

**WIRE AND CABLE, ELECTRICAL,  
INSULATED, HIGH TEMPERATURE**

This amendment forms a part of Tyco Electronics/Raychem Specification 35,  
Issue 2 dated February 11, 1982.

**PAGE 1**

Para. 3.1.1, Conductor: Change MIL-W-81044 to read "AS81044".

Para. 3.1.3, Shield: Change MIL-C-27500 to read "WC27500".

**PAGE 2 and 3**

Para. 4.3.2.1, 4.3.2.2, Accelerated Aging: Change MIL-W-81044 to read "AS81044" (4 places).

**PAGE 3**

Para. 4.3.3, Acid-Gas Generation: Delete this test in its entirety (4.3.3, 4.3.3.1, 4.3.3.2 and Figure 1) and add new 4.3.3 as follows:

**4.3.3 Aging Stability**

When required by the specification sheet, the finished wire shall be conditioned in accordance with Method 4031 of FED-STD-228 at the temperature and for the time specified in the applicable specification sheet. Elongation and tensile strength shall be determined in accordance with 4.3.7.

**PAGE 6**

Para. 4.3.11, Solder Iron Resistance: Delete and replace with the following:

“One inch (25 mm) of insulation shall be removed from each end of a 6-inch (150-mm) sample of 20 or 22 AWG 600V finished wire. The specimen shall then be bent into a loop and the ends tied together and weighted with a  $150 \pm 10$  gram weight. The specimen shall then be suspended over the solder iron having a clean 1/4-inch (6-mm) nominal diameter bit and maintaining a bit temperature of  $371 \pm 10^\circ\text{C}$ . This condition shall be maintained for 60 seconds. The specimen shall then be subjected to the Voltage Withstand Test of 4.3.12.”

**PAGE 7**

Para. 6.2, MIL-W-81044: Change MIL-W-81044 to read "AS81044" (2 places).

**PAGE 8**

Table 1, Requirements for Finished Wire and Cable: Make the following modifications:

- Acid-Gas Generation: Delete the listing for this test in its entirety.
- Immersion: Delete fluid a) "Insulating Oil (VV-I-530)".
- ~~Insulation Resistance: Delete this test for cable (i.e., replace "Applicable specification sheet" with "-----"), and change the Test Method from MIL-C-915 to read "MIL-W-22759".~~
- Insulation Resistance: Delete this test for cable (i.e., replace "Applicable specification sheet" with "-----"), and change the Test Method from MIL-C-915 to read "AS22759".
- Solder Iron Resistance: Change the requirement for finished wire from 60 seconds minimum to read "No dielectric breakdown".
- Test Methods column: Change MIL-W-81044 to read "AS81044" (3 places) and change MIL-C-27500 to read "WC27500" (2 places).
- Add Aging Stability for finished wire as follows:

Examination or Test	Requirements		Test Methods
	Finished Wire	Cable	
Aging Stability	Applicable specification sheet	-----	Section 4.3.3

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## WIRE AND CABLE, ELECTRICAL, INSULATED, HIGH TEMPERATURE

### 1. SCOPE

This specification covers radiation crosslinked, extruded, modified, flame retarded polyolefin insulated wire and cable which is suitable for use as a hookup wire and general purpose wire in the temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , continuous.

#### 1.1 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.

### 2. APPLICABLE DOCUMENTS

The specifications and standards referenced in Table I form a part of this specification to the extent specified herein.

### 3. REQUIREMENTS

#### 3.1 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:

##### 3.1.1 Conductor

Conductor shall be in accordance with MIL-W-81044 and the applicable specification sheet.

##### 3.1.2 Insulation

The insulation shall be extruded, flame retarded, radiation crosslinked, modified polyolefin. It shall be homogeneous and essentially free from flaws, defects, cracks, lumps, foreign material or porosity.

##### 3.1.3 Shield

Shield material shall be in accordance with MIL-C-27500 and the applicable specification sheet.

#### 3.2 PROPERTIES

The finished wire and cable shall conform to the requirements of Table I and those of the applicable specification sheet. In the event of conflict the latter shall govern.

## 4. QUALITY ASSURANCE PROVISIONS

### 4.1 CLASSIFICATION OF TESTS

#### 4.1.1 Qualification Inspection

Qualification inspection shall consist of all tests listed in Table I, as applicable to finished wire or cable.

