



**STANDARD FOR
CONCENTRIC NEUTRAL CABLES
RATED 5 THROUGH 46 KV**

Approved by
AMERICAN NATIONAL STANDARDS INSTITUTE
September 20, 2005
Publication # ANSI/ICEA S-94-649-2004

©2004 by
INSULATED CABLE ENGINEERS ASSOCIATION, Inc.

**STANDARD FOR
CONCENTRIC NEUTRAL CABLES
RATED 5 THROUGH 46 KV**

**Standard
ICEA S-94-649-2004**

Published By
INSULATED CABLE ENGINEERS ASSOCIATION, Inc.
Post Office Box 1568
Carrollton, Georgia 30112, U.S.A.

Approved by Insulated Cable Engineers Association, Inc.: August 31, 2004

Accepted by IEEE/ICC2-A 14: September 9, 2004

Accepted by AEIC: Cable Engineering Committee: September 13, 2004

Approved by ANSI: September 20, 2005

© Copyright 2004 by the Insulated Cable Engineers Association, Inc. All rights including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the international and Pan American Copyright Conventions.

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The Insulated Cable Engineers Association, Inc. (ICEA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together persons who have an interest in the topic covered by this publication. While ICEA administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgements contained in its standards and guideline publications.

ICEA disclaims liability for personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. ICEA disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. ICEA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, ICEA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is ICEA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgement or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

ICEA has no power, nor does it undertake to police or enforce compliance with the contents of this document. ICEA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to ICEA and is solely the responsibility of the certifier or maker of the statement.

FOREWORD

This Standards Publication for Concentric Neutral Cables Rated 5 to 46 kV (ICEA S-94-649) was developed by the Insulated Cable Engineers Association Inc. (ICEA).

ICEA standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the user and to assist the user in selecting and obtaining the proper product for his particular need. Existence of an ICEA standard does not in any respect preclude the manufacture or use of products not conforming to the standard. The user of this Standards Publication is cautioned to observe any health or safety regulations and rules relative to the manufacture and use of cable made in conformity with this Standard.

Requests for interpretation of this Standard must be submitted in writing to the Insulated Cable Engineering Association, Inc., P. O. Box 1568, Carrollton, Georgia 30112. An official written interpretation will be provided. Suggestions for improvements gained in the use of this Standard will be welcomed by the Association.

The ICEA expresses thanks to the Association of Edison Illuminating Companies, Cable Engineering Committee for providing the basis for some of the material included herein through their participation in the Utility Power Cable Standards Technical Advisory Committee (UPCSTAC), and to the Institute of Electrical and Electronics Engineers, Insulated Conductors Committee, Subcommittee A, Discussion Group A-14 for providing user input to this Standard.

The members of the ICEA working group contributing to the writing of this Standard consisted of the following:

