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MILITARY SPECIFICATION

WIRE, ELECTRICAL, SILICONE-INSULATED, COPPER, 600-VOLT, 200° C

This specification has been approved by the Department of the Air Force and by the Naval Air Systems Command.

1. SCOPE

1.1 Scope.- This specification covers single conductor copper wire with a silicone primary insulation capable of continuous operation at a maximum conductor temperature of 200° C (392° F). These wires are suitable for use in aircraft and missiles using any combination of electrical loading and ambient temperature, provided the maximum conductor temperature is not exceeded. The wires covered by this specification are not intended as fire-resistant wires.

1.2 Classification.- Single conductor insulated wire shall be as specified in the applicable MS standard (see 6.2).

2. APPLICABLE DOCUMENTS

2.1 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:

SPECIFICATIONS

Federal

QQ-W-343	Wire, Electrical and Nonelectrical, Copper (Uninsulated)
TT-I-735	Isopropyl Alcohol
UU-T-450	Tissue, Facial

Military

MIL-W-5088	Wiring, Aircraft, Installation of
MIL-T-5438	Tester; Abrasion, Electrical Cable
MIL-H-5606	Hydraulic Fluid, Petroleum Base, Aircraft, Missile, and Ordnance
MIL-T-5624	Turbine Fuel, Aviation Grades JP-4 and JP-5
MIL-C-7078	Cable, Electric, Aerospace Vehicle, General Specification for
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine Synthetic Base

FSC 6145

MIL-H-8446	Hydraulic Fluid, Nonpetroleum Base, Aircraft
MIL-C-12000	Cable, Cord, and Wire, Electric, Packaging of

STANDARDS

Federal

FED. TEST METHOD STD. NO. 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	Inspection Terms and Definitions
MIL-STD-129	Marking for Shipment and Storage
MS25471	Wire, Electrical - Silicone-Insulated, Copper, 600 Volt, 200° C, Polyester Jacket
MS27110	Wire, Electrical - Silicone Insulated, Copper, 600 Volt, 200° C, FEP Jacket

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

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:

Department of Defense - AFSSC

Federal Supply Code for Manufacturers

H4-1	Part I - Name to Code
H4-2	Part II - Code to Name

(Copies of Department of Defense Handbooks may be obtained from the Commander, Aeronautical Systems Division, Attn: ASNPS, Wright-Patterson Air Force Base, Ohio 45433.)

Munsell Color Company, Incorporated

Munsell Book of Color

(Copies of the Munsell Book of Color may be obtained from the Munsell Color Company, Incorporated, 2441 North Calvert Street, Baltimore, Maryland.)

American Society for Testing and Materials

ASTM B298-64 Silver-Coated Soft or Annealed Copper Wire

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

3. REQUIREMENTS

3.1 Qualification.- The wire furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.1.1 Precedence.- Detail requirements or exceptions applicable to individual types shall be as specified herein, in MS25471, MS27110, or in other applicable MS standards.

3.2 Materials.- All materials used in the construction of the finished wire shall be materials generally considered to be nonnutrient for fungi.

3.2.1 Conductor.- All strands used in the manufacture of wire to this specification shall be annealed or soft drawn copper wire from the best obtainable, commercially pure wire bars, and in accordance with QQ-W-343.

3.2.2 Insulation.- The primary insulation shall be silicone rubber, applied by extrusion or taping. If a silicone rubber tape is used, it shall be fused into a homogeneous mass.

3.2.3 Inner braid.- The inner braid shall consist of glass fibers or a combination of glass fibers and polyester fibers covering the primary insulation. The inner braid shall be treated with a heat-resistant finisher.

3.2.4 Outer jacket.- The outer jacket shall be as specified on the applicable MS standard.

3.3 Design and construction.- The wire shall consist of a uniformly silver-coated stranded conductor covered by insulation in accordance with the applicable MS standard.

3.3.1 Conductor.-

3.3.1.1 Conductor coating.- Individual strands shall be uniformly coated with a smooth continuous layer of commercially pure silver having a minimum thickness of 40 microinches when tested in accordance with 4.6.2.2. Following the continuity of coating test of 4.6.2.1, there shall be no evidence of exposed copper.

3.3.1.2 Stranding.-

3.3.1.2.1 The conductors of wire sizes 22 through 12 shall be concentric-lay conductors constructed as specified in table I. Concentric lay shall be interpreted to be a central core surrounded by one or more layers of helically wound

strands. It is optional for the direction of lay for the successive layers to be alternately reversed (true concentric lay) or to be in the same direction (unidirectional lay). When unidirectional lay is used, the strands shall be assembled in a geometric arrangement of concentric layers, so as to produce a smooth and uniform conductor, circular in cross-section and free of any cross-overs, high strands or other irregularities. The direction of lay of the individual strands in the outer layer of the concentrically stranded conductors of finished wire shall be left hand. The length of lay of the outer layer shall not be less than 8 nor more than 16 times the maximum conductor diameter as specified in the applicable MS standard or military specification sheet.

