4
27.1.2	Security and Safety Practices	27-4
27.1.3	Fiber Optic Cable Placement	27-5
27.2	Underground Cable Placement	27-5
27.2.1	Pre-Survey	27-6
27.2.2	Tools and Equipment	27-7
27.2.3	Fusion Splicing Fiber Optic Cable in Cable Entrance Facilities (CEFs) and Manholes	27-8
27.2.4	Innerduct	27-8
27.2.5	Standard Innerduct Coupling for Pulling Method	27-8
27.2.6	Occupied Conduits and Separate Ducts (Innerducts)	27-13
27.2.7	Microducts and Fabric Sleeves	27-14
27.2.8	Fabric Sleeves	27-18
27.3	Direct-Buried Cable	27-18
27.3.1	Depth of Cover	27-19
27.3.2	Pre-Survey	27-20
27.3.3	Trenching Placing Method	27-21
27.3.4	Cable Placing	27-21
27.3.5	Backfilling and Ground Restoration	27-22
27.3.6	Rollers and Guide Tubes	27-23
27.3.7	Fiber Drop Plant - ONUs, Pedestals, and Handholes	27-23
27.4	Aerial Cable Placing Method	27-24
27.4.1	Stationary-Reel Method (Backpull)	27-25
27.4.2	Moving Reel Without Aerial Lift (Drive Off)	27-25
27.4.3	Moving Reel With Aerial Lift (Drive Off)	27-26
27.4.4	All-Dielectric Self-Support (ADSS)	27-26
27.5	Pole-Mounted Cabinets	27-27
27.5.1	Pre-Planning	27-27
27.5.2	Mounting the Cabinet	27-28
27.6	Ground-Mounted Cabinets	27-28
27.7	Factory Installed Termination System (FITS)	27-29
27.7.1	General Considerations	27-29
27.7.2	Aerial FITS Plant	27-29
27.7.3	Buried FITS	27-30
27.8	Premises-Powered Broadband Communications Systems	27-30

28 Symbols for Grid and Mapping Diagrams

28.1	General	28-1
28.2	Drafting Practices Applicable to Graphic Symbols	28-1
28.3	Aerial Plant	28-2
28.3.1	Poles	28-2
28.3.2	Pole Line Support Elements	28-4
28.3.3	Cable Support Elements Stranded or Solid Messenger Items With Poles Shown	28-5
28.3.4	Anchoring and Guying With Poles Shown	28-5

- 28.3.5 Cross Connects 28-7
- 28.4 Underground and Buried 28-8
- 28.5 Terminals 28-10
- 28.6 Telecom Metallic Pair Devices 28-11
- 28.7 Power 28-11
- 28.8 House CATV Drop Designations With Poles Shown 28-12
- 28.9 CATV Devices 28-13
 - 28.9.1 Power Devices - Amplifiers 28-13
 - 28.9.2 Power Devices - Splitters 28-14
 - 28.9.3 Power Devices - AC Power Block 28-14
 - 28.9.4 Equalizer 28-15
 - 28.9.5 Subscriber Taps 28-15
 - 28.9.6 Other Powering Devices 28-16
 - 28.9.7 Other Devices 28-16
 - 28.9.8 Carrier Equipment 28-17
 - 28.9.9 Signal Processing Locations (Antenna Site, Head-End, Hub, etc.) . . . 28-18
 - 28.9.10 Coaxial Cables 28-18
- 28.10 Fiber Optic Plant 28-19

Appendix A: Clearance and Loading Issues in NESC

- A.1 Clearances A-1
 - A.1.1 1990 Changes A-1
 - A.1.2 Rule 235H - Clearances Between Communications Lines A-1
 - A.1.3 Wireless Facilities - Rule 235I and Others A-2
- A.2 Clearance Zones and Loading Districts A-2

Appendix B: NESC Code Cycle

- B.1 2017 NESC Overview Code B-1
- B.2 NESC Code Cycle Schedules B-2
- B.3 NESC Working Groups and Possible Future Issues B-2

