Raychem Wire and Cable
501 Oakside Avenue, Redwood City, CA 94063-3800

WIRE AND CABLE, ELECTRIC, RADIATION-CROSSLINKED, POLYALKENE-INSULATED COPPER OR COPPER ALLOY

1. SCOPE

1.1 SCOPE

This specification covers wire, insulated with radiation-crosslinked polyalkene in combination with radiation-crosslinked modified polyvinylidene fluoride. It also covers single and multiple conductor cables which may be shielded and jacketed. Cable jackets shall be radiation-crosslinked modified polyvinylidene fluoride. The wire and cable covered by this specification is suitable for installation in aerospace electrical systems and for general purpose use within the limitations of applicable performance requirements.

1.2 CLASSIFICATION

Products in accordance with this specification shall be of the following types, as specified in the applicable specification sheet.

Finished Wire: A single conductor, insulated as specified in the applicable specification sheet.

Finished Cable: Any construction other than finished wire, utilizing a wire or wires with or without shielding, and with or without an outer jacket.

1.2.1 Temperature Rating

The maximum conductor temperature of the finished wire and cable, for continuous use in any combination of conductor and insulation, shall be as specified in the applicable specification sheet.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT-FURNISHED DOCUMENTS

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

2.1.1 Department of Defense

Military

MIL-STD-104 Limits for Electrical Insulation Color
MIL-STD-681 Identification Coding and Application of Hook Up and Lead Wire

(Copies of Department of Defense documents may be obtained from the Naval Publications and Forms Center, Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Ave., Philadelphia, PA 19111-5094; or at https://quicksearch.dla.mil.)

2.2 OTHER PUBLICATIONS

The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

2.2.1 American Society for Quality (ASQ)

Z1.4 Sampling Procedures and Tables for Inspection by Attributes

(Copies of ASQ documents may be obtained from the American Society of Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203; or at www.asq.org.)

2.2.2 American Society for Testing and Materials (ASTM)

E 595 Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959; or at www.astm.org.)

2.2.3 National Electrical Manufacturers Association (NEMA)

WC 27500 Standard for Aerospace and Industrial Electrical Cable

(Copies of NEMA publications may be obtained from the National Electrical Manufacturers Association, 1300 N. 17th Street, Rosslyn, VA 22209; or at www.nema.org.)

2.2.4 Society of Automotive Engineers, Inc. (SAE)

AS81044 Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy

(Copies of SAE aerospace standards may be obtained from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001; or at www.sae.org.)

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

3. REQUIREMENTS

3.1 SPECIFICATION SHEETS

The requirements for the individual wires and cables furnished under this specification shall be as specified herein and in accordance with the applicable specification sheet. In the event of a conflict, the requirements of the specification sheet shall govern.

3.2 QUALIFICATION

The finished wire and cable furnished under this specification shall be a product which has been tested and has passed the qualification tests specified herein (see 4.2). Testing for requalification shall be performed at any time changes in materials or processes occur that are deemed to have the potential for significantly altering the performance of the product.

3.3 MATERIALS

Materials not specifically designated herein shall be of the quality and form best suited for the purpose intended. Unless otherwise specified, the materials shall meet the following requirements.

3.3.1 Conductor Materials

Conductor materials shall be in accordance with AS81044 and the applicable specification sheet.

3.3.2 Shield Materials

Shield materials shall conform to the requirements of WC 27500 and the applicable specification sheet.

3.3.3 Insulating Materials

3.3.3.1 Finished Wire

Finished wire materials shall be in accordance with AS81044 and the applicable specification sheet.

3.3.3.2 Cable Jackets

Cable jackets shall be radiation-crosslinked modified polyvinylidene fluoride.

3.3.4 Wraps

Wrap tapes, where specified in the applicable specification sheet, shall be applied with an overlap of 25 percent, minimum, and shall meet the material and construction requirements of the applicable specification sheet. Overlap is defined as the percentage of tape width covered by successive turns of tape.

© 2005 -2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

3.4 FINISHED WIRE AND CABLE

3.4.1 Finished Wire

Finished wire shall conform to the requirements of Table 1 and to those of the applicable specification sheet.

3.4.2 Finished Cable

Finished cable shall conform to the requirements of Table 2 and to those of the applicable specification sheet. Component wires used in the cable shall conform to the appropriate requirements of 3.4.1, prior to cabling.