#### 4.1.2 Quality Conformance Inspection

Quality conformance inspection shall be performed on each lot of finished wire or cable submitted for acceptance under contract. Quality conformance tests shall consist of those tests so denoted in Table I. Other tests shall be carried out as often as necessary to ensure compliance with all requirements of this specification.

### 4.2 SAMPLING INSTRUCTIONS

#### 4.2.1 Qualification Inspection

Qualification test samples shall consist of sufficient length of finished wire and any designated cable construction to perform the applicable tests. The sample may be of any size wire or cable within the specified size range and will qualify all sizes within that range.

Size Range  
30 AWG through 20 AWG  
18 AWG through 10 AWG  
8 AWG and larger

#### 4.2.2 Quality Conformance Inspection

Quality conformance test samples shall consist of a sufficient length of finished wire or cable, from each inspection lot, to perform the applicable tests. The inspection lot shall include all finished wire or cable of one part number submitted for inspection at one time. Finished wire or cable which has been rejected may be reworked to correct the defects and resubmitted for acceptance.

### 4.3 TEST METHODS

#### 4.3.1 Examination of Product

All samples of finished 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.

#### 4.3.2 Accelerated Aging

##### 4.3.2.1 Finished Wire

Finished wire shall be tested in accordance with the procedure specified in MIL-W-81044 and the applicable specification sheet except that retention of legibility of the product identification shall not be applicable. The specimen shall be conditioned for 4 hours at  $225 \pm 4$  °C and then subjected to the bend test of MIL-W-81044 followed by the voltage withstand test of 4.3.12.

##### 4.3.2.2 Finished Cable

Finished cable shall be tested in accordance with the procedure specified in MIL-W-81044 and the applicable specification sheet except as follows: Two inches (50 mm) of the jacket shall be removed 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 specimen and 1 inch (25 mm) of the insulation of each of the primary wires shall be removed

from each end of the specimen. The conductors then shall be tied together at each end, loaded with the weight specified in the applicable specification sheet and conditioned for 4 hours at  $225 \pm 3^\circ\text{C}$ . The specimen shall then be subjected to the bend test of MIL-W-81044 followed by the voltage withstand test of 4.3.12.

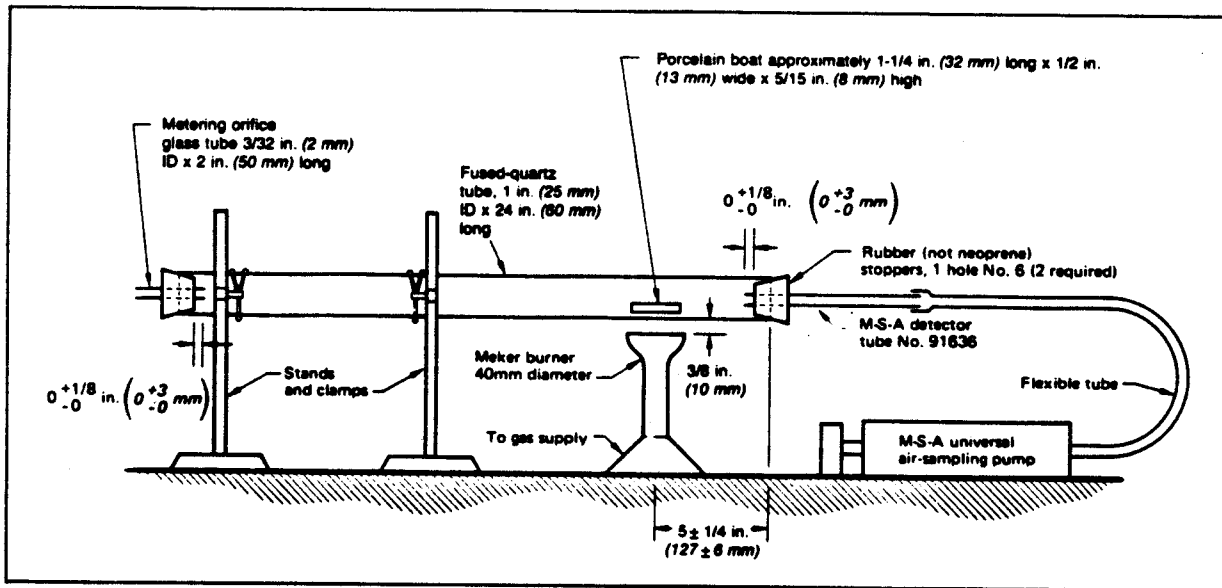
**4.3.3 Acid-Gas Generation**

**4.3.3.1 Apparatus**

The apparatus shall be as shown in Figure 1. The fused-quartz tube and the porcelain boat shall be flame and chemically cleaned to be free of deposits and organic material. The Meker burner shall be supplied with city gas at a pressure of approximately 6 inch (150 mm) of water and the adjustment orifices shall be completely open.