Appendix C: Historical Work Rules

Appendix D: References

- C.1 Telcordia Documents D-1
- C.2 Non-Telcordia Documents D-3
 - C.2.1 To Obtain Additional Reference Material D-9
- D.3 Family of Requirements (FR) and Family of Documents (FD) Sets D-10
- D.4 Reference Notes D-10
 - D.4.1 Contact Customer Service D-10
 - D.4.2 Order Documents Online From the Telcordia SuperStore D-10
 - D.4.3 Web Sites for Generic Requirements Information D-11
 - D.4.4 Licensing Agreements for Telcordia Documents D-12

Appendix E: Glossary

List of Figures

Figure 2-1	Various Types of Power Conductors	2-10
Figure 3-1	Clearance Between Licensee-Owned and Communications Company Cables	3-3
Figure 3-2	Vertical Separation Between Strand-Mounted Equipment and Other Cable	3-4
Figure 3-3	Clearances on Joint-Use Poles	3-9
Figure 3-4	Clearances Between Power Transformer Voltage Regulator or Capacitor and Communications Wire or Cable	3-10
Figure 3-5	Clearance Between Streetlight Bracket and Communications Cable	3-11
Figure 3-6	Spacer Cables	3-15
Figure 3-7	Triplex Power Cable	3-16
Figure 3-8	Midspan Clearance	3-16
Figure 3-9	Vertical Clearance Over Public Road	3-19
Figure 3-10	Climbing Space Where Drop Wires Are Present	3-28
Figure 3-11	Roof Anchor Method (Not Recommended)	3-31
Figure 3-12	Communications Service Mast Options	3-32
Figure 5-1	Cable-Suspension Clamp	5-4
Figure 5-2	Corner-Suspension Clamp	5-4
Figure 5-3	C Cable Clamp	5-5
Figure 5-4	Suspension Bolts for Supporting Suspension Clamps	5-6
Figure 5-5	Cable-Suspension Screw	5-8
Figure 5-6	Installed Cable-Suspension Screw	5-8
Figure 5-7	Reinforcing Strap	5-9
Figure 5-8	Installing Reinforcing Strap Using Drive Screw	5-10
Figure 5-9	Installing Reinforcing Strap Using Bolt	5-11
Figure 5-10	Nut and Washer Used to Space Reinforcing Strap	5-11
Figure 5-11	Reinforcing Link	5-12
Figure 5-12	Reinforcing Links Installed on Pole	5-13
Figure 5-13	Reinforcing Links Installed at Guard Arm Location on Pole	5-14
Figure 5-14	B- and C-Type Guy Hooks	5-16
Figure 5-15	Branch Strand Termination - 6.6 M or 6 M Main Strand	5-17
Figure 5-16	Installed Guy Hooks	5-18
Figure 5-17	Guy Hooks Installed - Pole-to-Pole Guy	5-18
Figure 5-18	Thimble Eye Bolts	5-19
Figure 5-19	Installation of Angled (Bent) Thimble Eye Bolt	5-20
Figure 5-20	Installation of a Straight Thimble Eye Bolt	5-21
Figure 5-21	Guy Straps	5-22
Figure 5-22	Arrangement of Guy Clamp	5-23
Figure 5-23	Serving the Guy Tail	5-24
Figure 5-24	Applying First Leg	5-26
Figure 5-25	Applying Second Leg	5-26
Figure 5-26	Guy Installed Using Guy Hooks and Guy Grip	5-27
Figure 5-27	Strandwise	5-28
Figure 5-28	Pole Attachment for 6.6 M or 6 M Suspension Strand Without Reinforcing Strap	5-29

Figure 5-29 Pole Attachment With Reinforcing Strap Attached With Drive Screw 5-30

Figure 5-30 Pole Attachment With Reinforcing Strap Attached With Suspension Bolt 5-31

Figure 5-31 6.6 M or 6 M Suspension Strand – Pull Away From Pole – 10 Feet or More 5-31

