



Raychem Wire and Cable

501 Oakside Avenue, Redwood City, CA 94063-3800

SPECIFICATION:

80

THIS ISSUE: Amendment 3, Issue 1
DATE: 12 November 2014
REPLACES: Amendment 2, Issue 1
PAGE: 1 of 4

**FLEXLINE WIRE AND CABLE, ELECTRIC, GENERAL PURPOSE,
RADIATION-CROSSLINKED, MODIFIED, FLEXIBLE FLUOROPOLYMER-INSULATED**

This amendment forms a part of TE Connectivity/Raychem Specification 80,
Issue 1, dated 16 July 1996.

PAGE 2

Para. 2.1.1, Department of Defense:

Under SPECIFICATIONS, Military, delete the following:

"MIL-C-27500", "MIL-W-22759", and "MIL-W-29606" in their entirety.

Under STANDARDS, Military, add the following:

"MIL-STD-2223 Test Methods for Insulated Electric Wire"

PAGE 3

Para 2.2.2, Society of Automotive Engineers, Inc. (SAE):

Rename paragraph 2.2.2 as 2.2.3.

Under Aerospace Standard, add the following:

"AS22759 Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy

AS29606 Wire, Electrical, Stranded, Uninsulated Copper, Copper Alloy, or Aluminum, or
Thermocouple Extension, General Specification For"

Insert new Para. 2.2.2 as follows:

"2.2.2 National Electrical Manufacturers Association (NEMA)

WC27500 Standard for Aerospace and Industrial Electrical Cable

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

Para. 3.3.1, Conductor: Add the following sentence to the end of the paragraph:

"For the 82 series conductors, the minimum allowable number of strands may be 98 percent of
the number specified in the applicable specification sheet, as long as the dimensional and
resistance requirements are met."

PAGE 4

Para 3.4.1, Conductor Elongation (High Strand Count): Delete and replace with the following:

"3.4.1 Conductor Elongation and Break Strength (High Strand Count Conductor)

3.4.1.1 Soft or Annealed Copper

The elongation for high strand count soft or annealed copper conductors shall be 5 percent, minimum average, for the whole stranded conductor of regular bunch constructions, or for one whole member from rope bunch constructions, as applicable, removed from the finished wire. There shall be no break strength requirements for soft or annealed copper conductors.

3.4.1.2 High-Strength Copper Alloy

The elongation for high strand count high-strength copper alloy conductors shall be 5 percent, minimum average, for the whole stranded conductor removed from the finished wire. The minimum break strength for high-strength copper alloy conductors shall conform to the following:

AWG Size	Minimum Break Strength (lbs)
28	7.10
26	10.7
24	17.8
22	24.0
20	40.0
18	70.3
16	110. "

PAGE 5

Table 1, Requirements for Finished Wire and Cable: Under Finished Wire, delete Conductor Elongation and Breaking Strength in its entirety and replace with the following:

Conductor Elongation and Break Strength:			
- Standard AS29606 Conductor (81 series part numbers)	AS29606	AS29606	1
- High Strand Count Conductor (82 series part numbers)	3.4.1	4.6.3	1

PAGE 7

Para. 3.5.6, Identification of Product: Delete and replace with the following:

"When specified by the procuring activity, 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 the contract or the applicable specification sheet. For marking wire insulations of AWG sizes 10 and smaller, the legend shall be printed in black ink, except where black ink is difficult to read, the printing shall be in a contrasting color. For marking wire insulations of AWG sizes 8 and larger, the legend shall be printed in black ink preferably. For all other marking surfaces, the legend shall be printed in a contrasting color. 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 (1.3 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 (1.3 mm). Wires with diameters of 0.035 inch (0.89 mm) and smaller shall not be marked."

PAGE 10

Table 2, Process Control Inspection: Delete "Conductor elongation (high strand count)" in its entirety.

PAGE 12

Para 4.6.3, Conductor Elongation (High Strand Count): Delete and replace with the following:

"4.6.3 Conductor Elongation and Break Strength (High Strand Count Conductor)

4.6.3.1 Soft or Annealed Copper

Elongation tests of soft or annealed copper conductors shall be tested in accordance with MIL-STD-2223, Method 5002, using a 10-inch (254-mm) initial jaw separation and a jaw separation speed of 10 ± 2 inches (254 \pm 51 mm) per minute. The test shall be performed upon the whole conductor for regular bunch-stranded constructions, or upon one whole member removed from rope bunch-stranded constructions, as applicable, taken from the finished wire. In either case, elongation shall be measured upon breakage of the first strand of the whole conductor or member, as applicable. Elongation shall be determined by the distance the jaw has traveled. Breaks occurring at the jaws shall be discounted and a new specimen shall be tested.