**4.3.3.2 Procedure**

The burner shall be located as shown in Figure 1 and the fused-quartz tube shall be heated for at least 5 minutes to a dull-red temperature. The porcelain boat containing  $1.0 \pm 0.1$  mg of insulation or jacket material shall be located in the end of the fused-quartz tube farthest from the flame. The ends of an M-S-A† Part No. 91636 detector tube shall be broken off and the tube shall be connected to the M-S-A universal air-sampling pump as shown in Figure 1, with the arrow on the tube pointing toward the sample pump. The other end of the detector tube then shall be inserted in the rubber stopper, which then shall be inserted in the fused-quartz tube. The sampling pump then shall be set at the index mark specified in the instructions supplied with the lot of detector tubes being used. The porcelain boat containing the specimen then shall be quickly pushed and centered over the Meker burner, at which point a timer shall be started. The open end of the fused-quartz tube then shall be immediately stoppered with the metering orifice. When the specimen ignites, the sample pump shall be pulled one-fourth stroke. After 1 minute, the detector tube shall be read using the calibration supplied with the lot of detector tubes being used. Five tests shall be performed. The acid-gas generation (ppm/mg) shall be the detector tube reading (ppm) and shall be the average of the last four tests.



**Figure 1 - Acid-Gas Generation Test Apparatus.**

†Trademark, Mine Safety Appliances Company

#### 4.3.4 Concentricity

The concentricity of the finished wire or cable shall be determined, under suitable magnification, by first locating and recording the minimum wall thickness measured on a cross section of the finished wire or cable insulation. The maximum wall thickness of this same cross section of the finished wire or cable shall also be located and recorded. The ratio of the minimum wall thickness to the maximum wall thickness, times 100, shall define the percent concentricity.

#### 4.3.5 Flammability

The apparatus and procedure contained herein conform to Underwriters Laboratories Vertical Wire Flame Test, VW-1.

##### 4.3.5.1 Apparatus

The test shall be performed within a metal enclosure approximately 12 inches (300 mm) wide, 14 inches (350 mm) deep and 24 inches (600 mm) high, open at the top and front to provide adequate ventilation for combustion but to prevent drafts. The specimen holder shall be so designed that the lower end of a 24-inch (600-mm) specimen is held by a clamp, while the upper end of the specimen passes over a pulley and can be suitably weighted to hold the specimen taut with its longitudinal axis vertical in the center of the enclosure. The test flame shall originate from a Tirrill gas burner with a pilot light attached. The barrel of the burner is to extend approximately 4 inches (100 mm) above the air inlets and its inside diameter is to be 3/8 inch (10 mm) nominal. The burner shall be adjusted, while in a vertical position, to furnish a flame height of approximately 4 to 5 inches (100 to 125 mm) with an inner blue cone of 1-1/2 inches (38 mm). The temperature at the tip of the blue cone is to be 816°C or higher as measured with an accurate thermocouple pyrometer. The burner shall be secured on a jig to provide for tilting the barrel 20 degrees from the vertical while the longitudinal axis of the barrel remains in a vertical plane. A 1/4 to 1-inch (6 to 25-mm) thick horizontal layer of untreated surgical cotton shall be placed on the chamber floor at no more than 9-1/2 inches (240 mm) below the point of application of the flame to the specimen, so that any material dripping from the specimen shall fall upon the cotton.