3.3.1.2.2 Wire sizes 10 through 00 shall be as specified in table I and rope lay as follows:

(a) Rope-lay stranded conductors shall be laid up concentrically; a central core surrounded by one or more helically wound members. It is optional for the direction of lay for successive layers to be alternately reversed (true concentric lay), or to be in the same direction (unidirectional lay). The length of lay of the outer layer of rope-lay stranded members forming the conductor shall be not less than 10 nor more than 14 times the outside diameter of the completed conductor. The direction of lay of the outer layer may be either left or right hand.

(b) Members of rope-lay stranded conductors: The length of lay of the wires composing the stranded members shall be not greater than 16 times the outside diameter of the member. Stranding of the individual members may be either concentric or bunch.

TABLE I. Wire construction details

Wire size	Nominal conductor area (cir. mils)	Number of strands	Allowable number of missing strands	Nominal dia. of individual strands (inch)	Maximum dia. of stranded conductor (inch)	Maximum resistance at 20° C (68° F) (ohms/1,000 ft.)
22	755	19	0	0.0063	0.033	15.2
20	1,200	19	0	.0079	.041	9.42
18	1,909	19	0	.0100	.052	6.03
16	2,409	19	0	.0113	.060	4.72
14	3,830	19	0	.0142	.074	2.99
12	6,088	19	0	.0179	.093	1.88
10	9,880	49	0	.0142	.128	1.16
8	16,864	133	0	.0113	.176	0.70
6	26,813	133	0	.0142	.218	0.436
4	42,613	133	0	.0179	.272	0.274
2	66,832	665	2	.0100	.345	0.179
1	82,108	817	2	.0100	.384	0.144
0	105,022	1,045	3	.0100	.432	0.114
00	133,665	1,330	3	.0100	.490	0.090

3.3.1.3 Splices.- Splices of individual strands shall be butt-brazed. Individual brazed splices in any section of the conductor shall not occur closer together than 10 feet. Splices in any individual stranded member, in rope-lay construction, shall be so finished off that the conductor diameter is not increased at the point of brazing. In no case shall the whole conductor be spliced at one point.

3.3.1.4 Elongation.- When tested as specified in 4.6.2.3, the individual strands from the conductor of the finished wire shall withstand an elongation of 10 percent before breaking.

3.3.1.5 Conductor diameter.- The diameter of the conductor of finished wire shall be as specified in table I.

3.3.2 Primary insulation.-

3.3.2.1 Concentricity.- The primary insulation shall be formed concentrically around the conductor. When measured in accordance with 4.6.3.1, the concentricity shall be not less than 70 percent.

3.3.2.2 Physical properties.- When tested separately in accordance with 4.6.3.2.1, the physical properties of extruded primary insulation shall be not less than specified in the applicable MS standard.

3.3.2.2.1 Physical properties after aging.- When tested in accordance with 4.6.3.2.2, extruded primary insulation removed from finished wire shall have physical properties not less than the values specified for aged samples in the applicable MS standard.

3.3.2.3 Primary insulation flaws.- After application of the primary insulation, and prior to the application of any other material, all of the wire shall pass the test specified in 4.6.3.3 without failure.

3.3.3 Finished wire requirements.-

3.3.3.1 Finished wire diameter.- The diameter of the finished wire shall be as specified in the applicable MS standard.

3.3.3.2 Finished wire weight.- When tested in accordance with 4.6.4.14, the weight of the finished wire shall be not greater than the values specified in the applicable MS standard.

3.3.3.3 Wire outer surface.- The outer surface of the wire shall be noncorrosive and flexible, and shall be finished smooth. The multiple layers of braided material, used as the outer covering, shall be bonded together by the heat-resistant finisher to prevent fraying. Adjacent layers of wire, when wound on a reel, shall not stick to one another at any temperature under 200° C.

3.3.3.4 Color.- The color shall be white in accordance with MIL-STD-104, or tan in accordance with the following limits as defined by the Munsell Book of Color:

Hue	- Red limit - 10R
Hue	- Green limit - 5Y
Value	- Not less than 6.0 (dark limit)
Chroma	- Not greater than 8.0 (saturation limit)

The above color requirements shall also apply after the test specified in 4.6.4.3.1.

3.3.4 Performance requirements on finished wire.-

3.3.4.1 Conductor resistance.- When tested in accordance with 4.6.4.1 the conductor resistance of the finished wire shall be as specified in table I.

3.3.4.2 Finished wire flaw test.- All of the finished wire shall conform to the test specified in 4.6.4.2 without electrical breakdown.

3.3.4.3 Life cycle.- Following the tests specified in 4.6.4.3.1 and 4.6.4.3.2, there shall be no cracking of the outer surface or of the primary insulation as viewed visually without magnification. The test specimen shall then conform to the test specified in 4.6.4.3.3 without electrical breakdown or flashover. The insulation shall not cause pitting of the conductor during the test specified in 4.6.4.3.

3.3.4.4 Cold bend.- The wire shall withstand the test of 4.6.4.4 without cracking of the outer surface or primary insulation when viewed visually without magnification. The test specimen shall then pass, without breakdown or flashover, the test specified in 4.6.4.3.3.