Figure 5-32 6.6 M or 6 M Suspension Strand With Reinforcing Strap – Pull Toward Pole – 10 Feet or More 5-32

Figure 6-1 Side Guy 6-2

Figure 6-2 Head Guy 6-3

Figure 6-3 Pole-to-Stub Guy 6-4

Figure 6-4 Pole-to-Pole Guy 6-5

Figure 6-5 Sidewalk Anchor Guy 6-6

Figure 6-6 Lead and Height Measurements 6-7

Figure 6-7 Lead and Height Measurements for Sidewalk Anchor Guy 6-8

Figure 6-8 Measuring Corner Pull (Taping) 6-9

Figure 6-9 Pull Finder 6-10

Figure 6-10 Determining the Corner Pull With a Pull Finder 6-11

Figure 6-11 Bisecting Corner Pull With Pull Finder 6-12

Figure 6-12 Bisecting Angle by Tape Measurement 6-12

Figure 6-13 One Head Guy for One Suspension Strand 6-17

Figure 6-14 One Head Guy for Two Suspension Strands 6-17

Figure 6-15 Two Head Guys for One Suspension Strand 6-18

Figure 6-16 Three Head Guys for Two Suspension Strands 6-18

Figure 6-17 Corner Pole With Guys on Bisector of Angle of Pull 6-19

Figure 6-18 Corner Pole With Two Head Guys 6-20

Figure 6-19 Right-Angle Corner Made on One Pole 6-20

Figure 6-20 Pipe Installation for Sidewalk Anchor Guy 6-22

Figure 6-21 Guy Shield Installation for Sidewalk Anchor Guy 6-23

Figure 7-1 Strain Insulator - Single Line Type 7-2

Figure 7-2 Location of Strain Insulators on Pole-to-Pole and Anchor Guys in Exposure Zones for Supply Lines of 18 kV or Under 7-5

Figure 7-3 Location of Strain Insulators on Pole-to-Pole and Anchor Guys - Zones Above 18,000 V 7-5

Figure 7-4 Location of Strain Insulators on Poles Carrying Trolley Feeders 7-6

Figure 7-5 Location of Strain Insulators in Anchor Guys on Jointly Used Poles 7-7