F. Kuchta, Chairman

E. Bartolucci
J. Cancelosi
D. Fox
B. Temple
E. Walcott

R. Bristol
P. Cinquemani
L. Hiivala
R. Thrash
N. Ware

S. Campbell
R. Fleming
A. Pack
B. Vaughn

TABLE OF CONTENTS

Part 1 GENERAL.....	1
1.1 SCOPE.....	1
1.2 GENERAL INFORMATION	1
1.3 INFORMATION TO BE SUPPLIED BY PURCHASER.....	1
1.3.1 Characteristics of Systems on which Cable is to be Used.....	1
1.3.2 Quantities and Description of Cable	2
1.4 DEFINITIONS AND SYMBOLS.....	2
 Part 2 CONDUCTOR	5
2.0 GENERAL.....	5
2.1 PHYSICAL AND ELECTRICAL PROPERTIES.....	5
2.1.1 Copper Conductors.....	5
2.1.2 Aluminum Conductors.....	5
2.2 OPTIONAL SEALANT FOR STRANDED CONDUCTORS	6
2.3 CONDUCTOR SIZE UNITS	6
2.4 CONDUCTOR DC RESISTANCE PER UNIT LENGTH.....	6
2.4.1 Direct Measurement of dc Resistance Per Unit Length.....	6
2.4.2 Calculation of dc Resistance Per Unit Length	6
2.5 CONDUCTOR DIAMETER.....	7
 Part 3 CONDUCTOR SHIELD (STRESS CONTROL LAYER).....	13
3.1 MATERIAL.....	13
3.2 EXTRUDED SHIELD THICKNESS	13
3.2.1 Reduced Extruded Shield Thickness.....	13
3.3 PROTRUSIONS AND CONVOLUTIONS	13
3.4 VOIDS	14
3.5 PHYSICAL REQUIREMENTS	14
3.6 ELECTRICAL REQUIREMENTS	14
3.6.1 Extruded Semiconducting Material.....	14
3.6.2 Extruded Nonconducting Material (For EPR Insulation Only)	14
3.6.3 Semiconducting Tape	14
3.7 WAFER BOIL TEST	14
 Part 4 INSULATION	15
4.1 MATERIAL.....	15
4.2 INSULATION THICKNESS.....	16
4.2.1 Selection of Proper Thickness	16
4.2.1.1 For Three-Phase Systems with 100 or 133 Percent Insulation Level	16
4.2.1.2 For Delta Systems Where One Phase May Be Grounded For Periods Over One Hour	16
4.2.1.3 For Single- and Two-Phase Systems with 100 Percent Insulation Level.....	16
4.2.1.4 For Single- and Two-Phase Systems with 133 Percent Insulation Level.....	16
4.3 INSULATION REQUIREMENTS	16
4.3.1 Physical and Aging Requirements	16
4.3.2 Electrical Requirements	17
4.3.2.1 Partial-Discharge Extinction Level for Discharge-Free Designs Only	17
4.3.2.2 Discharge (Corona) Resistance for Discharge-Resistant Designs Only.....	17
4.3.2.3 Voltage Tests.....	18
4.3.2.4 Insulation Resistance Test	18
4.3.2.5 Dielectric Constant and Dissipation Factor	18
4.3.3 Voids, Ambers, Gels, Agglomerates and Contaminants as Applicable.....	18

4.3.3.1	Crosslinked Polyethylene Insulation (XLPE or TRXLPE)	18
4.3.3.2	Ethylene Propylene Rubber (EPR).....	19
4.3.4	Shrinkback - Crosslinked Polyethylene Insulation (XLPE or TRXLPE) Only.....	19
Part 5 EXTRUDED INSULATION SHIELD.....		22
5.1 MATERIAL.....		22
5.2 THICKNESS AND INDENT REQUIREMENTS		22
5.3 PROTRUSIONS		23
5.4 INSULATION SHIELD REQUIREMENTS		23
5.4.1	Insulation Shield for DISCHARGE-FREE Cable Designs Only	23
5.4.1.1	Removability	23
5.4.1.2	Voids	23
5.4.1.3	Physical Requirements.....	23
5.4.1.4	Electrical Requirements	24
5.4.1.5	Wafer Boil Test.....	24
5.4.2	Insulation Shield for DISCHARGE-RESISTANT Cable Designs Only	24
5.4.2.1	Removability	24
5.4.2.2	Physical Requirements.....	24
5.4.2.3	Electrical Requirements	24
5.4.2.4	Wafer Boil Test.....	24
Part 6 CONCENTRIC NEUTRAL CONDUCTOR.....		25
6.1 MATERIAL.....		25
6.2 CROSS-SECTIONAL AREA.....		25
6.3 LAY LENGTH.....		25
6.4 CONCENTRIC WIRES.....		25
6.4.1	Minimum Sizes	25
6.4.2	Contrahelical Wire.....	25
6.4.3	Diameter and Area	25
6.5 FLAT STRAPS		26
6.6 OPTIONAL WATER BLOCKING COMPONENTS FOR METALLIC SHIELD		26
Part 7 JACKETS		28
7.1 MATERIAL.....		28
7.1.1	Low and Linear Low Density Polyethylene, Black (LDPE/LLDPE)	28
7.1.2	Medium Density Polyethylene, Black (MDPE).....	29
7.1.3	High Density Polyethylene, Black (HDPE).....	30
7.1.4	Semiconducting Jacket Type I.....	31
7.1.5	Semiconducting Jacket Type II.....	32
7.1.6	Polyvinyl Chloride (PVC).....	33
7.1.7	Chlorinated Polyethylene (CPE)	34
7.1.8	Thermoplastic Elastomer (TPE)	35
7.1.9	Polypropylene, Black (PP)	36
7.2 JACKET TYPES.....		37
7.2.1	Extruded-To-Fill Jacket	37
7.2.2	Overlaying Jacket.....	37
7.3 JACKET IRREGULARITY INSPECTION		37
7.3.1	Nonconducting Jackets.....	37
7.3.2	Semiconducting Jackets	37
Part 8 CABLE ASSEMBLY AND IDENTIFICATION.....		39
8.1 MULTIPLEX CABLE ASSEMBLIES		39
8.2 CABLE IDENTIFICATION		39