3.4.3 Accelerated Aging and Life Cycle

When finished cable is tested in accordance with 4.4.1, there shall be no cracking of the jacket and, when applicable, no dielectric breakdown of the jacket.

3.4.4 Conductor and Shield Continuity

When finished cable is tested in accordance with WC 27500, there shall be no indication of discontinuity in the conductors or shield.

3.4.5 Identification of Product

When specified by the procuring activity or the applicable specification sheet, finished wire or cable shall be identified by a marking applied to the outer surface. The identification shall consist of the appropriate mark as specified by contract or the applicable specification sheet. The mark color shall be in accordance with MIL-STD-104, Class 1, and shall be contrasting to that of the marking surface. Identification shall be applied with the vertical axis of the printed characters parallel to the longitudinal axis of the wire or cable when the nominal diameter of the marking surface is 0.050 inch *(1.27 mm)* or smaller. The vertical axis of the printed characters may be either perpendicular or parallel to the longitudinal axis of the wire or cable when the nominal diameter of the marking surface exceeds 0.050 inch *(1.27 mm)*.

3.4.6 Immersion

When finished cable is tested in accordance with 4.4.4, the diameter change shall be not more than 5 percent, there shall be no cracking of the jacket and, when applicable, there shall be no dielectric breakdown of the jacket.

3.4.7 Insulation Flaws

One hundred percent of finished wire and unshielded, unjacketed cable shall pass the impulse dielectric test or the spark test of AS81044 using the voltage specified in the applicable specification sheet. The test shall be performed during the final winding of the wire or cable on shipment spools or reels.

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

TABLE 1. FINISHED WIRE PROPERTIES

Examination or Test	Requirement	Test Method	Inspection Class (see 4.3.1)
Accelerated Aging	Specification Sheet and AS81044	AS81044	P
Blocking	Specification Sheet and AS81044	AS81044	Q
Color	Specification Sheet and AS81044	4.4.3	P
Concentricity	AS81044	AS81044	P
Conductor Diameter	Specification Sheet and AS81044	4.4.3	V
Conductor Elongation and Breaking Strength	Specification Sheet and AS81044	AS81044	P
Conductor Material	Specification Sheet and AS81044	4.4.3	V
Conductor Resistance	Specification Sheet and AS81044	AS81044	P
Conductor Stranding	Specification Sheet and AS81044	4.4.3	V
Finished Wire Diameter	Specification Sheet and AS81044	4.4.3	P
Flammability	Specification Sheet and AS81044	AS81044	P
Humidity Resistance	Specification Sheet and AS81044	AS81044	Q
Identification and Color Striping Durability	Specification Sheet and AS81044	AS81044	P
Identification of Product	Specification Sheet and 3.4.5	4.4.3	P
Immersion	Specification Sheet and AS81044	AS81044	Q
Insulation Elongation and Tensile Strength	Specification Sheet and AS81044	AS81044	P
Insulation Flaws	Specification Sheet and 3.4.7	AS81044	100%
Insulation Construction	Specification Sheet and AS81044	4.4.3	P
Insulation Material	Specification Sheet and AS81044	4.4.3	V
Insulation Resistance	Specification Sheet and AS81044	AS81044	P
Insulation Thickness	Specification Sheet and AS81044	AS81044	P
Life Cycle	Specification Sheet and AS81044	AS81044	Q
Low Temperature-Cold Bend	Specification Sheet and AS81044	AS81044	P
Radiation Resistance	Specification Sheet and 3.4.12	4.4.9	Q
Removability of Insulation	AS81044	AS81044	P
Shrinkage	Specification Sheet and AS81044	AS81044	Q
Smoke Test	Specification Sheet and AS81044	AS81044	Q
Solderability:			
Tin coated conductors only	Specification Sheet	AS81044	P
Silver coated conductors only	Specification Sheet	AS81044	Q
Surface Resistance	Specification Sheet and AS81044	AS81044	Q
Thermal Shock Resistance	Specification Sheet and AS81044	AS81044	Q
Vacuum Stability	Specification Sheet	ASTM E 595	Q
Weight	Specification Sheet and AS81044	AS81044	P
Wicking	Specification Sheet and AS81044	AS81044	Q
Workmanship	AS81044	AS81044	P
Wrap Test	Specification Sheet and AS81044	AS81044	Q

