

# Table of Contents

- Preface** . . . . . xi
- 1 Introduction**
  - 1.1 Purpose . . . . . 1-1
  - 1.2 Scope of GR-180-CORE, Issue 1 . . . . . 1-1
  - 1.3 Hardware Categories . . . . . 1-2
  - 1.4 Non-Wooden Poles . . . . . 1-3
    - 1.4.1 Concrete Poles . . . . . 1-4
    - 1.4.2 Steel Poles . . . . . 1-4
    - 1.4.3 Fiberglass Poles . . . . . 1-5
  - 1.5 Hardware for Non-Wood Poles . . . . . 1-6
  - 1.6 Specific Applications Notes . . . . . 1-9
    - 1.6.1 Smooth Rounded Hardware for Guy Attachments . . . . . 1-9
    - 1.6.2 Pre-Drilled Holes in Poles and Use of Driven-Fasteners . . . . . 1-9
    - 1.6.3 Through Bolts . . . . . 1-10
  - 1.7 Organization . . . . . 1-10
  - 1.8 Requirements Terminology . . . . . 1-11
  - 1.9 Requirement Labeling Conventions . . . . . 1-12
    - 1.9.1 Numbering of Requirement and Related Objects . . . . . 1-12
    - 1.9.2 Requirement, Conditional Requirement, and Objective Identification . . . . . 1-12
  - 1.10 Future Plans . . . . . 1-12
- 2 General Product Design Information**
  - 2.1 General Form, Fit, and Function Design . . . . . 2-1
    - 2.1.1 Specific Applications Requirements . . . . . 2-1
    - 2.1.2 Hardware Compatibility . . . . . 2-2
    - 2.1.3 General Features . . . . . 2-3
      - 2.1.3.1 Color and Gloss . . . . . 2-4
  - 2.2 Operational Environment and Design Lifetime . . . . . 2-4
  - 2.3 Safety, Tools, and Ease-of-Use . . . . . 2-5
    - 2.3.1 Environmental Safety . . . . . 2-5
    - 2.3.2 Installation Features —Tools . . . . . 2-6
    - 2.3.3 Damage to Pole Surface . . . . . 2-6
- 3 Documentation, Labeling, and Quality Management System Requirements**
  - 3.1 Product Labels and Marking . . . . . 3-1
  - 3.2 Shipping and Packaging . . . . . 3-1
    - 3.2.1 Drop Test . . . . . 3-1
  - 3.3 Documentation and Instructions . . . . . 3-2
    - 3.3.1 Instructions . . . . . 3-2
    - 3.3.2 Supplies and Spare Parts Support . . . . . 3-2
  - 3.4 Quality Management System (QMS) . . . . . 3-3
    - 3.4.1 Product Changes . . . . . 3-4

### 4 Functional Requirements — Features, Functions, and Technical Parameters

- 4.1 Materials . . . . . 4-1
  - 4.1.1 Steel . . . . . 4-2
  - 4.1.2 Aluminum . . . . . 4-3
  - 4.1.3 Other Materials . . . . . 4-3
  - 4.1.4 Commentary and Guidance on Material Choices . . . . . 4-3
  - 4.1.5 Coatings for Corrosion Resistance . . . . . 4-4
    - 4.1.5.1 Galvanizing . . . . . 4-6
  - 4.1.6 Finished Product Mechanical Tests . . . . . 4-8
    - 4.1.6.1 Tensile Test (Pole-Hardware Assembly) for Category 1 and 2 Hardware . . . . . 4-9
    - 4.1.6.2 Pull-Out Test (Pole-Hardware Assembly) for Category 1 and 2 Hardware . . . . . 4-10
  - 4.1.7 Compression and Hoop Stress (for Tubular Pole Hardware Only) . . . . . 4-11
  - 4.1.8 Impact Resistance . . . . . 4-12
- 4.2 Environmental and Operational Tests . . . . . 4-12
  - 4.2.1 Temperature Cycling Under Stress . . . . . 4-12
- 4.3 Corrosion Resistance . . . . . 4-14
- 4.4 Mechanical Fatigue Cycling . . . . . 4-14
- 4.5 Electromagnetic Compatibility (EMC) . . . . . 4-15