4.6.3.2 High-Strength Copper Alloy

Elongation and break strength tests of high-strength copper alloy conductors shall be tested in accordance with MIL-STD-2223, Method 5002 on the whole conductor removed from the finished wire, using a 10-inch (254-mm) initial jaw separation and a jaw separation speed of 2 ± 0.5 inches (51 \pm 13 mm) per minute. Elongation shall be determined by the distance the jaw has traveled. Breaks occurring at the jaws shall be discounted and a new specimen shall be tested."

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Para. 4.6.12.1 Life Cycle, Finished Wire Preparation: 4th sentence, change as follows:

Change from: "Each end of the conductor shall be loaded with the weight ... for the Crosslinking Proof Test, so that the portion ..."

Change to: "Each end of the conductor shall be loaded with the weight ... for the Crosslinking Proof Test (except that for 200°C rated wire, AWG sizes 22 and 20, the weight shall be 25 percent of that specified for the Crosslinking Proof Test), so that the portion ..."

MULTIPLE PAGES

Change all references of the following specs to read as indicated:

Change from:	Change to:	Found in the following locations:
MIL-C-27500	WC27500	3.3.2, 3.5.3, 4.6.11, Table 1
MIL-W-22759	AS22759	3.4.3, 3.5.8, 4.4.1.2, 4.6.11, 4.6.15, 6.3, Table 1, Table 2
MIL-W-29606	AS29606	3.3.1, 3.4.2, Table 1

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FLEXLINE WIRE AND CABLE, ELECTRIC, GENERAL PURPOSE, RADIATION-CROSSLINKED, MODIFIED, FLEXIBLE FLUOROPOLYMER-INSULATED

1. SCOPE

1.1 SCOPE

This specification covers radiation-crosslinked, extruded, modified, flexible fluoropolymer-insulated wire, and single- and multiple-conductor cables which may be shielded and jacketed. This flexible insulation is highly flame retarded and is intended for use as a high-temperature, thin-wall insulation system in military, aerospace, and general wire hook-up applications.

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, or with or without an outer jacket.

1.3 TEMPERATURE RATING

The maximum conductor temperature of the finished wire and cable for continuous use 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.

FlexLine is a trademark of Raychem Corporation.

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2.1.1 Department of Defense

SPECIFICATIONS

Federal

TT-I-735 Isopropyl Alcohol

Military

MIL-H-5606	Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance
MIL-T-5624	Turbine Fuel, Aviation, Grades JP-4 and JP-5
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-W-22759	Wire, Electric, Fluoropolymer-Insulated, Copper or Copper Alloy
MIL-L-23699	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-C-27500	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded, General Specification for
MIL-W-29606	Wire, Electrical, Uninsulated Copper, Copper Alloy, or Aluminum, or Thermocouple Extension, General Specification for

STANDARDS

Federal

FED-STD-191	Textile Test Methods
FED-STD-228	Cable and Wire, Insulated; Methods of Testing

Military

MIL-STD-104	Limits for Electrical Insulation Color
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-109	Quality Assurance Terms and Definitions
MIL-STD-129	Marking for Shipment and Storage
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, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.)

2.2 OTHER PUBLICATIONS

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

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2.2.1 American Society for Testing and Materials (ASTM)

D 882 Tensile Properties of Thin Plastic Sheet
F 777 Standard Test Method for Resistance of Electrical Wire Insulation Materials to
 Flame at 60°

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

2.2.2 Society of Automotive Engineers, Inc. (SAE)

Aerospace Standard

AS 1241 Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft

(Copies of SAE aerospace standards may be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.)

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 case of conflict, the requirements of the specification sheet shall govern.

3.2 QUALIFICATION

The qualification requirements specified herein characterize particular properties that are applicable to all products covered by this specification. Specific wire and cable constructions, as described in 4.2.1, are representative of the types of products furnished under this specification, and are used to demonstrate the ability to meet the qualification tests specified herein (see 4.2).

3.3 MATERIALS AND CONSTRUCTION

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

3.3.1 Conductor

Copper and copper alloy conductor materials and standard MIL-W-29606 conductor (81 series part numbers) constructions shall be in accordance with MIL-W-29606. All other conductor materials and constructions (e.g., 82 series part numbers with high-strand-count conductors) shall be as specified in the applicable specification sheet.

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3.3.2 Shield

Shield strands shall conform to the requirements for conductor materials (3.3.1), and shall be constructed in accordance with MIL-C-27500 and the applicable specification sheet.

3.3.2.1 Flat Wire Shield

Flat wire shields shall be constructed from strands which have been formed by flattening round wire strands. After flattening, the strands shall meet the coating thickness and continuity requirements of the appropriate round wire strand material.

3.3.3 Insulation and Jacket

All insulations and jackets shall be extruded, low-outgassing, radiation-crosslinked modified, flexible fluoropolymer, and shall be constructed as specified in the applicable specification sheet.