© 2005 -2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

TABLE 2. FINISHED CABLE PROPERTIES

Examination or Test	Requirement	Test Method	Inspection Class (see 4.3.1)
Accelerated Aging	Specification Sheet and 3.4.3	4.4.1	P
Blocking	Specification Sheet	WC 27500	Q
Cabling	Specification Sheet and WC 27500	WC 27500	P
Conductor and Shield Continuity	3.4.4	WC 27500	100%
Dielectric Withstand	Specification Sheet	WC 27500	100%
Dimensions	Specification Sheet	4.4.3	P
Flammability	Specification Sheet	WC 27500	Q
Identification of Product	Specification Sheet and 3.4.5	4.4.3	P
Immersion	3.4.6	4.4.4	Q
Insulation Flaws	Specification Sheet and 3.4.7	AS81044	100%
Jacket Color	Specification Sheet and 3.4.8	4.4.3	P
Jacket Concentricity	3.4.9	4.4.5	P
Jacket Elongation and Tensile Strength	Specification Sheet	4.4.6	P
Jacket Flaws	Specification Sheet and 3.4.10	4.4.7	100%
Jacket Material and Construction	Specification Sheet and 3.3.3.2	4.4.3	P
Jacket Removability	WC 27500	WC 27500	P
Jacket Thickness	Specification Sheet	4.4.3	P
Life Cycle	Specification Sheet and 3.4.3	4.4.1	Q
Low Temperature-Cold Bend	Specification Sheet and 3.4.11	4.4.8	Q
Radiation Resistance	Specification Sheet and 3.4.12	4.4.9	Q
Shield Coverage	Specification Sheet	WC 27500	P
Shield Material and Construction	Specification Sheet and 3.3.2	WC 27500	P
Thermal Shock	Specification Sheet	WC 27500	Q
Vacuum Stability	Specification Sheet	ASTM E 595	Q
Weight	Specification Sheet	AS81044	P
Workmanship	WC 27500	WC 27500	P
Wraps	Specification Sheet and 3.3.4	4.4.3	P

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

3.4.8 Jacket Color

Jacket color shall be in accordance with MIL-STD-104, Class 1. The preferred jacket color is white. Colors specified other than white shall be selected in accordance with MIL-STD-681.

3.4.9 Jacket Concentricity

When finished cable is tested in accordance with 4.4.5, the jacket concentricity shall be 70 percent, minimum.

3.4.10 Jacket Flaws

One hundred percent of finished shielded and jacketed cable shall pass the jacket flaws test in accordance with 4.4.7 using the voltage specified in the applicable specification sheet.

3.4.11 Low Temperature-Cold Bend

When finished cable is tested in accordance with 4.4.8, there shall be no cracking of the jacket and, when applicable, no dielectric breakdown of the jacket.

3.4.12 Radiation Resistance

When finished wire is tested in accordance with 4.4.9, there shall be no cracking of the insulation and no dielectric breakdown. When finished cable is tested in accordance with 4.4.9, there shall be no cracking of the jacket and, when applicable, no dielectric breakdown of the jacket.

4. QUALITY ASSURANCE PROVISIONS

4.1 RESPONSIBILITY FOR INSPECTION

The supplier is responsible for the performance of all the inspection tests specified herein. The supplier may utilize his own or any other inspection facility and services acceptable to the buyer. Inspection records of the examination and tests shall be kept complete and available to the buyer as required.

4.2 QUALIFICATION INSPECTION

Qualification inspection tests shall consist of all tests listed in Table 1 for wire and in Table 2 for cable.

4.2.1 Sampling for Qualification Inspection

Samples of wire or cable for qualification inspection shall be taken from product which has been manufactured under the most current Quality Control Plan.

© 2005 -2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

4.2.2 Qualification Test Reports

When requested by the procuring activity, qualification test reports shall be plainly identified with the following information:

Qualification test report for
WIRE AND CABLE, ELECTRIC, RADIATION-CROSSLINKED,
POLYALKENE-INSULATED, COPPER OR COPPER ALLOY
Manufacturer's Name
Part number of qualification sample
Specification 44

4.3 QUALITY CONFORMANCE INSPECTION

Quality conformance inspection consists of a series of tests and inspections that assure that raw materials and manufacturing processes are consistent and result in products that conform to specification requirements. In cases where customer requirements for sampling and testing exceed the requirements of this specification, the customer requirements shall apply.