### 5 Performance Verification and Test Procedures

- 5.1 Test Program Protocols . . . . . 5-1
- 5.2 Sample Number . . . . . 5-1

### Appendix A: Pole Hardware Inventory by Category

- A.1 Hardware Categories . . . . . A-1
- A.2 Category 1 Hardware . . . . . A-3
  - A.2.1 Commentary on Banded Hardware Attachments . . . . . A-4
- A.3 Category 2 Hardware . . . . . A-5
- A.4 Category 3 Hardware . . . . . A-6
- A.5 Category 4 Hardware . . . . . A-7
- A.6 Category 5 Hardware . . . . . A-8
  - A.6.1 Commentary on Fasteners . . . . . A-9
- A.7 Background of Documents . . . . . A-13

### Appendix B: Field Application Notes

- B.1 Drop Cable Clamps Case Study . . . . . B-1
- B.2 Hardware on Wood Poles - Design and Microstructure Issues . . . . . B-2
- B.3 Hardware Issues for Non-Wood Poles . . . . . B-3

### Appendix C: References

- C.1 Telcordia References . . . . . C-1
- C.2 ASTM References . . . . . C-1
- C.3 Other References . . . . . C-3



## **Appendix D: Acronyms**

### **Requirement-Object Index**

## List of Figures

Figure 4-1	90° Tensile Test and 45° Down Pull Test . . . . .	4-10
Figure 4-2	Through-Bolt Test for Point Loading Tests . . . . .	4-11
Figure 4-3	Schematic of Temperature Cycling Profile (Partial) . . . . .	4-14
Figure B-1	Decision Tree for Root Cause Analysis of Pole Failure . . . . .	B-4
Figure B-2	Fiberglass Pole Failure . . . . .	B-5

## List of Tables

Table 1-1	Hardware Types, Applications, and Categories . . . . .	1-7
Table 2-1	Minimum Breaking Strength Based on Strand . . . . .	2-3
Table 4-1	Intrinsic Strength of Materials . . . . .	4-3
Table 4-2	Galvanic Series for Metals Typically Used in Pole Hardware . . . . .	4-5
Table 4-3	ASTM A153 Classification . . . . .	4-6
Table 4-4	ASTM B633 Classifications . . . . .	4-7
Table 4-5	ASTM B695 Classifications and Requirements . . . . .	4-7
Table 4-6	Carriage and H-Machine Bolts . . . . .	4-8
Table 4-7	Cable Suspension and Clamp Bolts . . . . .	4-8
Table 4-8	Guy Hooks . . . . .	4-9
Table 4-9	Nuts . . . . .	4-9
Table 4-10	Other Apparatus . . . . .	4-9
Table 4-11	Breaking Strengths for Strand . . . . .	4-9
Table 4-12	Tensions for Cycling Tests . . . . .	4-15
Table A-1	Category 1 Hardware – Structural Support for Pole . . . . .	A-3
Table A-2	Category 2 Hardware – Physical Support of Trunk Cable Plant . . . . .	A-5
Table A-3	Category 3 Hardware – Support of Drop Plant Facilities . . . . .	A-6
Table A-4	Category 4 Hardware – Grounding, Bonding, and Guiding Hardware . . . . .	A-7
Table A-5	Category 5 Hardware Fasteners – Nuts, Bolts, Washers, Screws, Nails, and Staples . . . . .	A-8
Table A-6	Category 5 Hardware – Clips, Brackets, and Straps . . . . .	A-10
Table A-7	Category 5 Hardware – Steps, U Guards, and Pole-Mounted Pieces . . . . .	A-10
Table A-8	Category 5 Hardware – Clamps . . . . .	A-11
Table A-9	Category 5 Hardware – Tools – Drill Components . . . . .	A-11
Table A-10	Category 5 Hardware – Anchors . . . . .	A-12
Table A-11	Older Bell System Specifications for Pole Line Hardware . . . . .	A-13
Table A-12	Reference List of Bell System Practices (BSP) for Pole Line Hardware . . . . .	A-17