8.2.1	Jacketed Cable	39
8.2.1.1	Optional Cable Identification.....	39
8.2.2	Unjacketed Cable.....	39
8.2.3	Optional Center Strand Identification.....	40
8.2.4	Optional Sequential Length Marking.....	40
Part 9	PRODUCTION TESTS.....	41
9.1	TESTING	41
9.2	SAMPLING FREQUENCY	41
9.3	CONDUCTOR TEST METHODS	41
9.3.1	Method for DC Resistance Determination.....	41
9.3.2	Cross-Sectional Area Determination	41
9.3.3	Diameter Determination	41
9.4	TEST SAMPLES AND SPECIMENS FOR PHYSICAL AND AGING TESTS	41
9.4.1	General.....	41
9.4.2	Measurement of Thickness	41
9.4.2.1	Micrometer Measurements	42
9.4.2.2	Optical Measuring Device Measurements	42
9.4.3	Number of Test Specimens.....	42
9.4.4	Size of Specimens	42
9.4.5	Preparation of Specimens of Insulation and Jacket.....	43
9.4.6	Specimen for Aging Test.....	43
9.4.7	Calculation of Area of Test Specimens	43
9.4.8	Unaged Test Procedures	43
9.4.8.1	Test Temperature.....	43
9.4.8.2	Type of Testing Machine	44
9.4.8.3	Tensile Strength Test	44
9.4.8.4	Elongation Test.....	44
9.4.9	Aging Tests	44
9.4.9.1	Aging Test Specimens	44
9.4.9.2	Air Oven Test.....	45
9.4.9.3	Oil Immersion Test for Polyvinyl Chloride Jacket	45
9.4.10	Hot Creep Test.....	45
9.4.11	Solvent Extraction	45
9.4.12	Wafer Boil Test for Conductor and Insulation Shields	45
9.4.12.1	Insulation Shield Hot Creep Properties	45
9.4.13	Amber, Agglomerate, Gel, Contaminant, Protrusion, Indent, Convolutions and Void Test	46
9.4.13.1	Sample Preparation.....	46
9.4.13.2	Examination	46
9.4.13.3	Resampling for Amber, Agglomerate, Gel, Contaminant, Protrusion, Convolutions and Void Test.....	46
9.4.13.4	Protrusion, Indentation and Convolutions Measurement Procedure	46
9.4.14	Internal Irregularity Test Procedure for Crosslinked Polyethylene Insulation (XLPE or TRXLPE) only.....	47
9.4.14.1	Sample Preparation.....	47
9.4.14.2	Detection of Irregularities.....	48
9.4.14.3	Resampling for Internal Irregularity Test	48
9.4.15	Physical Tests for Semiconducting Material Intended for Extrusion	48
9.4.15.1	Test Sample	48
9.4.15.2	Test Specimens.....	48
9.4.15.3	Elongation.....	48
9.4.16	Retests for Physical and Aging Properties and Thickness	48