Figure 7-6 Strain Insulator Installation With Two 1-Bolt Clamps 7-8

Figure 7-7 Strain Insulator Installation With Two 2-Bolt Clamps 7-8

Figure 7-8 Strain Insulator Installation With Two 3-Bolt Clamps 7-9

Figure 7-9 Strain Insulator Installation With Four 3-Bolt Clamps 7-9

Figure 7-10 Strain Insulator Installation With Six 3-Bolt Clamps 7-10

Figure 7-11 Strain Insulator Installed in Series Using Guy Connector 7-10

Figure 7-12 Strain Insulator Installed in Series Using 3-Bolt Clamps 7-11

Figure 8-1 Types of Guy Rods 8-3

Figure 8-2 Expanding Anchor 8-4

Figure 8-3 Placing Anchor in Angled Hole 8-6

Figure 8-4 Placing Anchor in Vertical Hole With Slot 8-7

Figure 8-5 Nut Retainer on Underside of Expanding Anchor 8-8

Figure 8-6 Single and Twin Helix Anchors 8-9

Figure 8-7	Screw Anchor Wrench	8–10
Figure 8-8	Toggle-Type Anchor	8–13
Figure 8-9	Toggle Anchor Models	8–14
Figure 8-10	Adding an Eye on a Guy Rod	8–15
Figure 9-1	Wrap-Type False Dead-End	9–1
Figure 9-2	Wrap-Type False Dead-End Slack Span	9–2
Figure 9-3	Wrap-Type False Dead-End Installed on Self-Supporting Cable	9–3
Figure 9-4	False Dead-End Strandwise	9–3
Figure 9-5	False Dead-End Strandwise Installed at Strand Diminishing Point	9–4
Figure 9-6	False Dead-End Using Guy Clamp Method on 6.6 M and 6 M Strand Supported by a Cable Strand Connector	9–5
Figure 9-7	False Dead-End Using Guy Clamp Method on 6.6 M and 6 M Strand Supported by a Pole Strand Connector	9–5
Figure 9-8	False Dead-End Using Guy Clamp Method at Arm Location	9–6
Figure 9-9	False Dead-End Using Strandwise and Guy Clamps	9–6
Figure 9-10	False Dead-End Using Guy Clamps and Strandwise at Cable Extension Arm Location	9–7
Figure 9-11	Anchor Guy Installed for Slack Span Construction	9–9
Figure 9-12	Pole-to-Pole Guys Installed for Slack Span Construction	9–10
Figure 9-13	False Dead-End at Slack Span Location (No Change in Strand Size)	9–10
Figure 10-1	Connecting to a Vertical Grounding Conductor	10–6
Figure 10-2	Connecting to a Guy or Strand With a Cable-Lashing Clamp	10–7
Figure 10-3	Connecting to a Guy or Strand With a Strand Ground Clamp	10–7
Figure 10-4	Connecting to Jacketed Strand	10–8
Figure 10-5	Coiled Ground Wire Tied for Later Connection	10–9
Figure 10-6	Daisy Chain Configuration (Not Recommended - Should Not Be Used)	10–10
Figure 10-7	Bonding Parallel Strands	10–11
Figure 10-8	Maintenance Strand Continuity at Corners	10–12
Figure 10-9	Bonding Branch Strand to Main Strand	10–12
Figure 10-10	Guy Grounded at Corner	10–13
Figure 10-11	Guy Grounded at Dead-End	10–14
Figure 10-12	Guy Grounded at False Dead-End	10–14
Figure 10-13	Grounding Guy to Self-Supporting Strand	10–15
Figure 10-14	Grounding Guy Where Strandwise Is Used on Self-Supporting Cable	10–15
Figure 10-15	Grounding Guy That Is Not Electrically Connected Through Guy Bolt	10–16
Figure 10-16	Bonding With Tail of Guy Strand	10–17
Figure 10-17	Connection to Ground Rods	10–18
Figure 11-1	Identification Marker (Cable Tie)	11–2
Figure 11-2	Custom Cable Tags	11–3
Figure 11-3	Wrap-Around Cable Marker	11–4
Figure 12-1	Types of Internal Decay	12–9
Figure 12-2	Types of External Decay	12–10
Figure 12-3	A, B, and C Pole Tags	12–18
Figure 12-4	Pole Brand	12–19
Figure 13-1	Ice Storm Loading Districts Map – Figure 250-1 from NESC	13–3
Figure 13-2	Storm Loads on Cable or Conductors	13–5

Figure 13-3 Storm Loads Imposed on Poles 13-5

Figure 14-1 Clearance and Grounding Methods for Power Supply Cabinet -
Communications Cable and Licensee Cable on Opposite Sides
of Pole 14-6

Figure 14-2 Clearance and Grounding Methods for Power Supply Cabinet -
Communications Cable and Licensee Cable on Same Side of
Pole 14-7

Figure 14-3 Power Supply Location Where Sufficient Clearance Above
Cable Is Available 14-8

Figure 14-4 Power Supply Location Serving Buried or Underground Cable . . . 14-9

Figure 14-5 Cable Support and Cable Arrangement – Expansion Loop on
Opposite Side of Pole from Amplifier 14-10

Figure 14-6 Cable Support and Spacer Arrangement – Expansion Loop on
Same Side and Between Pole and Amplifier 14-11

Figure 15-1 Wireless Infrastructure (from GR-3171) 15-4

Figure 15-2 RF Hazard Warning Sign 15-8

Figure 15-3 RF Energy Advisory Symbol 15-14

Figure 15-4 RF Signage and Demarcation Examples 15-16

Figure 15-5 Space Allocation on Utility Pole 15-20

Figure 15-6 Pole Top Antenna Attachments 15-27

Figure 15-7 Wireless Facilities on Light Poles 15-30

Figure 15-8 Wireless Self-Standing Pole 15-31

Figure 15-9 Example of a Cross Arm Antenna Attachment 15-35

Figure 17-1 Typical Setup for Purging Large Conventional Manholes 17-8

Figure 17-2 Typical Setup for Purging Irregular-Shape Manholes 17-9

Figure 17-3 Typical Setup for Purging Offset-Access Manhole With No
Entrance Manhole 17-10