##### 4.3.5.2 Procedure

The lower end of a 24-inch (600-mm) specimen shall be clamped in position in the specimen holder and the upper end shall be passed over the pulley of the holder and weighted with sufficient weight to hold the specimen taut. The burner shall be positioned in front of the specimen with the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen and the plane being parallel to the side of the enclosure. The burner shall be located at a distance of 1-1/2 inches (38 mm) from the specimen, as measured from the tip of the barrel to the outer surface of the insulation, along the extended longitudinal axis of the barrel. A 1/2-inch (13-mm) wide strip of unreinforced, 5-mil-thick (approx. 0.1-mm), 60-pound Kraft paper that is gummed on one side shall be used to make an indicator flag. The gumming is to be moistened just sufficiently to facilitate adhesion. With the gum toward the specimen, the strip is to be wrapped around the specimen once with its lower edge 10 inches (250 mm) above the point at which the blue cone is to touch the specimen. The ends of the strip are to be pasted together evenly and trimmed to provide a flag that projects 3/4 inch (19 mm) from the specimen toward the rear of the enclosure with the flag parallel to the sides of the enclosure (see Figure 2). The pilot light shall then be lit and the valve supplying gas to the burner turned on, applying flame to the specimen. After 15 seconds of flame application to the specimen, the burner shall be turned off for 15 seconds (or until burning ceases if the specimen continues to burn longer than 15 seconds after removal of flame). This on/off cycle shall be repeated four times, for a total of five 15-second applications of the gas flame to the specimen with 15 seconds (longer if flaming of specimen persists) between applications. The following criteria shall then be evaluated and recorded: 1) The time of burning after removal of the test flame after the final application of the flame, and time of burning, if in excess of 15 seconds, after removal of the flame on any of the first four applications of the flame 2) Percentage of the indicator flag burned away or charred. Soot that can be removed with a cloth or the fingers and brown scorching are to be ignored 3) The presence or absence of flame in the cotton due to incendiary drips from the specimen. Flameless charring of the cotton is to be ignored. Breaking of the specimens shall not be considered as failure.

