

Table of Contents

1 General

1.1 Purpose and Scope	1-1
1.2 Reason for GR-421-CORE Re-Issues	1-1
1.2.1 Reasons for Issue 2	1-1
1.2.2 Reasons for Issue 1	1-2
1.3 Safety Considerations	1-2
1.4 Reference Documents	1-3
1.5 Units and Tolerances	1-4
1.6 Product Reliability and Quality Management Systems	1-4
1.6.1 Product Changes	1-4
1.7 Requirements Terminology	1-5
1.8 Requirement Labeling Conventions	1-5
1.8.1 Numbering of Requirement and Related Objects	1-5
1.8.2 Requirement, Conditional Requirement, and Objective Identification	1-6

2 Conductors

2.1 General	2-1
2.2 Conductor Sizes	2-1
2.3 Factory Joints	2-1
2.4 Conductor Elongation	2-2

3 Conductor Insulation

3.1 Insulation Material	3-1
3.2 Insulation Construction	3-1
3.3 Insulation Tests	3-1
3.3.1 Insulation Imperfections	3-2
3.3.2 Insulation Adhesion	3-2
3.3.3 Elongation	3-2
3.3.4 Compression	3-2
3.3.5 Cold Bend	3-3
3.3.6 Shrinkback	3-3
3.4 Thermal Oxidative Stability Requirements	3-3
3.4.1 Introduction	3-3
3.4.2 Sample Selection	3-4
3.4.3 Qualification Testing	3-4
3.4.3.1 Product Qualification Requirements	3-4
3.4.3.2 Air Core Exemption	3-4
3.4.3.3 Exemption for Solid Insulations in Filled Cables	3-5
3.4.3.4 New Formulations and Insulation Material Qualification Requirements	3-5
3.4.4 Testing Requirements	3-6
3.4.4.1 Pedestal Test	3-6
3.4.4.2 OIT Test	3-6
3.4.4.2.1 Sample Preparation	3-6
3.4.4.2.2 OIT Measurement	3-7
3.4.4.2.3 Test Requirements	3-8

- 3.5 Insulation Colors, Dimensions, and Splices 3-9
- 3.6 Twist Lengths and Color Coding 3-9

- 4 Core Construction**
- 4.1 Binders 4-1
- 4.2 Core Wrap 4-1
- 4.3 Filling Compound 4-2
 - 4.3.1 Materials 4-2
 - 4.3.2 Compound Flow 4-2
- 4.4 Flooding Compound 4-3
 - 4.4.1 Type 1 Compound (For Cables with Self-Support Strands) 4-3
 - 4.4.2 Type 2 Compound 4-3

- 5 Screens and Shields**
- 5.1 Core Separator Screen for Screened Cables 5-1
 - 5.1.1 Film Adhesion 5-1
- 5.2 Shields 5-1
 - 5.2.1 General Information 5-1
 - 5.2.1.1 Single and Dual Tape Types 5-2
 - 5.2.1.2 Gopher Resistance 5-2
 - 5.2.2 General Shield Requirements 5-3
 - 5.2.3 Shield Splices 5-3
 - 5.2.4 Aluminum Shield Requirements 5-4
 - 5.2.5 Steel Shield Requirements 5-4
 - 5.2.6 Copper Shield Requirements 5-5
- 5.3 Residue Oil in Cable (Unfilled Cable Only) 5-6

- 6 Polyethylene Inner and Outer Jacket**
- 6.1 Inner Jacket 6-1
 - 6.1.1 Material and Test Requirements 6-1
 - 6.1.2 Inner Jacket Thickness Requirement 6-1
- 6.2 Outer Jacket 6-2
 - 6.2.1 Material 6-2
 - 6.2.1.1 Ultraviolet Resistance 6-3
 - 6.2.1.2 Mechanical Properties 6-3
 - 6.2.1.3 Thermal Oxidative Stability 6-3
 - 6.2.1.4 Environmental Stress Cracking Resistance 6-3
 - 6.2.2 Shrinkback Resistance - Unbonded 6-4
 - 6.2.3 Sheath Adherence 6-4
 - 6.2.3.1 Unbonded 6-4
 - 6.2.3.2 Bonded 6-4
 - 6.2.4 Jacket Thickness Requirement 6-6

- 7 Electrical Requirements**
- 7.1 DC Resistance 7-1
- 7.2 DC Resistance Unbalance 7-1
- 7.3 Mutual Capacitance 7-1
- 7.4 Capacitance Unbalance 7-2
 - 7.4.1 Pair-to-Pair 7-2