3.3.3.1 Insulation Material Under Conductor Strands

When stranded conductors are used in the construction of the finished wire, there shall be no insulation under any of the strands of the conductor.

3.4 IN-PROCESS REQUIREMENTS

3.4.1 Conductor Elongation (High Strand Count)

When high-strand-count conductors are tested in accordance with 4.6.3, the elongation shall be 5 percent, minimum average, for the whole stranded conductor of regular bunch constructions, or for one whole member from rope bunch constructions, as applicable.

3.4.2 Conductor Splices

Splices shall be in accordance with MIL-W-29606.

3.4.3 Insulation Flaws

One hundred percent of the wire shall pass the impulse dielectric test or the spark test of MIL-W-22759 at any designated point or points in the manufacturing process prior to completion of the finished wire, using the voltage specified in the applicable specification sheet.

3.5 FINISHED WIRE AND CABLE

Finished wire and cable shall conform to the applicable requirements of 3.5.1 to 3.5.14, Table 1 and the applicable specification sheet.

3.5.1 Blocking

Adjacent turns and layers of wire insulation or cable jacket shall not block after specimens are subjected to $200 \pm 3^\circ\text{C}$. Blocking shall be defined as a transfer of material between adjacent surfaces when they are separated.

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TABLE 1
REQUIREMENTS FOR FINISHED WIRE AND CABLE

EXAMINATION OR TEST	REQUIREMENT	TEST METHOD	TEST TYPE 1/
<u>Finished Wire</u>			
Blocking	3.5.1 and MIL-W-22759	MIL-W-22759	Q
Color	3.5.2	4.6.6	1
Concentricity	Specification Sheet	MIL-W-22759	2
Conductor Diameter	Specification Sheet	4.6.2	1
Conductor Elongation and Breaking Strength:			
– Standard MIL-W-29606 Conductor			
(81 series part numbers)	MIL-W-29606	MIL-W-29606	1
– High-Strand-Count Conductor			
(82 series part numbers)	3.4.1	4.6.3	P
Conductor Material	3.3.1	4.6.6	1
Conductor Resistance	Specification Sheet	MIL-W-29606	1
Conductor Stranding	Specification Sheet	4.6.6	1
Crosslinking Proof Test	Specification Sheet and 3.5.4	4.6.4	2
Finished Wire Diameter	Specification Sheet	4.6.2	1
Flammability	3.5.5	4.6.7	Q
Identification and Color Striping Durability	Specification Sheet	MIL-W-22759	1
Identification of Product	3.5.6	4.6.6	1
Immersion	3.5.7	4.6.8	Q
Insulation Elongation and Tensile Strength	Specification Sheet	4.6.9	1
Insulation Flaws	Specification Sheet and 3.5.8	MIL-W-22759	3
Insulation Material and Construction	3.3.3	4.6.6	1
Insulation Resistance	3.5.9	MIL-W-22759	Q
Insulation Thickness	Specification Sheet	4.6.6	2
Life Cycle	3.5.12	4.6.12	Q
Low Temperature-Cold Bend	3.5.13 and MIL-W-22759	MIL-W-22759	Q
Removability of Insulation	MIL-W-22759	MIL-W-22759	1
Secant Modulus	3.5.14	4.6.13	Q
Shrinkage	Specification Sheet	MIL-W-22759	2
Weight	Specification Sheet	MIL-W-22759	1
Workmanship	MIL-W-22759	MIL-W-22759	1

(continued)

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TABLE 1 (CONTINUED)
REQUIREMENTS FOR FINISHED WIRE AND CABLE

EXAMINATION OR TEST	REQUIREMENT	TEST METHOD	TEST TYPE <u>1/</u>
<u>Finished Cable</u>			
Blocking	3.5.1 and MIL-C-27500	MIL-C-27500	Q
Cabling	MIL-C-27500	MIL-C-27500	1
Conductor and Shield Continuity	3.5.3 and MIL-C-27500	MIL-C-27500	3
Crosslinking Proof Test	Specification Sheet and 3.5.4	4.6.4	2
Dielectric Withstand	Specification Sheet	MIL-C-27500	3
Dimensions	Specification Sheet	4.6.6	1
Flammability	3.5.5	4.6.7.1	Q
Identification of Product	3.5.6	4.6.6	1
Immersion	3.5.7	4.6.8	Q
Jacket Color	3.5.2	4.6.6	1
Jacket Concentricity	3.5.10	4.6.10	2
Jacket Elongation and Tensile Strength	Specification Sheet	4.6.9	1
Jacket Flaws	Specification Sheet and 3.5.11	4.6.11	3
Jacket Material and Construction	3.3.3	4.6.6	1
Jacket Thickness	Specification Sheet	4.6.6	2
Life Cycle	3.5.12	4.6.12	Q
Low Temperature-Cold Bend	3.5.13 and MIL-C-27500	MIL-C-27500	Q
Secant Modulus	3.5.14	4.6.13	Q
Shield Material and Construction	3.3.2	MIL-C-27500	1
Shield Coverage	Specification Sheet	MIL-C-27500	1
Weight	Specification Sheet	4.6.15	1
Workmanship	MIL-C-27500	MIL-C-27500	1