4.3.1 Inspection Classification

Quality Control Plan QP-D-0004 specifies the inspection class for European manufactured products.

a. Vendor Control (V) - Requirements for raw materials such as conductor, insulation and jacketing material over which the vendor has control and responsibility.

b. Process Control (P) - Inspections performed on samples taken from lots of wire or cable. Inspections may be performed on finished wire and cable or after the process which establishes the specified characteristic. The Quality Control Plan establishes the frequency of inspection based on process control data.

c. One hundred Percent (100%) - Tests performed on the total length of each wire or cable. Tests may be performed on the finished product or "in process", as applicable.

d. Qualification (Q) - Test performed only at the time of initial qualification or requalification.

4.3.2 Nonconforming Inspection Lots

Disposition of material found unacceptable during quality-conformance inspection shall be in accordance with ASQ Z1.4.

4.4 TEST METHODS

4.4.1 Accelerated Aging and Life Cycle

Finished cable shall be tested in accordance with the procedures specified in AS81044, using the bend test of 4.4.2 herein. The voltage withstand test of 4.4.10 herein shall then be conducted on shielded and jacketed specimens only. Finished cable specimens shall be prepared by removing 2 inches *(51 mm)* of the jacket from each end of the specimen. When applicable, the shield then shall be pushed back and formed into a pigtail at each end of the

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

specimen and 1 inch *(25 mm)* of insulation from each conductor shall be removed from each end of the specimen. The conductors then shall be tied together at each end and loaded with
SPECIFICATION 44, ISSUE 7 Page 9 of 12
the weight specified in the applicable specification sheet. The test mandrel shall be as specified in the applicable specification sheet.

4.4.2 Bend Test

At a temperature maintained between 20 and 25°C, one end of the cable specimen shall be secured to the mandrel and the other end to the load weight specified in the applicable specification sheet. The mandrel shall be rotated until the full length of the specimen is wrapped around the mandrel and is under the specified tension with adjoining turns in contact. The mandrel then shall be rotated in the reverse direction until the full length of the specimen which was outside during the first wrapping is now next to the mandrel. This procedure shall be repeated until two bends in each direction have been formed in the same section of the specimen. The specimen then shall be examined visually for cracks.

4.4.3 Examination of Product

All samples of wire and cable shall be examined to determine conformance with this specification and the applicable specification sheet with regard to requirements not covered by specific test methods.

4.4.4 Immersion

Finished cable shall be tested in accordance with the procedure specified in AS81044, using the bend test of 4.4.2 herein. The voltage withstand test of 4.4.10 herein shall then be conducted on shielded and jacketed specimens only. Cable specimens shall be prepared by removing 2 inches *(51 mm)* of the jacket from each end of a 24-inch *(610-mm)* length of each specimen. When applicable, the shield then shall be pushed back and formed into a pigtail at each end of the specimen and 1 inch *(25 mm)* of insulation from each conductor shall be removed from each end of the specimen.

4.4.5 Jacket Concentricity

The concentricity of the cable jacket shall be determined by first locating and recording the minimum wall thickness measured on a cross section of the jacket. The maximum wall thickness of this same cross section of the jacket shall be measured and recorded. The wall thickness shall be the radial distance between the inner and outer rim of the jacket as measured under suitable magnification. The ratio of the minimum wall thickness to the maximum wall thickness, times 100, shall define the percent concentricity.

4.4.6 Jacket Elongation and Tensile Strength

The elongation and tensile strength of the jacket shall be determined in accordance with the procedure specified for insulation elongation and tensile strength in AS81044.

4.4.7 Jacket Flaws

Finished shielded and jacketed cable shall be tested in accordance with the jacket flaws test of WC 27500, or the procedure of the impulse dielectric test of AS81044 with the shield grounded at one or both ends.

© 2005 -2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

4.4.8 Low Temperature-Cold Bend

Jacketed cable shall be tested using the procedure of WC 27500. Temperature, mandrel diameter and test weight shall be as specified in the applicable specification sheet. After examination for cracks, shielded and jacketed specimens shall be subjected to the voltage withstand test of 4.4.10 herein.

4.4.9 Radiation Resistance

A 10-foot *(3-m)* specimen of the finished wire or cable shall be subjected to the electron radiation dosage specified in the applicable specification sheet at an average rate of between 5 and 10 megarads *(50 and 100 kGy)* per minute. Following exposure, the center portion of the specimen shall be wound around the mandrel as specified in the applicable sheet. The ends of the specimen shall extend at least 6 inches *(152 mm)* beyond the wound portion. For finished wire and shielded and jacketed specimens, the specimen shall then be removed from the mandrel without unwinding and shall be subjected to the voltage withstand test of 4.4.10. For jacketed only specimens, the specimen shall be examined for cracks while still on the mandrel.