7.4.2 Pair-to-Ground	7-2
7.5 Attenuation	7-2
7.6 Crosstalk	7-3
7.6.1 Unit Crosstalk Requirements	7-3
7.6.2 Crosstalk Qualification Test	7-4
7.6.3 Between-Compartment Crosstalk Requirements for Screened Cables	7-5
7.6.4 Between-Compartment Crosstalk Qualification Test for Screened Cables	7-5
7.7 DC Voltage Test	7-6
7.7.1 Conductor-to-Conductor	7-6
7.7.2 Core-to-Shield	7-6
7.7.3 Screen-to-Conductor for Screened Cables	7-7
7.8 Insulation Resistance	7-7
7.9 Shield Resistance	7-7
7.10 Continuity of Metallic Cable Elements	7-7

8 Finished Cable - Mechanical and Environmental Tests

8.1 Cable Bend Test	8-1
8.1.1 Cold Bend	8-1
8.1.2 Hot Bend	8-1
8.2 Impact Test	8-1
8.3 Torsion Test for Cables with Shields Containing Steel	8-2
8.4 Gopher Resistance Test	8-2
8.5 Water Penetration	8-3
8.5.1 Standard Performance — 3-Foot Waterhead	8-3
8.5.2 Improved Performance — 12-Foot Waterhead	8-3
8.6 Soil Corrosion Resistance (Shielded Cables)	8-4

9 General Requirements

9.1 Shipping and Packaging	9-1
9.2 Identification Marking	9-1
9.2.1 Jacket Marking	9-1
9.2.2 Length Marking	9-3
9.3 Pressurization	9-3
9.4 End-Sealing	9-4
9.5 Information Accompanying the Reel	9-4
9.6 Mechanical Reel Protection	9-4
9.7 Pulling Eyes	9-5

10 Product Classification

10.1 PIC Solid Aircore Cable (ALPETH or Bonded PASP Sheath)	10-3
10.1.1 Mechanical Design Requirements	10-3
10.1.1.1 Conductors	10-3
10.1.1.2 Conductor Insulation	10-3
10.1.1.2.1 Material	10-3
10.1.1.2.2 Insulation Test Requirements	10-3
10.1.1.2.3 Insulation Colors, Dimensions, and Splices	10-4
10.1.1.2.4 Twist Lengths and Color Coding	10-4
10.1.1.3 Binders	10-4
10.1.1.4 Core Wrap	10-4

- 10.1.1.5 Polyethylene Inner Jacket (Bonded PASP Cable Only) 10-4
- 10.1.1.6 Aluminum Shield 10-4
- 10.1.1.7 Steel Shield (Bonded PASP Cable Only) 10-4
- 10.1.1.8 Polyethylene Outer Jacket 10-4
- 10.1.1.9 Pressurization for PASP Cable Products 10-5
- 10.1.2 Core Layups 10-5
 - 10.1.2.1 Cables (Up to 25 Pairs) 10-5
 - 10.1.2.2 Cables (26 to 900 Pairs) 10-5
 - 10.1.2.3 Cables (Greater than 900 Pairs) 10-6
 - 10.1.2.4 Defective Pairs 10-6
 - 10.1.2.5 Defective Pair Marking 10-7
 - 10.1.2.6 Spare Pairs 10-8
- 10.1.3 Electrical Requirements 10-9
- 10.1.4 Mechanical and Environmental Tests 10-9
- 10.2 PIC Foam-Skin Aircore Cable with Bonded STALPETH Sheath 10-9
 - 10.2.1 Mechanical Design Requirements 10-9
 - 10.2.1.1 Conductors 10-9
 - 10.2.1.2 Conductor Insulation 10-9
 - 10.2.1.2.1 Material 10-9
 - 10.2.1.2.2 Insulation Test Requirements 10-10
 - 10.2.1.2.3 Insulation Colors, Dimensions, and Splices 10-10
 - 10.2.1.2.4 Twist Lengths and Color Coding 10-10
 - 10.2.1.3 Binders 10-10
 - 10.2.1.4 Core Wrap 10-10
 - 10.2.1.5 Aluminum Shield 10-10
 - 10.2.1.6 Steel Shield 10-10
 - 10.2.1.7 Polyethylene Outer Jacket 10-11
 - 10.2.2 Core Layups 10-11
 - 10.2.2.1 600 and 900 Pair Cables 10-11
 - 10.2.2.2 1200 to 3600 Pair Cables 10-11
 - 10.2.2.3 4200 Pair Cables 10-11
 - 10.2.2.4 Defective Pairs 10-12
 - 10.2.2.5 Defective Pair Marking 10-12
 - 10.2.2.6 Spare Pairs 10-12
 - 10.2.2.7 Pressurization 10-12
 - 10.2.3 Electrical Requirements 10-12
 - 10.2.4 Mechanical and Environmental Tests 10-12
- 10.3 PIC Filled Solid/Foam-Skin Cable With ASP Sheath 10-12
 - 10.3.1 Mechanical Design Requirements 10-13
 - 10.3.1.1 Conductors 10-13
 - 10.3.1.2 Conductor Insulation 10-13
 - 10.3.1.2.1 Insulation Type 10-13
 - 10.3.1.2.2 Insulation Test Requirements 10-13
 - 10.3.1.2.3 Insulation Colors, Dimensions, and Splices 10-13
 - 10.3.1.2.4 Twist Lengths and Color Coding 10-13
 - 10.3.1.3 Binders 10-13
 - 10.3.1.4 Core Wrap 10-14
 - 10.3.1.5 Filling Compound 10-14
 - 10.3.1.6 Flooding Compound 10-14
 - 10.3.1.7 Aluminum Shield 10-14