9.5 DIMENSIONAL MEASUREMENTS OF THE METALLIC SHIELD	49
9.6 DIAMETER MEASUREMENT OF INSULATION AND INSULATION SHIELD	49
9.7 TESTS FOR JACKETS	49
9.7.1 Heat Shock.....	49
9.7.2 Heat Distortion.....	50
9.7.3 Cold Bend.....	50
9.8 VOLUME RESISTIVITY	50
9.8.1 Conductor Shield (Stress Control).....	50
9.8.2 Insulation Shield.....	50
9.8.3 Test Equipment.....	51
9.8.4 Test Procedure.....	51
9.8.4.1 Two-electrode Method.....	51
9.8.4.2 Four-electrode Method.....	51
9.8.4.3 Measurement.....	51
9.8.5 Semiconducting Jacket Radial Resistivity Test.....	51
9.8.5.1 Sample Preparation.....	52
9.8.5.2 Test Equipment Setup.....	52
9.8.5.3 Calculation	53
9.9 ADHESION (Insulation Shield Removability) TEST	54
9.10 SHRINKBACK TEST PROCEDURE	54
9.10.1 Sample Preparation	54
9.10.2 Test Procedure.....	54
9.10.3 Pass/Fail Criteria and Procedure.....	54
9.11 RETESTS ON SAMPLES.....	54
9.12 AC VOLTAGE TEST.....	55
9.12.1 General.....	55
9.12.2 AC Voltage Test.....	55
9.13 PARTIAL-DISCHARGE TEST PROCEDURE	55
9.14 METHOD FOR DETERMINING DIELECTRIC CONSTANT AND DIELECTRIC STRENGTH OF EXTRUDED NONCONDUCTING POLYMERIC STRESS CONTROL LAYERS	55
9.15 WATER CONTENT	55
9.15.1 Water Under the Jacket.....	55
9.15.2 Water in the Conductor	56
9.15.3 Water Expulsion Procedure	56
9.15.4 Presence of Water Test	56
9.16 PRODUCTION TEST SAMPLING PLANS	57
 Part 10 QUALIFICATION TESTS.....	60
10.0 GENERAL	60
10.1 CORE QUALIFICATION TESTS	60
10.1.1 Material Qualification Requirements.....	60
10.1.1.1 Conductor Shield/Insulation Qualification	60
10.1.1.2 Insulation/Insulation Shield Qualification.....	61
10.1.2 Manufacturing Qualification Requirements	61
10.1.2.1 Conductor Shield/Insulation Test	61
10.1.2.2 Insulation/Insulation Shield Test.....	61
10.1.3 High Voltage Time Test (HVTT) Procedure	63
10.1.4 Hot Impulse Test Procedure	64
10.1.5 Cyclic Aging.....	64
10.1.5.1 Cable Length	64
10.1.5.2 Sample Preparation	64
10.1.5.3 Conduit.....	64

10.1.5.4	Load Cycle	65
10.1.6	Accelerated Water Treeing Test (AWTT) Procedure	65
10.1.6.1	General	65
10.1.6.2	Quantity of Cable To Be Aged.....	65
10.1.6.3	Aging Time.....	65
10.1.6.4	Conduit Fixture	65
10.1.6.4.1	Structures Above Conduit Fixtures.....	66
10.1.6.4.2	Conduit Fixtures Dimensions	66
10.1.6.5	Water	66
10.1.6.6	Ambient Temperature	66
10.1.6.7	Test Procedure	66
10.1.6.8	Water pH	68
10.1.6.9	High Voltage Time Test Requirements.....	68
10.1.6.10	Retesting.....	69
10.1.7	Qualification Test Electrical Measurements	69
10.1.8	Qualification Test Physical Measurements	70
10.2	THERMOMECHANICAL QUALIFICATION TEST - Optional.....	70
10.2.1	Scope	70
10.2.2	Procedure.....	70
10.2.2.1	Fixture	70
10.2.2.2	Load Cycling	70
10.2.2.3	Electrical Measurements	71
10.2.2.4	Physical Measurements Before and After the Thermomechanical Design Test.....	71
10.3	JACKET MATERIAL QUALIFICATION TESTS.....	72
10.3.1	Polyethylene And Polypropylene Jackets	72
10.3.1.1	Environmental Stress Cracking Test	72
10.3.1.1.1	Test Specimen.....	73
10.3.1.1.2	Test Procedure	73
10.3.1.2	Absorption Coefficient Test	73
10.3.2	Semiconducting Jackets	73
10.3.2.1	Brittleness Temperature.....	73
10.3.3	Polyvinyl Chloride and Chlorinated Polyethylene Jackets	73
10.3.3.1	Sunlight Resistance.....	73
10.3.3.1.1	Test Samples.....	73
10.3.3.1.2	Test Procedure	73
10.3.4	Extruded Red Stripe For Jackets.....	73
10.3.4.1	Sunlight Resistance.....	73
10.3.4.1.1	Test Samples.....	74
10.3.4.1.2	Test Procedure	74
10.4	CV EXTRUSION QUALIFICATION TEST	74
10.4.1	Thermal Conditioning.....	74
10.4.2	Dissipation Factor Verification	74
10.4.3	AC Withstand Verification	74
10.5	OTHER QUALIFICATION TESTS	75
10.5.1	Insulation Resistance	75
10.5.2	Accelerated Water Absorption Tests.....	75
10.5.3	Resistance Stability Test.....	76
10.5.4	Brittleness Temperature for Semiconducting Shields	76
10.5.5	Dry Electrical Test for Class III Insulations	76
10.5.5.1	Test Samples.....	76
10.5.5.2	Test Procedure	76
10.5.5.3	Electrical Measurements	77