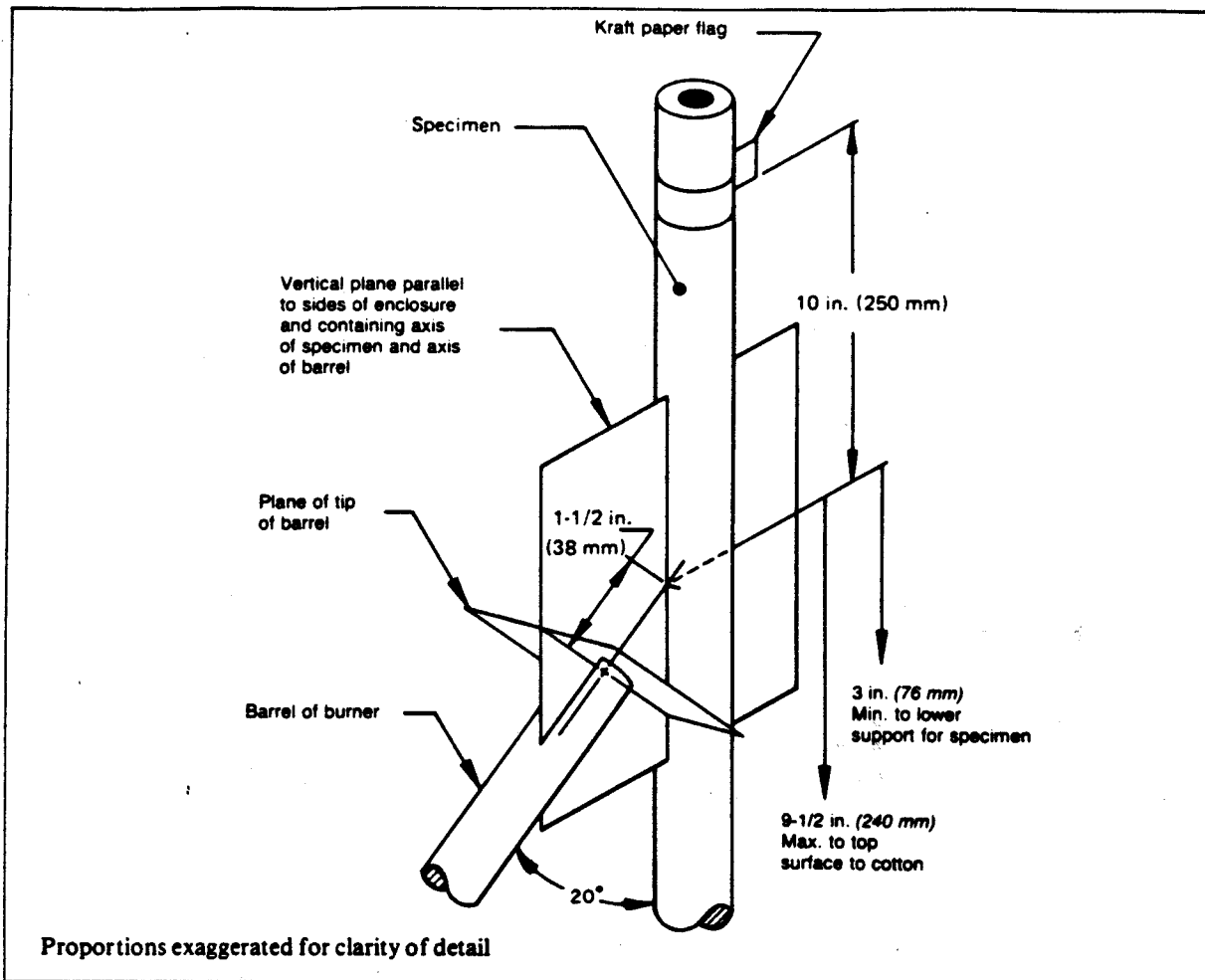


Figure 2 - Essential Dimensions For Vertical Flammability Test.

#### 4.3.6 Immersion

Specimens of finished wire or cable of sufficient length to perform the subsequent tests shall be measured to determine their initial diameter and shall then be immersed to within 6 inches (150 mm) of their ends in the fluids listed in Table I (using a separate specimen for each fluid) for 20 hours at a temperature of  $25 \pm 5^\circ\text{C}$ . During the immersion tests, the radius of bend of the finished wire or cable shall not be less than fourteen times the specified maximum diameter of the finished wire or cable under test. Upon removal from the liquids, the specimen shall remain for 1 hour in free air at room temperature. The diameter shall be measured and compared to the initial diameter. The insulation shall be removed for a distance of 1 inch (25 mm) from each end of a 24-inch (600-mm) length of the specimen. One end of the 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 coils 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 finished wire or cable. The specimen shall then be subjected to the voltage withstand test of 4.3.12.

#### 4.3.7 Insulation Elongation and Tensile Strength

The determination of tensile strength and elongation shall be made in accordance with FED-STD-228, Methods 3021 and 3031, respectively, utilizing 1 inch (25 mm) initial jaw separation, and a jaw separation rate of 2 inches (50 mm) per minute.

#### 4.3.8 Life Cycle

One inch (25 mm) of the insulation shall be removed from each end of an 18-inch (450-mm) specimen of the finished wire or from each wire of a finished cable. This specimen shall be suspended vertically in an air-circulating oven and conditioned for 96 hours at  $175 \pm 3^\circ\text{C}$ . The velocity of air past the specimen location in the oven shall be between 100 and 200 feet (30 and 60 m) per minute as determined at room temperature. After completion of the air oven exposure, the specimen shall be allowed to cool to between 20 and 25 °C. The specimen shall then be wound tightly around a mandrel approximately, but not less than, three times the overall diameter of the finished wire or cable for five close turns and removed as a helical coil. The specimen shall then be subjected to the voltage withstand test of 4.3.12 with the bent portion submerged.

#### 4.3.9 Low Temperature-(Cold Bend)

One end of a finished wire or cable specimen 36 inches (900 mm) in length shall be secured to a rotatable mandrel in a cold chamber and the other end to the load weight specified in the applicable specification sheet. The diameter of the mandrel shall be as specified in the specification sheet. Provision shall be made for rotating the mandrel by means of a handle or control located outside the chamber. The specimen and the mandrel shall be conditioned for 4 hours at a temperature of  $-55 \pm 2^\circ\text{C}$ . At the end of this period and while both mandrel and specimen are still at this low temperature, the specimen shall be wrapped helically, for its entire length or for 20 turns whichever is the lesser number of turns, around the mandrel without opening the chamber. The bending shall be accomplished at a uniform rate of  $2 \pm 1$  RPM. At the completion of this test the specimen shall be removed from the cold box and from the mandrel without straightening. The specimen shall be examined for cracks in the insulation. The insulation shall then be removed for a distance of 1 inch (25 mm) from each end of the specimen and the specimen shall be subjected to the voltage withstand test specified in 4.3.12 with the bent portion submerged.

#### 4.3.10 Shrinkage

A 12-inch (300-mm) specimen of the finished wire or cable shall be cut so that the insulation and conductor are flush at both ends. The specimen shall then be placed in an air-circulating oven and maintained for a period of 4 hours at  $225 \pm 3^\circ\text{C}$ . The velocity of air past the specimen location in the oven shall be between 100 and 200 feet (30 and 60 m) per minute as determined at room temperature. At the end of the 4-hour period, the specimen shall be removed from the oven, allowed to return to room temperature, and measured for shrinkage. The sum of the insulation or jacket shrinkage of both ends of the specimen shall be considered the shrinkage of the specimen.