10.3.1.8	Steel Shield	10-14
10.3.1.9	Polyethylene Outer Jacket	10-14
10.3.2	Core Layups	10-14
10.3.3	Electrical Requirements	10-14
10.3.4	Mechanical and Environmental Tests	10-15
10.4	PIC Filled Foam-Skin Cable with ALPETH Sheath	10-15
10.5	PIC Filled Solid/Foam-Skin Screened Cable with ASP Sheath	10-15
10.5.1	Mechanical Design Requirements	10-15
10.5.1.1	Conductors	10-15
10.5.1.2	Conductor Insulation	10-15
10.5.1.2.1	Insulation Type	10-15
10.5.1.2.2	Insulation Test Requirements	10-15
10.5.1.2.3	Insulation Colors, Dimensions, and Splices	10-16
10.5.1.2.4	Twist Lengths and Color Coding	10-16
10.5.1.3	Binders	10-16
10.5.1.4	Core Separator Screen	10-16
10.5.1.5	Core Wrap	10-16
10.5.1.6	Filling Compound	10-16
10.5.1.7	Flooding Compound	10-16
10.5.1.8	Aluminum Shield	10-16
10.5.1.9	Steel Shield	10-17
10.5.1.10	Polyethylene Outer Jacket	10-17
10.5.2	Core Layups	10-17
10.5.2.1	T-Carrier Service Pair Unit	10-17
10.5.2.2	Screened Cables	10-17
10.5.3	Electrical Requirements	10-18
10.5.4	Mechanical and Environmental Tests	10-18
10.6	PIC Bonded Screened Cable with Bonded PASP Sheath	10-18
10.6.1	Mechanical Design Requirements	10-18
10.6.2	Core Layups	10-18
10.6.3	Electrical Requirements	10-18
10.6.4	Mechanical and Environmental Tests	10-18
10.7	PIC Self-Support Cable With ALPETH Sheath and Reinforced Sheath	10-19
10.7.1	Mechanical Design Requirements	10-19
10.7.1.1	Conductors	10-19
10.7.1.2	Material	10-19
10.7.1.3	Insulation Test Requirements	10-19
10.7.1.4	Insulation Colors, Dimensions, and Splices	10-19
10.7.1.5	Twist Lengths and Color Coding	10-20
10.7.1.6	Binders	10-20
10.7.1.7	Core Wrap	10-20
10.7.1.8	Aluminum Shield	10-20
10.7.1.9	Polyethylene Inner Jacket (Reinforced Cable Only)	10-20
10.7.1.10	Steel Shield (Reinforced Cable Only)	10-20
10.7.1.11	Steel Strand	10-21
10.7.1.12	Flooding Compound	10-21
10.7.1.12.1	Type 1 Compound (Reinforced and Non-Reinforced Cables)	10-21
10.7.1.12.2	Type 2 Compound (Reinforced Cable Only)	10-21
10.7.1.12.3	Polyethylene Outer Jacket	10-21

- 10.7.2 Core Layups 10-21
 - 10.7.2.1 Core Undulating 10-22
 - 10.7.2.2 Self-Support Sheath 10-22
 - 10.7.2.2.1 Self-Support Sheath (Non-Reinforced Only) 10-22
 - 10.7.2.2.2 Reinforced Self-Support Sheath 10-22
- 10.7.3 Electrical Requirements 10-22
- 10.7.4 Mechanical and Environmental Tests 10-22
 - 10.7.4.1 Torsion Test (Reinforced Cable Only) 10-23
 - 10.7.4.2 Support Strand 10-23
 - 10.7.4.3 Excess Core 10-23
- 10.8 Unsoldered Mechanical (UM) Protection Applied Over Basic Cable 10-24
- 10.9 Stub Cables 10-25
 - 10.9.1 Product Descriptions 10-25
 - 10.9.2 Cable 10-26