1/ TEST TYPE:

- Q - Qualification Test (4.2)
- 1 - Quality Conformance Test, Group 1 (4.3)
- 2 - Quality Conformance Test, Group 2 (4.3)
- 3 - Quality Conformance Test, Group 3 (4.3)
- P - Process Control Inspection (4.4)

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3.5.2 Color

Color shall be in accordance with MIL-STD-104, Class 1. White is preferred for both insulation and jacket. Color code designators, and colored stripes and bands, if used, shall be in accordance with MIL-STD-681.

3.5.3 Conductor and Shield Continuity

When finished cable is tested in accordance with MIL-C-27500, there shall be no loss of continuity in the conductors or shield.

3.5.4 Crosslinking Proof Test

When finished wire and cable is tested in accordance with 4.6.4, there shall be no cracking of the insulation or jacket and no dielectric breakdown.

3.5.5 Flammability

3.5.5.1 Procedure 1

When qualification samples are tested in accordance with 4.6.7.1, the burn length shall not exceed 3 inches (76 mm) and the afterburn time shall not exceed 3 seconds.

3.5.5.2 Procedure 2

When AWG 22 and 20 wire specimens are tested in accordance with 4.6.7.2, the burn length shall not exceed 3 inches (76 mm) and the afterburn time shall not exceed 3 seconds.

3.5.6 Identification of Product

When specified, the finished wire and 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 shall be in a contrasting color to that of the finished wire or cable. Identification shall be applied with the vertical axis of the characters parallel to the longitudinal axis of the wire when the nominal diameter of the wire is 0.050 inch (1.27 mm) or smaller. The vertical axis of the characters may be either perpendicular or parallel to the longitudinal axis of the wire when the nominal diameter of the wire exceeds 0.050 inch (1.27 mm). Wires with diameters of 0.035 inch (0.89 mm) and smaller shall not be marked.

3.5.7 Immersion

When qualification samples are tested in accordance with 4.6.8, the diameter change shall be no more than 5 percent, and there shall be no cracking of the insulation or jacket and no dielectric breakdown.

3.5.8 Insulation Flaws

One hundred percent of finished wire shall pass the impulse dielectric test or the spark test of MIL-W-22759 using the voltage specified in the applicable specification sheet. The test shall be performed during the final winding of the wire on shipment spools or reels.

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3.5.9 Insulation Resistance

The minimum insulation resistance for 1000 feet of the wire specimens shall be 500 megohms ($152.4\text{ M}\Omega\text{-}1\text{ km}$) for AWG 22 and 20, and 100 megohms ($30.5\text{ M}\Omega\text{-}1\text{ km}$) for AWG 8.

3.5.10 Jacket Concentricity

When finished cable is tested in accordance with 4.6.10, the jacket concentricity shall be 70 percent, minimum.

3.5.11 Jacket Flaws

One hundred percent of finished shielded and jacketed cable shall pass the jacket flaws test of 4.6.11 using the voltage specified in the applicable specification sheet.

3.5.12 Life Cycle

When tested in accordance with 4.6.12, using a test temperature of $230 \pm 3^\circ\text{C}$ for the AWG 8 specimen, and $200 \pm 3^\circ\text{C}$ for the other specimens, qualification samples shall exhibit no cracking of the insulation or jacket and no dielectric breakdown.

3.5.13 Low Temperature-Cold Bend

When qualification samples are tested at $-65 \pm 3^\circ\text{C}$, there shall be no cracking of the insulation or jacket and no dielectric breakdown.

3.5.14 Secant Modulus

When tested in accordance with 4.6.13, the secant modulus shall not exceed $5.0 \times 10^4\text{ lbf/in}^2$ (345 N/mm^2) for AWG 22 and 20 wire specimens, or $4.0 \times 10^4\text{ lbf/in}^2$ (276 N/mm^2) for cable and AWG 8 wire specimens.

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 shall consist of all tests in Table 1, as applicable to finished wire or to finished cable.

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4.2.1 Qualification Samples

Qualification samples shall consist of the following part numbers (insulation/jacket colors shall be optional):

81A081X-22	<i>(will qualify all dual-wall primary wire, AWG 10 and smaller)</i>
81A081X-8	<i>(will qualify all dual-wall primary, AWG 8 and larger)</i>
82A011X-20	<i>(will qualify all single-wall primary wire)</i>
82A112X-20	<i>(will qualify all cable constructions)</i>

The "X" in the part numbers above shall be replaced by a conductor material designator, which, for qualification samples, may be either "1" or "3" (tin- or nickel-coated copper, respectively).

