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***STANDARD FOR
BURIED TELECOMMUNICATIONS WIRE
FILLED, POLYOLEFIN INSULATED, COPPER CONDUCTOR
TECHNICAL REQUIREMENTS***

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ACRONYMS, ABBREVIATIONS AND SYMBOLS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ASQC	American Society for Quality Control
AWG	American Wire Gauge
°C	Degrees of Temperature, Celsius scale, Centigrade
CM	UL Listing designation for General Purpose Communication Cable
CMG	UL Listing designation for General Purpose Communication Cable
CMR	UL Listing designation for Riser Communication Cable
CMX	UL Listing designation for Communication Cable, Limited Use
dc	Direct Current
EIA	Electronic Industries Association
ELFEXT	Equal Level Far-End Crosstalk
FCC	Federal Communications Commission
f	Variable representing any frequency in the applicable range
°F	Degrees of Temperature, Fahrenheit scale
ft	foot or feet
ICEA	Insulated Cable Engineers Association
in	inch
ISO	International Organization for Standardization
lb	pounds
lbf	pounds of force
NEXT	Near-End Crosstalk
psi	pounds per square inch
PVC	Polyvinyl chloride
UL	Underwriters Laboratories
α	Attenuation

STANDARD FOR BURIED TELECOMMUNICATIONS WIRE FILLED, POLYOLEFIN INSULATED, COPPER CONDUCTOR TECHNICAL REQUIREMENTS

SECTION 1 GENERAL

- 1.1 PURPOSE:** The purpose of this Standard is to establish generic technical requirements that may be referenced by individual telecommunications wire specifications covering products intended for normal outside plant use. The parameters covered provide material, construction, and performance requirements.

Because this Standard does not cover all details of individual wire design, it cannot be used as a single document for procurement of product. It is intended to be used in conjunction with an individual product specification that provides complete design details for the specific wire type and designates the applicable performance requirements. Such individual wire specifications may be prepared either by the user or the manufacturer. The specification designated for procurement is at the option of the user.

- 1.2 SCOPE:** This Standard covers mechanical and electrical requirements for filled, polyolefin insulated, copper conductor, buried telecommunications wire. It provides alternative choices for type of insulation, type of filling compound, sheath design (shielding materials, single or double jackets, and jacket type and thickness) and armoring.

Buried wire is used to extend buried telephone plant from the distribution cable to the subscriber.

- 1.3 OPTIONS AND INFORMATION:** This Standard is arranged in Sections covering specific areas of wire requirements and may be referenced as complete Sections or as individual paragraphs.

Paragraphs of this specification where the user may specify a particular option are listed below:

- 3.2 Insulation Type
- 4.4.1 Filling Compound Type
- 4.5 Flooding Compound
- 4.7 Rip Cord(s)
- 5.1 Shielding System
- 6.1 Inner Jacket
- 6.2.1 Outer Jacket (Material Type)
- 6.3 Armoring Systems
- 7.13 Fusing Coordination Test
- 8.6 Flammability Test
- 9.1 Identification and Marking
- 9.3 Packaging

To assist the user in the selection of products and to avoid possible misunderstandings between the manufacturer and user, it is suggested that a check-off sheet similar to that shown in Informative Annex A be utilized.

- 1.4 **UNITS AND TOLERANCES:** SI units are specified throughout this Standard except for conductor size. Approximate US equivalents and Fahrenheit temperatures are included for information only. Unless otherwise specified, the rounding-off method of ASTM E 29 shall be used for determining measurement tolerances.
- 1.5 **REFERENCES:** All documents referenced herein shall be as listed in Table 1 with issues and/or dates as indicated.
- 1.6 **QUALITY ASSURANCE:** It is the responsibility of the manufacturer to establish a quality assurance system consistent with ANSI/ASQ Q9000, ISO 9000, TL 9000®, or an alternate system acceptable to the user. When the user requires a specific quality assurance program and/or special testing procedures, agreement between the user and the manufacturer should be reached before the order is placed.

Requirements shall be met on every length of completed wire as assured by quality control methods or by 100 % testing. The term "completed wire" refers to a continuous length of finished wire resulting from the last jacketing operation.

Properties that shall be tested on 100 percent of the wire lengths produced are listed below by paragraph number:

- 6.1.2 Inner Jacket Thickness Requirements
- 6.2.2 Outer Jacket Thickness Requirements
- 7.3 Average Mutual Capacitance
- 7.9 Conductor-to-Conductor DC Proof Test
- 7.10 Core-to-Shield DC Proof Test
- 7.14 Continuity of Metallic Wire Elements

- 1.7 **SAFETY CONSIDERATIONS:** Materials in the wire shall comply with current industry standards and applicable federal, state, or local laws and regulations. Materials used in the construction of wires covered by this document shall comply with the European Commission Directive 2002/95/EC on the Restriction of Certain Hazardous Substances in Electrical and Electronic Equipment (the RoHS Directive) as amended by 2005/618/EC and 2005/717/EC.

