



STANDARD FOR
600 VOLT RATED CABLES OF RUGGEDIZED DESIGN
FOR DIRECT BURIAL INSTALLATIONS AS SINGLE
CONDUCTORS
OR ASSEMBLIES OF SINGLE CONDUCTORS

Approved by
AMERICAN NATIONAL STANDARDS INSTITUTE
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INSULATED CABLE ENGINEERS ASSOCIATION, Inc.

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INSULATED CABLE ENGINEERS ASSOCIATION
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Copies of this publication may be obtained from:

INSULATED CABLE ENGINEERS ASSOCIATION, Inc.
Post Office Box 1568
Carrollton, Georgia 30117
Telephone (770) 830-0369

Foreword

This standard publication for 600 Volt rated cables of ruggedized design for direct burial installations as single conductors and assemblies of single conductors, ICEA S-81-570 was developed by the Insulated Cable Engineers Association, Inc. (ICEA)

ICEA standards and guides are adopted in the public interest and are designed to eliminate misunderstanding 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 or guide does not in any respect preclude the manufacture or use of products not conforming to the standard or guide. The user of this standard is cautioned to observe any health or safety regulations and rules relative to the manufacture and use of the cable made in conformity with this standard.

Request for interpretation of this standard must be submitted in writing to the Insulated Cable Engineers Association, Inc. Box 1568, Carrollton, Georgia, 30117. An official written interpretation will be provided. Suggestions for improvements gained in the use of this standard will be welcomed by the Association.

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PART 1

GENERAL

1.1 SCOPE

This standard applies to the materials, constructions, and testing of single conductor cables and assemblies of completed single conductor cables used for the distribution of electrical energy at phase-to-phase voltages not exceeding 600 volts, 60 Hz, and at conductor temperatures not exceeding 75 °C or 90 °C, as applicable to the construction. It requires the use of ruggedized extruded insulations to improve the resistance of the cable to certain forms of mechanical damage associated with their intended use as directly buried Secondary Distribution and Service Cables. These cables, when operated within the voltage and temperature limits stated herein, are also suitable for use in other types of installations under the conditions normally associated with those installations.

1.2 CONSTRUCTIONS

Single conductor cables and assemblies of single conductors cables shall use conductors not smaller than 8 AWG and not larger than 1,000 kcmil. The conductors of a duplex assembly shall be of the same size. When allowed, the neutral in an assembly of three cables for use in single-phase 3-wire circuits, or the neutral in an assembly of four cables, may be reduced but shall not be less than 50% of the cross-sectional area of one phase conductor.

1.3 DESIGN OPTIONS

The use of this standard should recognize that it covers many options. The user should select the necessary options required for a complete description of the desired cable.

1.3.1 Conductors

Metal - Aluminum 1350, AA-8000 Series alloy, copper.
Size - 8 AWG to 1000 kcmil, aluminum or copper.
Conductor Stranding - See Part 2.

1.3.2 Insulation – 75 °C or 90 °C Rated - See Part 3.1.

1.3.3 Assembly - See Part 4.1.

Twisted or parallel - Two or more insulated conductors without an overall covering.

1.4 OPERATING CONDITIONS

The design and construction of the cable shall be such that the cable will operate satisfactorily under maximum conductor temperatures as follows:

Conductor Temperature, °C Operation			
Insulation Rating	Normal Service	Emergency Overload	Short Circuit
75	75	95	150
90	90	130	250

Exception:

When adequate knowledge of the thermal characteristics of a cable environment is lacking, the permissible conductor temperature should be reduced by 10 °C or in accordance with available data.

1.4.1 The 75 °C or 90 °C "Normal Service" temperature is the highest allowable temperature that may be attained by the hottest portion of a cable line during daily operating load cycles. It may be used in ampacity calculations where adequate information is known about the overall thermal characteristics of the environment to assure that the normal service temperature will not be exceeded.