10.5.6	Discharge Resistance Test for EPR Class IV Insulation Only	77
10.5.6.1	Test Specimens.....	77
10.5.6.2	Test Environment	77
10.5.6.3	Test Electrodes.....	77
10.5.7	Dissipation Factor Characterization Test.....	78
10.5.7.1	Test Samples.....	78
10.5.7.2	Thermal Conditioning	78
10.5.7.3	Dissipation Factor Testing.....	78
Part 11	APPENDICES	79
APPENDIX A	NEMA, ICEA, IEEE, ASTM AND ANSI STANDARDS (Normative).....	79
A1	NEMA PUBLICATIONS	79
A2	ICEA PUBLICATIONS	79
A3	IEEE AND ANSI STANDARDS	79
A4	ASTM STANDARDS.....	79
APPENDIX B	EMERGENCY OVERLOADS (Normative)	82
APPENDIX C	PROCEDURE FOR DETERMINING DIAMETERS OF CABLE (Normative).....	83
APPENDIX D	SHIELDING (Informative).....	88
D1	DEFINITION OF SHIELDING	88
D2	FUNCTIONS OF SHIELDING	88
D3	USE OF INSULATION SHIELDING	88
D4	GROUNDING OF THE INSULATION SHIELD.....	89
D5	SHIELD MATERIALS.....	89
D6	SPLICES AND TERMINATIONS	89
APPENDIX E	HANDLING AND INSTALLATION PARAMETERS (Informative).....	90
E1	INSTALLATION TEMPERATURES	90
E2	RECOMMENDED MINIMUM BENDING RADIUS.....	90
E3	DRUM DIAMETERS OF REELS	90
E4	MAXIMUM TENSION AND SIDEWALL BEARING PRESSURES	90
E5	TESTS DURING AND AFTER INSTALLATION	90
E5.1	During Installation	90
E5.2	After Installation	90
E5.3	In Service	90
APPENDIX F	OPTIONAL FACTORY DC TEST (Informative)	92
APPENDIX G	REDUCED NEUTRAL DESIGNS (Informative)	93
APPENDIX H	ADDITIONAL CONDUCTOR INFORMATION (Informative)	97
APPENDIX I	ETHYLENE ALKENE COPOLYMER (EAM) (Informative)	100
APPENDIX J	REVISED AWTT CONDUIT FIXTURES (Informative).....	101
APPENDIX K	INSULATION COMPOUND INSPECTION (Normative)	102
K1	SCOPE	102
K2	PROCEDURE	102
K2.1	Compound Tape Inspection Sampling Plan	102
K2.2	Compound Pellet Inspection Sampling Plan.....	102