4.2.2 Qualification Test Reports

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

Qualification test report for
FLEXLINE WIRE AND CABLE,
ELECTRIC, GENERAL PURPOSE,
RADIATION-CROSSLINKED MODIFIED,
FLEXIBLE FLUOROPOLYMER-INSULATED
Raychem Corporation
Part number of qualification sample
Part numbers qualified
Specification 80

4.3 QUALITY CONFORMANCE INSPECTION

Quality conformance inspection shall consist only of those examinations and tests listed in Table 1 and identified by a group number, as applicable to finished wire or to finished cable. Quality conformance inspection shall be performed on every lot of wire or cable procured under this specification.

4.3.1 Sampling for Quality Conformance Inspection

MIL-STD-109 shall apply for definitions of inspection terms used herein. For purposes of this specification, the following shall apply:

4.3.1.1 Lot

The inspection lot shall include all wire and cable of one part number subjected to inspection at one time.

4.3.1.2 Unit of Product

The unit of product for determining lot size for sampling shall be one continuous length of wire or cable as offered for inspection.

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4.3.1.3 Sample Unit (Groups 1 and 2 tests)

The sample unit for Groups 1 and 2 tests shall consist of a single length of finished wire or cable chosen at random from the inspection lot and of sufficient length to permit all applicable examinations and tests. Unless otherwise specified, the length of the sample unit for Group 1 tests of Table 1 shall be 20 feet (6.1 m) and the length of the sample unit for Group 2 tests shall be 25 feet (7.6 m). Not more than one sample unit for each group of tests shall be taken from a single unit of product.

4.3.1.4 Inspection Levels and Acceptable Quality Levels (AQL) (Groups 1 and 2 tests)

For Group 1, the inspection level shall be S-2 and the AQL shall be 6.5 percent in accordance with MIL-STD-105; for Group 2, the inspection level shall be S-3 and the AQL shall be 1.5 percent.

4.3.1.5 Sampling and Acceptance Level for Group 3 Tests

Unless otherwise specified in the applicable specification sheet, the finished wire or cable sample for the Group 3 tests shall be 100 percent of the finished wire or cable, and every length of the wire or cable shall be fully tested. Portions showing breakdown in these dielectric tests and ends or portions not subjected to these tests shall be marked or removed and the remaining lengths tested until no failure occurs.

4.3.2 Nonconforming Inspection Lots

Disposition of inspection lots found unacceptable under initial quality conformance inspection shall be in accordance with MIL-STD-105.

4.4 PROCESS CONTROL INSPECTION

This inspection comprises tests and examinations (Table 2) of such a nature that they cannot be performed on the finished wire or cable and therefore must be performed at an appropriate stage of manufacture. Process control inspection shall be performed on every lot of wire or cable procured under this specification.

TABLE 2
PROCESS CONTROL INSPECTION

Examination or Test	Requirement	Test Method
Conductor material	3.3.1	4.6.6
Shield material	3.3.2	4.6.6
Insulating and jacketing material	3.3.3	4.6.6
Conductor elongation (high strand count)	3.4.1	4.6.3
Conductor splices	3.4.2	4.6.6
Insulation flaws	3.4.3	MIL-W-22759

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4.4.1 Sampling for Process Control Inspection

4.4.1.1 Conductor Material

Process control sample selection and inspection of uninsulated conductor shall be performed at receiving inspection. The conductor lot size, for purposes of sampling, shall consist of the number of reels of a given type and size of conductor received at one time from one supplier against a single purchase order. For lot sizes of 3 reels or less, one 15-foot (4.6-m) length of conductor shall be selected from each reel. For lot sizes of not less than 4 and not more than 25 reels, a minimum of three 15-foot (4.6-m) lengths of conductor shall be selected at random, in such a manner as to be representative of the material. For lot sizes in excess of 25 reels, the inspection level shall be Level 1 and the AQL shall be 4.0 percent in accordance with MIL-STD-105.

4.4.1.2 Insulation Flaws (Impulse Dielectric Test or Spark Test)

One hundred percent of the wire, after the application of the primary insulation, shall be tested in accordance with the applicable specification sheet and MIL-W-22759.

4.4.2 Rejection and Retest in Process Control Inspection

When a sample selected from an inspection lot fails to meet the specified test (Table 2), except the insulation flaws test (see 4.4.1.2), no items still on hand or later produced from that lot shall be accepted until the extent and cause of the failure has been determined.

4.4.2.1 Effect of Process Control Failure on Quality Conformance Testing

Quality conformance testing may be continued during the investigation of a failure of a process control sample, but final acceptance of the material shall not be made until it is determined that the lot meets all the process control and quality conformance requirements of the specification.