1.4.2 The 95 °C or 130 °C "Emergency Overload" temperature is the highest allowable temperature that may be attained by the hottest portion of a cable line during an emergency. Operation at that overload temperature shall not exceed 100 hours in any twelve consecutive months or 500 hours during the lifetime of the cable.

1.4.3 The 150 °C or 250 °C "Short Circuit" temperature is the highest allowable temperature that may be attained by an insulated conductor along any part of a cable line during a short circuit of a specified magnitude and number of cycles. (See ICEA Publication P-32-382)

1.4.4 The "Rated Voltage" for the purpose of this standard is 600 volts phase-to-phase.

1.5 QUALIFICATION

Each manufacturer shall qualify their cable. The Qualification Tests in Part 6 and Engineering Information Tests in Part 7 are intended to demonstrate the capability of the manufacturer to furnish cables with the desired performance characteristics. An insulation resistance stability test, six abuse resistance tests, and a sunlight resistance test on insulations of colors other than black shall be made initially on cable specimens and whenever an insulating material is changed. A flexure test shall be performed for Engineering Information only. All data shall be recorded and retained. If requested, a manufacturer shall furnish copies of his qualification tests on cable specimens with the type of insulation being supplied.

1.6 TESTING

All cables shall comply with the requirements given in Parts 2, 3, and 4. A program of sampling frequencies is given in ICEA Publication T-26-465/NEMA WC 54 if a frequency is not provided in this standard.

1.7 TEST METHODS

When cables are tested for the requirements in Parts 2, 3, or 4, the test method shall be in accordance with ICEA Publication T-27-581/NEMA WC 53.

1.8 STANDARDS AND SPECIFICATIONS

A list of standards and specifications referenced in this document are in Appendix D. The recommended bending radii for insulated conductors and cable assemblies are in Appendix B. Minimum drum diameters of reels for singles and assemblies are in Appendix C.

Part 2

CONDUCTOR

2.0 GENERAL

Conductors shall meet the requirements of the appropriate ASTM standard referenced in this standard except resistance will determine cross-sectional area as noted in Part 2.3 and diameters shall be in accordance with 2.4.

2.1 PHYSICAL AND ELECTRICAL PROPERTIES

The conductors used in the cable shall be copper in accordance with 2.1.1 or aluminum in accordance with 2.1.2 except as noted in 2.0. The outer layer of an uncoated stranded copper conductor may be coated to obtain free stripping of an adjacent polymeric layer.

2.1.1 Copper Conductors

1. ASTM B 3 for Soft or Annealed Uncoated Copper.
2. ASTM B 5 for Electrical Grade Copper.
3. ASTM B 8 for Class A or B Stranded Copper Conductors.
4. ASTM B 33 for Soft or Annealed Tin-Coated Copper Wire.
5. ASTM B 496 for Compact-Round Stranded Copper Conductors.
6. ASTM B 784 for Modified Concentric Lay Stranded Copper Conductor.
7. ASTM B 787 for 19 Wire Combination Unilay-Stranded Copper Conductors.
8. ASTM B 835 for Compact Round Stranded Copper Conductors Using Single Input Wire Constructions.

2.1.2 Aluminum Conductors

1. ASTM B 230 for Electrical Grade Aluminum 1350-H19.
2. ASTM B 231 for Class A or B Stranded Aluminum 1350 Conductors.
3. ASTM B 233 for Electrical Grade Aluminum 1350 Drawing Stock.
4. ASTM B 400 for Compact-Round Stranded Aluminum 1350 Conductors.
5. ASTM B 609 for Electrical Grade Aluminum 1350 Annealed and Intermediate Tempers.
6. ASTM B 786 for 19 wire Combination Unilay-Stranded Aluminum 1350 Conductors.
7. ASTM B 800 for 8000 Series Aluminum Alloy Annealed and Intermediate Tempers.
8. ASTM B 801 for 8000 Series Aluminum Alloy Wires, Compact Round, Compressed and Concentric-Lay Class A or B Stranded Conductors.
9. ASTM B 836 for Compact Round Stranded Aluminum Conductors Using Single Input Wire Constructions.
10. ASTM B 901 for Compressed Round Stranded Aluminum Conductors Using Single Input Wire Constructions

2.2 CONDUCTOR SIZE UNITS

Conductor size shall be expressed by cross-sectional area in thousand circular mils (kcmil). The AWG equivalents for the smaller kcmil sizes are shown in Table 2-3. The metric equivalents for all sizes are found in Table 2-3 (Metric).