LIST OF TABLES

Table 2-1	Weight Increment Factors	7
Table 2-2	Schedule for Establishing Maximum Direct Current Resistance Per Unit Length of Completed Cable Conductors listed in Table 2-4	7
Table 2-3	Nominal Direct Current Resistance in Ohms Per 1000 Feet at 25 °C of Solid and Concentric Lay Stranded Conductor	8

Table 2-3 (Metric)	Nominal Direct Current Resistance in Milliohms Per Meter at 25 °C	
	of Solid and Concentric Lay Stranded Conductor	9
Table 2-4	Nominal Diameters for Copper and Aluminum Conductors	10
Table 2-4 (Metric)	Nominal Diameters for Copper and Aluminum Conductors	11
Table 2-5	Factors for Determining Nominal Resistance of Stranded Conductors	
	Per 1000 Feet at 25 °C	12
Table 3-1	Extruded Conductor Shield Thickness	13
Table 3-2	Extruded Conductor Shield Requirements	14
Table 4-1	Conductor Maximum Temperatures	15
Table 4-2	Insulation Physical Requirements	17
Table 4-3	Dielectric Constant and Dissipation Factor	18
Table 4-4	Shrinkback Test Requirements Cables Having Sealed Strand Conductors and/or a Tape Over the Conductor	19
Table 4-5	Shrinkback Test Requirements All Cables Not Covered by Table 4-4	19
Table 4-6	Cable BIL Values	20
Table 4-7	Conductor Sizes, Insulation Thicknesses and Test Voltages	20
Table 4-7 (Metric)	Conductor Sizes, Insulation Thicknesses and Test Voltages	21
Table 5-1	Insulation Shield Thickness Cables With Wire Neutral	22
Table 5-2	Extruded Insulation Shield Requirements Discharge-Free Designs	23
Table 5-3	Extruded Insulation Shield Requirements Discharge-Resistant Designs	24
Table 6-1	Concentric Neutral Wire Size	26
Table 6-2	Full Neutral Concentric Copper Conductor	26
Table 6-3	One-third Neutral Concentric Copper Conductor	27
Table 7-1	Low Density and Linear Low Density Polyethylene, Black (LDPE/LLDPE)	28
Table 7-2	Medium Density Polyethylene, Black (MDPE)	29
Table 7-3	High Density Polyethylene, Black (HDPE)	30
Table 7-4	Semiconducting Jacket Type I	31
Table 7-5	Semiconducting Jacket Type II	32
Table 7-6	Polyvinyl Chloride (PVC)	33
Table 7-7	Chlorinated Polyethylene (CPE)	34
Table 7-8	Thermoplastic Elastomer (TPE)	35
Table 7-9	Polypropylene, Black (PP)	36
Table 7-10	Extruded-To-Fill Jacket Thickness and Test Voltage	37
Table 7-11	Overlaying Jacket Thickness and Test Voltage	38
Table 8-1	Nominal Insulation Thickness	40
Table 9-1	Test Specimens for Physical and Aging Tests	42
Table 9-2	Insulation Shield Hot Creep Requirements	46
Table 9-3	Bending Requirements for Heat Shock Test	49
Table 9-4	Bending Requirements for Cold Bend Test	50
Table 9-5	Summary of Production Tests and Sampling Frequency Requirements	57
Table 9-6	Plan E	59
Table 9-7	Plan F	59
Table 10-1	Minimum ac Withstand Values	69
Table 10-2	Maximum Temperature Gradient for Thermal Aging	71
Table 10-3	Generic Grouping of Cable Components	72
Table 10-4	AC Withstand Voltage Requirements 15-35 kV Rated Cables	75
Table 10-5	Accelerated Water Absorption Properties	76
Table C-1	Insulation Diameter Calculation	83
Table C-2	Insulation Shield Adders	84
Table C-3	Calculated Dimensions For Round Wire Neutral – Concentric Stranding	85
Table C-4	Calculated Dimensions For Round Wire Neutral – Compressed Stranding	86
Table C-5	Calculated Dimensions For Round Wire Neutral – Compact Stranding	87
Table E-1	DC Field Test Voltages	91