4.5 PERIODIC QUALIFICATION RE-EVALUATION

Qualification re-evaluation shall be performed, at the manufacturer's discretion, whenever any significant change is made to the materials or manufacturing process.

4.6 TEST METHODS

4.6.1 Bend Test (Post-Environmental)

At a temperature maintained between 20 and 25°C, one end of a finished wire specimen shall be secured to the mandrel and the other end to the weight specified in the applicable specification sheet. For finished cable specimens, the mandrel shall be as specified in Table 3 and sufficient weight shall be used to maintain contact with the mandrel. 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 shall then 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 shall then be examined for cracking of the insulation or jacket, as applicable.

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TABLE 3
MANDREL DIAMETERS FOR CABLES FOR BEND TEST
(POST-ENVIRONMENTAL)

Finished Cable Diameter		Mandrel Diameter	
inch	mm	inch	mm
≤ 0.083	≤ 2.11	.750	19
> 0.083 and ≤ 0.111	> 2.11 and ≤ 2.82	1.00	25
> 0.111 and ≤ 0.139	> 2.82 and ≤ 3.53	1.25	32
> 0.139 and ≤ 0.194	> 3.53 and ≤ 4.93	1.75	44
> 0.194 and ≤ 0.250	> 4.93 and ≤ 6.35	2.25	57
> 0.250 and ≤ 0.334	> 6.35 and ≤ 8.48	3.00	76
> 0.334 and ≤ 0.444	> 8.48 and ≤ 11.3	4.00	102
> 0.444 and ≤ 0.556	> 11.3 and ≤ 14.1	5.00	127
> 0.556 and ≤ 0.667	> 14.1 and ≤ 16.9	6.00	152
> 0.667 and ≤ 0.889	> 16.9 and ≤ 22.6	8.00	203
> 0.889 and ≤ 1.111	> 22.6 and ≤ 28.2	10.0	254
> 1.111 and ≤ 1.556	> 28.2 and ≤ 39.5	14.0	356
> 1.556 and ≤ 2.000	> 39.5 and ≤ 50.8	18.0	457

4.6.2 Conductor and Finished Wire Diameter

Diameter measurements shall be made on a 24-inch (610-mm), minimum, length of finished wire taken from the end of the sample unit. The conductor shall be made accessible by stripping and removing the insulation carefully so as not to nick, cut, cold-work, or otherwise damage the conductor. Three points for measurement shall be located 8 inches (203 mm) apart along the conductor or finished wire specimen length, as applicable. For AWG 10 and smaller, measurements shall be made at each point at two approximately perpendicular planes or as required to assure that the minimum and maximum reading is attained at each point. A total of six measurements shall be performed on each specimen. Measurements shall be made with a micrometer caliper or equivalent device capable of resolving a measurement to 0.0001 inch (0.0025 mm). For AWG 8 and larger, a circumferential measuring tape may be used in lieu of a micrometer, and a total of three measurements, taken 8 inches (203 mm) apart, shall be performed on each specimen. The circumferential measuring tape shall be capable of resolving a measurement to 0.001 inch (0.025 mm) over a diameter range of 0.200 inch (5.08 mm) and larger. The average diameter of all applicable measurements shall be calculated and recorded.

4.6.3 Conductor Elongation (High Strand Count)

High-strand-count conductors shall be tested for elongation in accordance with Method 3211 of FED-STD-228, except that the test shall be performed upon the whole conductor for regular bunch-stranded constructions, and upon one whole member removed from rope bunch-stranded constructions. In either case, elongation shall be measured upon breakage of the first strand of the whole conductor or member, as applicable.

4.6.4 Crosslinking Proof Test

Crosslinking proof tests of finished wire and cable shall be conducted in accordance with the life cycle test method of 4.6.12. The time and temperature specified for the crosslinking proof test on the applicable specification sheet shall be used.

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4.6.5 Examination of Preparation for Delivery

Preparation for delivery of materials ready for shipment shall be examined to determine compliance with the requirements of Section 5.

4.6.6 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.

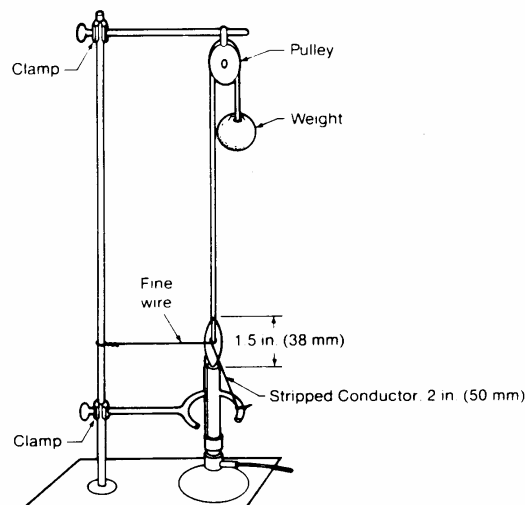
4.6.7 Flammability

4.6.7.1 Procedure 1

Procedure 1 flammability testing shall be in accordance with ASTM F 777, with a flame application period of 30 seconds. The procedure of ASTM F 777 conforms with FAR, Part 25, Appendix F (g).