Figure 17-4 Typical Setup for Purging Offset-Access Manhole With
Entrance Manhole 17-11

Figure 17-5 Deep-Neck Manhole Ventilated by Coupling Two Blower
Hoses 17-13

Figure 17-6 Deep-Neck Manhole Ventilated With Permanent Ventilating
Duct Installed in Collar 17-14

Figure 17-7 Deep-Neck Manhole Ventilated With Permanent Ventilating
Duct Adjacent to Manhole 17-15

Figure 17-8 Alignment Chart – Side 1 Covering Small Manholes 17-16

Figure 17-9 Alignment Chart – Side 2 Covering Larger Manholes 17-17

Figure 17-10 Manhole Testing, Purging, and Ventilating Procedures –
Initial Tests 17-23

Figure 17-11 Manhole Testing, Purging, and Ventilating Procedures –
Additional Tests 17-24

Figure 19-1 Cable Ownership Code 19-1

Figure 19-2 Examples of Metal Tags 19-2

Figure 19-3 Cable Tags 19-3

Figure 19-4 Strap-Type Tag Installed 19-4

Figure 19-5 Attaching Cable Tag With Lead Lashing Wire 19-4

Figure 20-1 Split-Conduit Plug Wrench 20-4

Figure 20-2 Split-Conduit Plug Remover 20-4

Figure 20-3 Solid Rubber Conduit Plugs 20-6

Figure 20-4 Square Split Rubber Conduit Plugs 20-8

Figure 20-5	Round Split Rubber Conduit Plugs	20-10
Figure 20-6	Example - Triplex Split Plug	20-11
Figure 20-7	Placing Split Rubber on Cable	20-12
Figure 20-8	Tightening Plug With Plug Wrench	20-13
Figure 20-9	Inserting Remover Sleeve	20-15
Figure 20-10	Inserting Extractor	20-16
Figure 20-11	Engaging Rubber With Extractor	20-16
Figure 20-12	Removing Split Rubber Plug	20-17
Figure 20-13	Serving Tape Used as a Spacer	20-18
Figure 20-14	Serving Tape Inserted in a Duct	20-18
Figure 20-15	4-Inch Universal Plug	20-21
Figure 20-16	Schematic of Foam Duct Plug	20-22
Figure 20-17	Example of Foam Injection Step	20-23
Figure 21-1	Handhole Application Guide from GR-902	21-17
Figure 22-1	Schematic of HASB Operation	22-2
Figure 22-2	Typical Cable Placement Distances (Single HASB Unit) [Courtesy of Outside Plant Consulting Services, Inc.]	22-3
Figure 24-1	Mini-HDD, Initial Pilot Hole Boring Process	24-2
Figure 24-2	Mini-HDD, Backreaming/Pullback Process	24-4
Figure 24-3	Predicted Mini-HDD Pull Load vs. Safe Pull Tension	24-13
Figure 24-4	Mini-HDD, Bore Path Profile/Trajectory (Vertical Plane)	24-16
Figure 25-1	Examples of Terminology for Grounding and Bonding Connections	25-4
Figure 25-2	Selection of Approved Ground (Use in Conjunction with Section 25.3)	25-8
Figure 25-3	Communications Drop Wire Clearances and Grounding	25-15
Figure 25-4	NID Bond and Grounding	25-24
Figure 25-5	Grounding Wire	25-24
Figure 25-6	Ground Rod Clamps	25-25
Figure 25-7	Grounding Wire Clamps	25-25
Figure 25-8	Threaded Metallic Conduit Clamps - Strap Clamps	25-26
Figure 25-9	Meter Box Clamps	25-26
Figure 25-10	Typical Ground Tags	25-27
Figure 25-11	NID Installation	25-28
Figure 25-12	Test Method 1 for Grounding Continuity Check	25-29
Figure 25-13	Test Method 2 for Meter Box Connection	25-30
Figure 25-14	Example 1 - Aerial Service to AC Power Disconnect/Meter	25-33
Figure 25-15	Example 2 - Buried Service to AC Power Disconnect/Meter	25-34
Figure 25-16	Example 3 - Aerial Service within 20 Feet of AC Power Primary Grounding Electrode	25-34
Figure 25-17	Example 4 - Aerial Service in Excess of 20 Feet of AC Power Primary Grounding Electrode	25-35
Figure 25-18	Example 5 - Buried Service to a Mobile Home Stake - Power Service Primary Grounding Electrode within 20 Feet	25-35
Figure 25-19	Example 6 - Buried Service to a Mobile Home Stake - Power Service Primary Grounding Electrode in Excess of 20 Feet	25-36
Figure 26-1	Cable Guard	26-1
Figure 26-2	Cable Guard Installations	26-3
Figure 27-1	Example of Innerduct Couplings	27-9
Figure 27-2	Pulling Eye Setup for Multiple Innerduct Placement	27-10