The user of this Standard is cautioned to observe any applicable health or safety regulations and rules relative to the manufacture and use of wire made in conformity with this Standard. This Standard hereafter assumes that manufacture, testing, installation, and maintenance of wires defined by this Standard will be performed only by properly trained personnel using suitable equipment and employing appropriate safety precautions.

SECTION 2 CONDUCTORS

- 2.1 **REQUIREMENTS:** Each conductor shall be a solid wire of commercially pure annealed copper and shall meet the requirements of ASTM B 3 except that requirements for "Dimensions and Permissible Variations" are not applicable and elongation requirements are superseded by this Standard.

The conductor sizes shall be 19, 22, or 24 American Wire Gauge (AWG) per ASTM B 258. The nominal diameters are stated in Table 2-1 for reference only:

Table 2-1
CONDUCTOR DIAMETER

Conductor Size (AWG)	Nominal Diameter	
	In	(mm)
19	0.0359	(0.912)
22	0.0253	(0.643)
24	0.0201	(0.511)

When tested in accordance with ASTM E 8, the minimum conductor elongation in completed wire shall be as shown in Table 2-2:

Table 2-2
CONDUCTOR ELONGATION

Conductor Size (AWG)	Minimum Elongation (%)
19	22
22	20
24	16

- 2.2 **FACTORY JOINTS:** Prior to insulating, factory joints in conductors may be either butt brazed, using a silver alloy solder and nonacid flux, or butt welded. Joints in uninsulated conductors shall be free from lumps and sharp projections. Subsequent to insulating, solder sleeves may also be used. The tensile strength of any conductor containing a joint shall not be less than 90 % of the strength of an adjacent length of conductor outside the joint area.

SECTION 3 CONDUCTOR INSULATION

- 3.1 **INSULATION MATERIAL:** The conductor shall be insulated with suitable polyolefin material. The polyolefin shall consist of 100 % virgin material as defined in ASTM D 883. The insulation shall contain a stabilization system sufficient to pass the Thermal Oxidative Stability Test of Paragraph 3.4.6.
- 3.2 **INSULATION TYPE:** The type of conductor insulation shall be either solid, foam, or foam-skin as defined under Paragraphs 3.2.1, 3.2.2, or 3.2.3. The specific type of insulation required for any product shall be designated by the individual product specification.

- 3.2.1 Solid. The insulation shall be a colored solid material.
- 3.2.2 Foam. The insulation shall be a colored cellular material.
- 3.2.3 Foam-Skin. The insulation shall consist of an inner layer of cellular material covered by a continuous outer layer of colored solid insulation.
- 3.3 INSULATION DIMENSIONS, COLORS, AND SPLICES: The insulation shall be as uniform and smooth as is consistent with good commercial practice. The nominal diameter of the insulation shall be such that all applicable electrical requirements of this Standard are met.

The outer layer of the insulation shall be uniformly colored using the colors listed in Table 3-1:

Table 3-1
INSULATION COLORS

RING	TIP
Blue (BL)	White (W)
Orange (O)	Red (R)
Green (G)	
Brown (BR)	
Slate (S)	

Colors of the insulation are specified in terms of the Munsell Color System of ASTM D 1535 and shall comply with ANSI/EIA-359-A.

Splices in the insulated conductors shall be reinsulated with a nonhygroscopic, dielectric material. There shall be no exposed conductor at the splice. Insulated conductors with reinsulated splices in completed wire shall be capable of meeting all applicable electrical requirements of this Standard.

- 3.4 INSULATION PHYSICAL REQUIREMENTS: Unless otherwise specified, insulation taken from each gauge size of completed wire shall meet the applicable requirements listed under this Section.
- 3.4.1 Adhesion. When tested in accordance with ASTM D 4565 at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($73\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$) and a rate of travel of $50\text{ mm} \pm 25\text{ mm}$ (2 in $\pm$ 1 in) per minute, the force required to strip the insulation from the conductor shall not be greater than 24(5), 20(4), or 15(3) N(lbs), respectively for 19, 22, or 24 AWG.
- 3.4.2 Elongation. When tested in accordance with ASTM D 4565 at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($73\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$), elongation of the insulation removed from the conductor shall not be less than 150%. The minimum length of unclamped specimen shall be 50 mm (2.0 in). The minimum speed of jaw separation shall be 25 mm (1.0 in) per minute per 25 mm (in) of unclamped specimen.
- 3.4.3 Compression. When tested in accordance with ASTM D 4565 at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($73\text{ }^{\circ}\text{F} \pm 5$

°F), foam and foam-skin insulated conductors shall withstand the compression requirements specified in Table 3-2, using a rate of approach not to exceed 0.50 mm (0.02 in) per minute.