Appendix A: Historical Reference Information

- A.1 Superseded Telcordia Documents A-1
- A.2 Cable Codes A-1
- A.3 Applications A-6

Appendix B: Insulation Spark Test

Appendix C: Pedestal Thermal Oxidative Stability Performance Test

Appendix D: Test Procedures for Wicking and Hygroscopicity

Appendix E: Core Layups

Appendix F: Excess Core Test Procedure

Appendix G: References

Requirement-Object Index

List of Figures

Figure 5-1	Forming of Steel Tape Overlap	5-6
Figure 6-1	Sheath Adherence Sample Preparation	6-5
Figure 8-1	Examples of Corrosion Grades	8-5
Figure 9-1	Jacket Marking	9-2
Figure 10-1	Polyethylene Jacket Thickness Requirements for Self-Support Sheath (Non-Reinforced Cable)	10-23
Figure 10-2	Polyethylene Jacket Thickness Requirements for Reinforced Self-Support Sheath	10-24
Figure A-1	Cable Code	A-1
Figure C-1	Pedestal Test Setup	C-4
Figure C-2	Metal Brackets	C-5
Figure C-3	Coil Forming Procedure	C-6
Figure C-4	Heating Mantle Assembly	C-7
Figure D-1	Wicking Test Configuration	D-2
Figure E-1	12, 13 and 25 Pair Primary Units	E-2
Figure E-2	50 and 100 Pair Multi Units; 100 Pair Core Layup	E-3
Figure E-3	300 Pair Multiunit	E-3
Figure E-4	6 to 25 Pair Cable Core Layups	E-4
Figure E-5	50 to 100 Pair Cable Core Layups	E-5
Figure E-6	150 to 300 Pair Cable Core Layups (*)	E-6
Figure E-7	Alternate Core Lay-Ups for 200 Pair Cables	E-7
Figure E-8	Alternate Core Lay-Ups for 300 Pair Cables	E-8
Figure E-9	400, 600, and 900 Pair Cable Core Layups	E-9
Figure E-10	Alternate Core Lay-Ups for 400 Pair Cables	E-10
Figure E-11	25-Pair and 100-Pair Units for Alternate Core Lay-Ups of 600 and 900 Pair Foam-Skin Aircore (DuctPIC) Cables	E-11
Figure E-12	Alternate Core Lay-Ups for 600 and 900 Pair Foam-Skin Aircore (DuctPIC) Cables Using Mirror-Image and 100-Pair Units (See Figure E-11)	E-12
Figure E-13	1200, 1500 and 1800 Pair Cable Core Layups	E-13
Figure E-14	2100 and 2400 Pair Cable Core Layups	E-14
Figure E-15	2700 and 3000 Pair Cable Core Layups	E-15
Figure E-16	26 AWG 3600 Pair Core Layup	E-16
Figure E-17	Alternate 3600 Pair Core Layup - 300 Pair Multiunits	E-17
Figure E-18	4200 Pair Core Layup, 26 AWG	E-18
Figure E-19	4, 6, 8, 10, 14, 16, and 18 Pair T-Carrier Service Pair Units	E-19
Figure E-20	158, 158 Alternate and 210 Pair Core Layups	E-20
Figure E-21	314, 314 Alternate and 418 Pair Core Layups	E-21
Figure E-22	616 and 616 Alternate Pair Core Layups	E-22
Figure F-1	Excess Core Test Setup	F-2

List of Tables

Table 3-1	Equivalent OIT Values at Different Temperatures	3-7
Table 3-2	Thermal Oxidative Stability Requirements for Polyolefin Insulations	3-8
Table 7-1	DC Resistance in Ohms per Sheath-Mile (km)	7-1
Table 7-2	Mutual Capacitance nF/mile (nF/km)	7-1
Table 7-3	Capacitance Unbalance pF/kft(pF/km)	7-2
Table 7-4	Capacitance Unbalance-To-Ground pF/kft (pF/km)	7-2
Table 7-5	Maximum Average Attenuation in dB/kft (dB/km)	7-3
Table 7-6	Equal Level Far End Crosstalk (EL FEXT) Power Sum in dB/kft	7-3
Table 7-7	Near End Crosstalk (NEXT) Power Sum in dB/kft	7-4
Table 7-8	DC Test Voltage (kV)	7-6
Table 8-1	Gopher Damage Descriptions	8-2
Table 8-2	Corrosion Damage Descriptions	8-5
Table 10-1	Thickness	10-25
Table 10-2	Transition Cable or Stub Cable Construction Designs	10-26
Table B-1	Electrode Potential For Single Insulated Conductor	B-3
Table B-2	Gradient	B-3