Figure 27-3 Basket-Type Cable Grips 27-11
Figure 27-4 Swivel Connector for Fiber Optic Cable Placement 27-11
Figure 27-5 Cable Lubricant and Hand Pump 27-12
Figure 27-6 Intermediate Manhole Cable Lubricator 27-12
Figure 27-7 Flat, linked and ILU Microduct Product Assemblies 27-16
Figure 27-8 Direct-Buried and In-Conduit Microduct Configurations 27-17
Figure 27-9 Multiple ADSS Cables Adjacent to Existing Plant 27-26
Figure C-1 1911 Rules For Troublemens - Chicago Telephone Company - 1 . . . C-1
Figure C-2 1911 Rules For Troublemens - Chicago Telephone Company - 2 . . . C-2

List of Tables

Table 2-1	Minimum Approach Distances (MADs)	2-7
Table 2-2	Communications Work Rules and Risk Mitigation Strategies	2-15
Table 2-3	Minimum Depth of Electric Supply Cable	2-26
Table 2-4	Minimum Depth of Communications Plant	2-27
Table 2-5	Inspection Checklist	2-32
Table 2-6	Make-Ready Survey Checklist	2-34
Table 3-1	Minimum Vertical Clearances Between Power Facilities and Noncurrent-Carrying Parts of Communications Facilities on Poles	3-7
Table 3-2	Vertical Clearance at Span Crossing Between Supply and Communications Cables	3-13
Table 3-3	Minimum Mid-Span and Vertical Clearances	3-14
Table 3-4	Vertical Clearances for Communications Cables and Messengers	3-17
Table 3-5	Ice Loading Conditions	3-19
Table 3-6	Clearance from Supply Line Conductors on the Same Structure in Any Direction from Communications Antennas (0 - 750 V) Mounted in the Power Supply Space	3-21
Table 4-1	Strand Breaking Strength	4-2
Table 4-2	Maximum String Tension – 4.7 M HS, 6.6 M EHS, and 6 M Steel Strand	4-3
Table 4-3	Maximum Stringing Tension – 10 M Strand	4-4
Table 4-4	Maximum Stringing Tension – 16 M Strand	4-4
Table 4-5	Strand Size Comparison - 6 M Versus 6.6 M	4-10
Table 5-1	Minimum Breaking Strengths	5-6
Table 5-2	Characteristics of Cable-Suspension Bolts	5-7
Table 5-3	Suspension Strand Hardware for 6.6 M, 6 M, and 10 M Strand	5-15
Table 5-4	Combinations of Guy Hooks and Suspension Bolts for Terminating Guys	5-17
Table 5-5	Hardware for Terminating Strands – Lead-Over-Height Ratio of 1-1/4	5-20
Table 5-6	Hardware for Terminating Strands Where the Lead-Over-Height Ratio Is Greater Than 1-1/4	5-21
Table 5-7	Dimensions and Types of Guy Clamps	5-23
Table 5-8	Number and Type of Clamps Used to Terminate Guy Strand	5-23
Table 5-9	Dimensions and Color Markings of “B” Strand Grips	5-25
Table 5-10	Hardware Types and Applications	5-35
Table 6-1	Head Guy Strand Sizes	6-13
Table 6-2	Side Guy Strand Sizes for 6.6 M Suspension Strand	6-13
Table 6-3	Side Guy Strand Sizes for 6 M Suspension Strand	6-14
Table 6-4	Side Guy Strand Sizes for 10 M Suspension Strand	6-14
Table 6-5	Side Guy Strand Sizes for 16 M Suspension Strand	6-15
Table 6-6	Guy Strand Sizes for Sidewalk Anchor Guys	6-16
Table 6-7	Pipe Sizes for Sidewalk Anchor Guys	6-21
Table 7-1	Strain Insulator Characteristics	7-2
Table 7-2	Guy Strain Insulator Locations	7-6
Table 7-3	Strand Loop Sizes	7-11
Table 8-1	Unmarked Guy Rods (Used With Expanding Anchors)	8-3
Table 8-2	Sizes of Anchors, Guy Rods, and Associated Guy Strands	8-5