4.6.7.2 Procedure 2 *(N/A for cable and AWG 8 wire samples)*

The test shall be performed in a sheet metal cabinet conforming to FED-STD-191, Method 5903. Two inches (51 mm) of insulation shall be removed from one end of an 18-inch (457-mm) specimen of finished wire and the specimen shall be mounted as shown in Figure 1. A 1.5-inch (38-mm) high yellow flame from a Bunsen burner conforming to FED-STD-191, Method 5903, shall be applied to the specimen at the junction of the insulation and the bare conductor in such a manner that the lower end of the insulation is located 0.75 inch (19 mm) into the flame. After 12 seconds of flame application, the burner shall be removed from below the specimen and immediately turned off. The burn length and the time of burning after removal of the flame shall be recorded. The burn length shall be the distance from the original bend made in the conductor to the farthest point of damage. Damage shall consist of bare conductor and charred insulation. Light discoloration of the insulation shall not constitute failure.



**FIGURE 1 - Flammability Test Apparatus, Procedure 2
(shown without metal cabinet)**

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4.6.8 Immersion

Specimens of sufficient length to perform the subsequent tests shall be measured at their midpoints to determine their initial diameters, and shall then be immersed to within 6 inches (152 mm) of their ends in each of the fluids (using a separate specimen for each fluid) for the time and temperature specified in Table 4. During immersion, the radius of bend of the specimens shall be not less than 14, nor more than 35, times the specified maximum diameter of the wire or cable under test. Upon removal from the fluids, the specimens shall remain for 1 hour in free air at room temperature. The diameters shall then be remeasured at the original point of measurement and compared to the initial diameters. The percent change in diameter shall then be calculated. For finished wire, 1 inch (25 mm) of insulation shall be removed from each end of a 24-inch (610-mm) length of each specimen. For finished cable, 2 inches (51 mm) of the jacket shall be removed from each end of a 24-inch (610-mm) length of each specimen, and the shield shall be pushed back and formed into a pigtail at each end of the specimen. One inch (25 mm) of insulation of each of the primary wires shall then be removed from each end of the specimen. The specimens shall then be subjected to the bend test (4.6.1 - use the mandrels and test weights specified on the applicable specification sheet for the Crosslinking Proof Test), followed by the voltage withstand test (4.6.14).

TABLE 4
IMMERSION TEST FLUIDS

	TEST FLUID	TEST TEMPERATURE	IMMERSION TIME
(a)	MIL-L-23699, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base	48 to 50°C (118 to 122°F)	20 hours
(b)	MIL-H-5606, Hydraulic Fluid, Petroleum Base, Aircraft, Missile and Ordnance	48 to 50°C (118 to 122°F)	20 hours
(c)	TT-I-735, Isopropyl Alcohol	20 to 25°C (68 to 77°F)	168 hours
(d)	MIL-T-5624, Turbine Fuel, Aviation, Grade JP-4 or JP-8	20 to 25°C (68 to 77°F)	168 hours
(e)	SAE-AS-1241, Fire Resistant Phosphate Ester Hydraulic Fluid for Aircraft	48 to 50°C (118 to 122°F)	20 hours
(f)	MIL-L-7808, Lubricating Oil, Aircraft Turbine Engine, Synthetic Base; or NATO 148	118 to 121°C (244 to 250°F)	30 minutes

4.6.9 Insulation Elongation and Tensile Strength

Specimens of the entire insulation shall be carefully removed from the conductor and tested for tensile strength and elongation in accordance with FED-STD-228, Methods 3021 and 3031, respectively, using 1-inch (25-mm) bench marks, a 1-inch (25-mm) initial jaw separation, and a jaw separation speed of 2 inches (51 mm) per minute. For cables, the method shall be the same, but only the cable jacket shall be tested.

4.6.10 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 also be measured and recorded. The ratio of the minimum wall thickness to the maximum wall thickness shall define the concentricity. All wall-thickness measurements shall be made under suitable magnification. The wall thickness shall be the radial distance between the inner and outer rim of the jacket.

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4.6.11 Jacket Flaws

Finished cable shall be tested in accordance with the jacket flaws test of MIL-C-27500, or the impulse dielectric test procedure of MIL-W-22759, with the shield grounded at one or both ends.