4.4.10 Voltage Withstand Test (Post Environmental)

The uninsulated ends of the specimen shall be attached to an electric lead. The specimen shall be immersed in a 5-percent, by weight, solution of sodium chloride in water at 20 to 25°C, except that the uninsulated ends and 1.5 in. *(38 mm)* of insulated wire or cable at each end of the specimen shall protrude above the surface of the solution. After immersion for 5 hours, the voltage specified in the applicable specification sheet at 60 Hz shall be applied between the conductor or the shield, as applicable, and an electrode in contact with the liquid. The voltage shall be gradually increased at a uniform rate from zero to the specified voltage in 0.5 minute, maintained at that voltage for a period of 5 minutes for finished wire specimens and 1 minute for finished cable specimens, and gradually reduced to zero in 0.5 minute.

4.4.10.1 Inner Jacket

For accelerated aging and life cycle cable specimens only, containing a jacket between two shields, the voltage withstand test of 4.4.10 shall additionally be conducted on the inner jacket with the voltage as specified in the applicable specification sheet being applied between the two shields.

5. STANDARD PACKAGING

Unless otherwise specified (see 6.1), the following shall define the standard spooling and labeling requirements for wire and cable furnished under this specification. Standard shipping tolerance on ordered quantity for both wire and cable shall be ± 10 percent.

5.1 SPOOLING REQUIREMENTS (for North America manufacture)

All layers of wire or cable shall be wound on spools or reels (see 5.3) with sufficient tension to prevent shifting of layers and creation of crossovers within layers.

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

5.1.1 Finished Wire

Finished wire lengths shall be wound on spools or reels with the ends spliced together to provide one mechanically and electrically continuous length. Unless otherwise specified, the minimum continuous length between splices shall be in accordance with Table 3.

TABLE 3. FINISHED WIRE LENGTHS

Wire Size Range (AWG)	Minimum Length
10 and smaller	100 feet *(30 m)*
8 and larger	50 feet *(15 m)*

(NOTE: Metric lengths specified above apply only to those orders placed in metric.)

5.1.2 Finished Cable

Finished cable lengths shall be wound on spools or reels with all ends exposed. There shall be no more than 5 lengths per spool or reel and no length shall be less than 50 feet *(15 m)*.

5.2 SPOOLING REQUIREMENTS (for Europe manufacture)

All layers of wire or cable shall be wound on spools or reels (see 5.3) with sufficient tension to prevent shifting of layers and creation of crossovers within layers. Unless otherwise specified, the minimum continuous length for all wire and cable shall be 82 feet *(25 m),* and the ends of all lengths shall be exposed.

5.3 SPOOLS AND REELS

Spools and reels shall be of a nonreturnable type. Each spool and reel shall have an appropriate diameter for the respective wire or cable size. In no case shall the barrel of the spool or reel have a diameter less than 3.5 in. *(89 mm)*. Spools and reels shall be suitably finished to prevent corrosion under typical storage and handling conditions. Loaded plastic spools shall not exceed 50 pounds *(23 kg)*. Loaded wooden reels shall have no weight restriction.

5.4 CONTAINERS

Unless otherwise specified (see 6.1), wire and cable shall be delivered in standard commercial containers so constructed as to ensure acceptance by common or other carrier for safe transportation at the lowest rate to the point of delivery.

5.5 LABELING REQUIREMENTS

All spools and reels shall be identified with the following information:

Manufacturer's Part Number
Lot Number
Quantity in Feet *(or Meters)*
Name of Manufacturer

© 2005 -2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.

6. NOTES

6.1 ORDERING DATA

Procurement documents should specify the following:

a. Title, number, and date of this specification
b. Applicable specification sheet part number
c. Quantity
d. Special preparation for delivery requirements, if applicable (see Section 5.)

6.2 METRIC UNITS

Unless otherwise specified, the metric units noted herein are for information only.

6.3 AS81044

Wherever AS81044 refers to "applicable detail specification", use the applicable TE specification sheet (3.1).

© 2005-2022 TE Connectivity Ltd. family of companies. All Rights Reserved.

NOTE: ANY PRINTED COPY OF THIS DOCUMENT IS AN UNCONTROLLED COPY.