Table 8-3 Anchor Placement Measurements (for Figure 8-4) 8-7

Table 8-4 Screw Anchors 8-11

Table 8-5 Soil Class Definitions 8-12

Table 8-6 Toggle Anchor Guying Systems 8-13

Table 9-1 False Dead-End for Galvanized Steel Strand 9-2

Table 9-2 Optional Stringing Tensions for Slack Spans 9-8

Table 9-3 Approximate Slack Span Sags and Tensions for
100-Foot Spans at 60°F (17°C) 9-8

Table 12-1 Examples of Wood Species by Sapwood Thickness 12-6

Table 12-2 Poles With Hollow Hearts 12-11

Table 12-3 Poles With Enclosed Pockets 12-12

Table 12-4 Poles With Exposed Pockets 12-13

Table 13-1 Wood Pole Classification System 13-2

Table 13-2 NESC 2007 Edition - Ice Storm Loading Districts per Rule 250B . . 13-4

Table 13-3 Examples of NESC Load Factors - per NESC Table 253-1 13-7

Table 13-4 Construction Grades for Communications Lines
(from NESC Table 242-1) 13-8

Table 13-5 Depth of Setting Pole 13-11

Table 13-6 Strength Factors for Structures - Derived from NESC
Table 261-1 13-13

Table 15-1 FCC Limits for Maximum Permissible (MPE) Exposure for
Public and Occupational Workers 15-7

Table 20-1 Solid Rubber Conduit Plugs – Dimensions 20-7

Table 20-2 Square Split Rubber Conduit Plugs – Dimensions 20-7

Table 20-3 Round Split Rubber Conduit Plugs – Dimensions 20-9

Table 21-1 Cable Depth - Random Separation of Communications Cables
[Note 1] 21-3

Table 21-2 Trench Depth 21-3

Table 21-3 Conduit/Innerduct Selection Guide 21-10

Table 21-4 Conduit/Innerduct - Minimum Working Pulling Strength (*) 21-10

Table 22-1 Minimum Recommended Air Compressor Size 22-6

Table 24-1 APWA Uniform Color Code 24-11

Table 26-1 U Cable Guards, Straps, and Material Required for Installing
U Cable Guards 26-2

Table 26-2 Cast Iron Caps, G Plastic Caps, U Cable Guard Sizes, and
Cable Diameters 26-2

Table 27-1 PMD Guidelines 27-3

Table 27-2 Summary of Underground Tools for Fiber Optic Cable
Placement 27-7

Table 27-3 Innerduct Utilization 27-10

Table B-1 NESC Dates of Interest B-2