#### 4.3.11 Solder Iron Resistance

One inch (25 mm) of insulation shall be removed from each end of a 6-inch (150-mm) sample of 20 AWG 600V finished wire. The specimen shall then be bent into a loop and the ends tied together and weighted with a  $150 \pm 10$  gram weight. A 12-volt detection circuit shall be connected between the solder iron and conductor to detect dielectric failure. The specimen shall then be suspended over the solder iron having a clean 1/4-inch (6-mm) nominal diameter bit and maintaining a bit temperature of  $371 \pm 10^\circ\text{C}$ . This condition shall be maintained until dielectric failure occurs or until the time specified in Table I has been reached, whichever occurs first.



**4.3.12 Voltage Withstand Test**

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 2 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 1 minute and gradually reduced to zero in 0.5 minute.

**5. PREPARATION FOR DELIVERY****5.1 PACKAGING**

Wire and cable shall be packaged on reels or spools of appropriate construction.

**5.2 LABELING**

Each reel or spool shall be labeled or tagged to indicate the product designation, the individual lengths in proper sequence and the manufacturer.

**6. NOTES****6.1 METRIC UNITS**

Metric units, where shown in parenthesis, are for information only.

**6.2 MIL-W-81044**

Wherever MIL-W-81044 refers to "applicable specification sheet", use the applicable specification sheet of this Raychem specification.

**TABLE I  
REQUIREMENTS FOR FINISHED WIRE AND CABLE**

Examination or Test	Requirements		Test Methods
	Finished Wire	Cable	
Materials	Section 3.1	Section 3.1	Section 4.3.1
*Construction	Applicable specification sheet	Applicable specification sheet	Section 4.3.1
*Accelerated aging 4 hours at 225 °C	No cracking	No cracking	Section 4.3.2
Followed by test for: Voltage withstand	No dielectric breakdown	No dielectric breakdown	Section 4.3.12
Acid-gas generation	Applicable specification sheet	Applicable specification sheet	Section 4.3.3
*Color	MIL-STD-104	MIL-STD-104	Section 4.3.1 and MIL-STD-104
*Concentricity	70 percent minimum	70 percent minimum	Section 4.3.4
*Conductor resistance	Applicable specification sheet	—————	MIL-W-81044
*Dielectric withstand	—————	Applicable specification sheet	MIL-C-27500
*Dimensions	Applicable specification sheet	Applicable specification sheet	Section 4.3.1
*Flammability	Self extinguishing within 60 seconds; No more than 25% of flag burned or charred; No flaming of cotton	Self extinguishing within 60 seconds; No more than 25% of flag burned or charred; No flaming of cotton	Section 4.3.5
Immersion 20 hours at 25 °C a) Insulating Oil (VV-1-530) b) Lubricating Oil (MIL-L-23699) c) Isopropyl Alcohol (TT-I-735) d) Salt Water (5% salt)			Section 4.3.6
Followed by tests for: Diameter increase	5 percent maximum	5 percent maximum	Section 4.3.1
Voltage withstand	No dielectric breakdown	No dielectric breakdown	Section 4.3.12
*Insulation elongation	Applicable specification sheet	Applicable specification sheet	Section 4.3.7 and FED-STD-228
*Insulation tensile strength	Applicable specification sheet	Applicable specification sheet	Section 4.3.7 and FED-STD-228
*Insulation flaws	Applicable specification sheet	Applicable specification sheet	MIL-W-81044
*Insulation resistance	Applicable specification sheet	Applicable specification sheet	MIL-C-915
Life cycle 96 hours at 175 °C	No cracking	No cracking	Section 4.3.8
Followed by test for: Voltage withstand	No dielectric breakdown	No dielectric breakdown	Section 4.3.12
Low temperature-cold bend 4 hours at -55 °C	No cracking	No cracking	Section 4.3.9
Followed by test for: Voltage withstand	No dielectric breakdown	No dielectric breakdown	Section 4.3.12
*Shield coverage	—————	85 percent minimum	MIL-C-27500
*Shrinkage 4 hours at 225 °C	1/4 inch (6 mm) maximum	1/4 inch (6 mm) maximum	Section 4.3.10
Solder iron resistance	60 seconds minimum	—————	Section 4.3.11
*Weight	Applicable specification sheet	Applicable specification sheet	MIL-W-81044

\*Quality Conformance Test: Section 4.1.2 and 4.2.2.