Table 3-2
INSULATION COMPRESSION

Conductor Size (AWG)	Minimum Compressive Strength for 50 mm (2-in) Sample	
	N	(lbf)
19	710	(160)
22	490	(110)
24	380	(85)

- 3.4.4 **Cold Bend.** When tested in accordance with ASTM D 4565 at $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ ($73\text{ }^{\circ}\text{F} \pm 5\text{ }^{\circ}\text{F}$), insulated conductors shall show no cracks, when observed with normal or corrected-to-normal vision. The test temperature shall be $-40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ ($-40\text{ }^{\circ}\text{F} \pm 4\text{ }^{\circ}\text{F}$) with a mandrel diameter of three times the outside diameter of the insulated conductor.
- 3.4.5 **Shrinkback.** When tested at $115\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($239\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$) in accordance with ASTM D 4565, insulation shrinkback shall not exceed 10 mm (3/8 in). All changes in insulation length, which occur from the time the samples are cut shall be included.
- 3.4.6 **Thermal Oxidative Stability.** Insulation of the completed wire shall be capable of meeting the following requirement:

A sample length of wire shall be preconditioned in a forced air circulating oven, conforming to ASTM D 5423, Type II, for 14 days at $70\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($158\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$). When tested in accordance with ASTM D 4565, insulation specimens removed from the sample shall meet a minimum oxidative induction time of 20 minutes for solid and 60 minutes for foam or foam-skin. Test temperature shall be $200\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($392\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$). The copper conductors shall be removed from the insulation before testing. Pan material for the tests shall be aluminum.

Alternately, the foam and foam-skin insulation may be tested at $210\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ($410\text{ }^{\circ}\text{F} \pm 2\text{ }^{\circ}\text{F}$) and shall meet a minimum oxidative induction time of 25 minutes. In case of dispute, the $200\text{ }^{\circ}\text{C}$ test shall be used as the referee method.

NOTE: The above requirement is based upon a stabilization system utilizing compounds identified by the Chemical Abstract Service as CAS #6683-19-8 and CAS #32687-78-8. If a different insulating compound, stabilization system or filling compound is employed, then a suitable qualification program should be initiated to predict long term performance with subsequent modification of the oxidation induction time requirements as appropriate.

- 3.5 **TWIST LENGTH AND COLOR CODING:** Insulated conductors shall be formed into pairs using twist lengths that will ensure that the finished wire shall be capable of meeting the electrical requirements of this Standard. The average twist length of any pair in the finished wire shall not exceed 165 mm (6.5 in) if band marking or striping is employed, 130 mm (5.0 in) if not.

Insulated conductors shall be formed into pairs in accordance with the color code and pair designations shown in Table 3-3:

Table 3-3
PAIR COLOR CODE

Pair Number	Conductor Color	
	Ring	Tip
1	Blue	White
2	Orange	White
3	Green	White
4	Brown	White
5	Slate	White
6	Blue	Red

The white conductor may be striped or band marked with the color of its mate. The blue conductor of pair 6 may be striped or band marked with red.

SECTION 4 CORE CONSTRUCTION

- 4.1 **CORE LAYUP:** The appropriate number of pairs shall be assembled into a core.
- 4.2 **BINDERS:** If required for manufacturing reasons, a binder may be applied over the core or core wrap. The binder shall be a dielectric material.
- 4.3 **CORE WRAP:** A core wrap may be utilized for any wire design. When present, the core wrap shall be a dielectric material. The core wrap shall be continuous and shall be applied with an overlap. The wrap shall provide a sufficient heat barrier to prevent visible deformation of conductor insulation or adhesion between insulated conductors caused by heat transfer during subsequent manufacturing operations.
- 4.4 **FILLING COMPOUND:** The filling compound shall be applied in a manner to fill the voids and interstices under the core wrap. The filling material shall be a uniformly mixed compound meeting all requirements of this Standard. It shall contain a suitable antioxidant to provide long-term stability. The compound shall be as colorless as required to maintain pair identification and shall be free from foreign matter.
- 4.4.1 **Filling Compound Type.** The following types of filling compound are allowed by this Standard:

PEPJ - Polyethylene/Petroleum Jelly
ETPR - Extended Thermoplastic Rubber
ATG - Absorbent Thixotropic Gel

The type of filling compound may be specified in the individual product specification. Filling compounds and flow test temperatures other than those designated in this Standard may be used subject to agreement between user and manufacturer.