2.3 CONDUCTOR DC RESISTANCE PER UNIT LENGTH

The dc resistance per unit length of each conductor in a production or shipping length of completed cable shall not exceed the value determined from the schedule of maximum dc resistance specified in Table 2-1 when using the appropriate nominal value specified in Table 2-2. The dc resistance shall be determined in accordance with 2.3.1 or 2.3.2.

Where the outer layer of an uncoated stranded copper conductor is tin coated, the direct current resistance of the resulting conductor shall not exceed the value specified for an uncoated conductor of the same size.

When a sample is taken from a multiple conductor cable, the resistance shall comply with the appropriate maximum resistance value specified for a single conductor cable.

2.3.1 Direct Measurement of dc Resistance per Unit Length

The dc resistance per unit length shall be determined by dc resistance measurements made in accordance with ICEA Publication T-27-581/NEMA WC-53 to an accuracy of 2 percent or better. If measurements are made at temperatures other than 25 °C, the measured value shall be converted to resistance at 25 °C by using either of the following:

1. The appropriate multiplying factor obtained from ICEA T-27-581/NEMA WC-53.
2. A multiplying factor calculated using the applicable formula in ICEA T-27-581/NEMA WC-53.

If verification is required for the direct current resistance measurement made on an entire length of completed cable, a sample at least one foot (0.305 m) long shall be cut from that reel length and the direct current resistance of each conductor shall be measured using a Kelvin-type bridge or a potentiometer.

2.3.2 Calculation of dc Resistance per Unit Length

The dc resistance per unit length at 25 °C shall be calculated using the following formula:

$$R = k \frac{\rho}{A}$$

Where:

R = Conductor resistance in Ω / 1000 ft.

k = Weight increment factor, as given in Table 2-5 or calculated per applicable ASTM standard.

ρ = Volume resistivity in $\Omega \cdot \text{cmil}$ / ft., determined in accordance with ASTM B 193 using round wires

A = Cross-sectional area of conductor in kmil , determined in accordance with ICEA T-27-581/NEMA WC-53.

When the volume resistivity is expressed in nanoohm meter ($\text{n}\Omega \cdot \text{m}$) and area is expressed in square millimeters (mm^2), the resistance is expressed in milliohms per meter ($\text{m}\Omega$ / m).

2.4 CONDUCTOR DIAMETER

The diameter of a conductor shall be measured in accordance with ICEA T-27-581/ NEMA WC-53. The diameter shall not differ from the nominal values shown in Tables 2-3 and 2-3 (Metric) by more than ± 2 percent.

Table 2-1

Schedule for Establishing Maximum Direct Current Resistance Per Unit Length of Completed Cable Conductors Listed in Table 2-3

Cable Type	Maximum dc Resistance
Single Conductor Cables and Flat Parallel Cables	Table 2-2 Value Plus 2% ($R_{\text{max}} = R \times 1.02$)
Twisted Assemblies of Single Conductor Cables	Table 2-2 Value Plus 2% Plus an Additional 2% For One layer of Conductors ($R_{\text{max}} = R \times 1.02 \times 1.02$)

For conductor strandings or sizes not listed in Table 2-2, the nominal direct current resistance per unit length of a completed single conductor cable shall be calculated using the following formula:

$$R = \frac{f}{A} 10^{-3}$$

Where:

R = Conductor Resistance in Ω / 1000 ft

f = Factor from Table 2-4

A = Nominal Cross-Sectional Area of Conductor in kmil