4.6.12 Life Cycle

Finished wire and cable specimens, prepared in accordance with 4.6.12.1 or 4.6.12.2, as applicable, shall be conditioned in an air-circulating oven for 500 hours at the temperature specified. The velocity of air past the specimens (measured at room temperature) shall be between 100 and 200 feet (30 and 61 m) per minute. After conditioning, the oven shall be shut off, the door opened, and the specimens allowed to cool in the oven for at least 1 hour. When cool, the finished wire specimens shall be freed from tension, removed from the mandrel, and straightened. The finished wire and cable specimens shall then be subjected to the bend test (4.6.1) followed by the voltage withstand test (4.6.14).

4.6.12.1 Finished Wire Preparation

One inch (25 mm) of insulation shall be removed from each end of a 24-inch (610-mm) specimen of finished wire. The central portion of the specimen shall then be bent at least halfway around a horizontally positioned smooth stainless steel mandrel of the diameter specified in the applicable specification sheet for the Crosslinking Proof Test. To prevent sticking of the specimen to the mandrel, the mandrel shall be covered with polytetrafluoroethylene in the form of either a dispersion coating (preferred) or wrapped tape, provided that the diameter of the mandrel still conforms to the applicable specification sheet. Each end of the conductor shall be loaded with the weight specified in the applicable specification sheet for the Crosslinking Proof Test, so that the portion of the insulation between the conductor and mandrel is under compression while the conductor is under tension. This specimen, so prepared on the mandrel, shall be conditioned and tested as specified above.

4.6.12.2 Finished Cable Preparation

Two inches (51 mm) of the jacket shall be removed from each end of a 15-inch (380-mm) specimen of finished cable, and the shield, if any, shall be pushed back and formed into a pigtail at each end of the specimen. One inch (25 mm) of insulation of each of the primary wires shall then be removed from each end of the specimen. The cable specimen shall then be loaded with sufficient weight to hang straight, and shall be conditioned and tested as specified above.

4.6.13 Secant Modulus

Specimens of the wire insulation, or cable jacket, shall be carefully removed and tested for secant modulus in accordance with ASTM D 882, using a 2-inch (50-mm) initial jaw separation, a jaw speed of 0.2 inch (5 mm) per minute, and a chart speed of 20 inches (508 mm) per minute. The pounds-force (N) shall be read from the chart 4 inches (102 mm) from where the trace begins to rise for 0 pounds-force (N).

$$\text{Secant Modulus (lbsf/in}^2 \text{ @ 2\%)} = \frac{\text{lbsf}}{\text{CSA} \times 0.2}$$

Where: CSA = cross sectional area

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4.6.14 Voltage Withstand

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 inches (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 shall be applied at 60 Hz 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 then gradually reduced to zero in 0.5 minute.

4.6.15 Weight

The weight of each lot of finished cable shall be determined in accordance with the procedure specified for finished wire in MIL-W-22759.

5. **PREPARATION FOR DELIVERY**

5.1 **PACKAGING AND PACKING**

Wire and cable shall be delivered wound on reels or spools in accordance with 5.1.3.

5.1.1 Winding Requirements

All layers of wire or cable shall be wound on the reel or spool with sufficient tension to prevent shifting of layers and creation of crossovers within layers.

5.1.1.1 **Finished Wire**

All finished wire lengths wound on one reel or spool shall be spliced into one mechanically and electrically continuous length.

5.1.1.2 **Finished Cable**

Finished cable shall be wound with no more than 5 lengths per reel or spool, and in such a manner that all ends are accessible.

5.1.2 Lengths

Unless otherwise specified, minimum continuous length (between splices) for finished wire shall be in accordance with Table 5. For finished cable, the minimum acceptable length for shipment shall be 50 feet (15.2 m).

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TABLE 5
FINISHED WIRE LENGTHS

Wire Size Range		Minimum Percentage of Total Length in Shipment With Lengths Greater Than:		
AWG	mm ²	500 ft (152 m)	100 ft (30.5 m)	50 ft (15.2 m)
30 through 10	0.057 through 4.74	50	100	---
8 through 0000	8.60 through 106.9	---	---	100

5.1.3 Reels and Spools

Reels and spools shall be of a nonreturnable type. Each reel and spool shall have an appropriate diameter for the respective wire size. In no case shall the barrel of the reel or spool have a diameter less than 3.5 inches (89 mm). Reels and spools shall be suitably finished to prevent corrosion under typical storage and handling conditions.

5.1.4 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.

5.1.5 Marking of Shipments

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

Specification Sheet Part Number
Lot Number
Quantity in feet (*or meters*)
Raychem Corporation (*or Raychem Ltd.*)

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

6.2 METRIC UNITS

Metric units are for information only.

6.3 MIL-W-22759

Wherever MIL-W-22759 refers to "applicable specification sheet", use the applicable specification sheet of this Raychem specification.

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