3.3.4.5 Oil absorption.- After having been subjected to the test specified in 4.6.4.5, the increase in diameter shall not exceed 5 percent. The insulation shall show no evidence of coming through the outer cover. The test specimen shall then withstand the tests specified in 4.6.4.3.2 and 4.6.4.3.3 without electrical breakdown or flashover.

3.3.4.6 Immersion.- Following the test specified in 4.6.4.6, the increase in diameter shall not exceed 5 percent. The insulation shall show no evidence of coming through the outer cover. The test specimen shall then withstand the test specified in 4.6.4.3.3 without electrical breakdown.

3.3.4.7 High temperature endurance.- Following the test specified in 4.6.4.7, the test specimen shall withstand the tests specified in 4.6.4.4, 4.6.4.5, and 4.6.4.3.3 without electrical breakdown or flashover. Discoloration of the silver surface shall not be cause for rejection.

3.3.4.8 Flammability.- The wire shall withstand the test specified in 4.6.4.8.2 without electrical breakdown. The wire shall withstand the test specified in 4.6.4.8.3, during which the flame rate of travel along the wire shall not exceed 3 inches per minute, and the wire shall be self-extinguishing within 30 seconds after removal of the flame. Burning particles or drippings shall not cause the tissue paper to burst into flames. Charred holes or spots in the tissue paper shall not constitute failure.

3.3.4.9 Abrasion resistance.- All wire shall meet the minimum requirements specified in the applicable MS standard, when tested in accordance with 4.6.4.9. Following immersion in the fluid specified in 4.6.4.6, the wire shall have not less than 70 percent of the abrasion resistance specified in the applicable MS standard.

3.3.4.10 Humidity resistance.- When tested in accordance with 4.6.4.10, sizes 22 through 12 of the finished wire shall have a humidity resistance as specified in the applicable MS.

3.3.4.11 Insulation resistance.- When tested as specified in 4.6.4.11, sizes 22 through 12 of the finished wire shall have an insulation resistance as specified on the applicable MS.

3.3.4.12 Surface resistance.- When tested as specified in 4.6.4.12, sizes 22 through 12 of the finished wire shall have a computed resistance as specified on the applicable MS. Following the application of a potential of 2,500 volts rms, 60 Hertz, there shall be no evidence of distress, such as arcing, smoking, burning, flashover or dielectric failures.

3.3.4.13 Smoke.- When tested in accordance with 4.6.4.13, the finished wire shall not give off visible smoke.

3.3.4.14 Thermal shock resistance.- When tested in accordance with 4.6.4.15, the wire insulation layer, or layers, shall not exhibit shrinkage or expansion greater than 0.06 inch. Flaring (separation of adjacent layers) shall also constitute failure.

3.3.4.15 Stripping.- The insulation of the finished wire shall be readily removable by wire-stripping devices.

3.4 Identification of product.- Unless otherwise specified, the finished wire shall be identified by a printed marking applied to the outer surface or visible through the outer surface. The printed identification shall consist of the following, at intervals of 9 inches to 60 inches:

MS or specification sheet part number
Manufacturer's code designation in accordance with
Publications H4-1 and H4-2

The printing shall be green in color in accordance with MIL-STD-104, class 1, except that when the wire is solid green, the printing shall be of any other class 1 color of MIL-STD-104, black and white excluded. Identification printing shall be applied with the vertical axes of the printed characters lengthwise of the wire when the nominal diameter of the finished wire is 0.050 inch or smaller. The vertical axes of the printed characters may be either crosswise or lengthwise of the wire when the nominal diameter of the wire exceeds 0.050 inch.

3.4.1 Durability of identification.- Identification printing, when applied to the outer surface of the finished wire, shall be capable of withstanding the durability test specified in 4.6.4.16 for the number of cycles, and with the total applied weight specified in the applicable MS or specification sheet. When no weight or number of cycles is thus specified, wires with extruded outer covering shall be subjected to 125 cycles (250 strokes) with 500 grams total weight; wires with braided outer covering shall be subjected to 50 cycles (100 strokes) with 250 grams total weight. This test shall not be required, when the identification marking is under a clear jacket.

3.5 Workmanship.- The wire shall be constructed and finished in accordance with high-grade cable production techniques. It shall be free from lumps, kinks, splits, abrasions, scrapes, corroded surfaces, and skin impurities.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection.- Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspection.- The inspection of the wire shall be classified as follows:

(a) Qualification inspection (4.3).
(b) Quality conformance inspection (4.4).
(c) Process control inspections (4.5).

4.3 Qualification inspection.-

4.3.1 Sampling.- Qualification inspection samples shall consist of 150 feet each of wire sizes 20 and 14, and 100 feet each of wire sizes 8 and 0. Two feet of each size coated strands used in the manufacture of the wire samples shall be submitted with the wire qualification inspection samples. When approved, wire size 20 will qualify wire sizes 22, 20, and 18; wire size 14 will qualify wire sizes 16, 14, and 12; wire size 8 will qualify wire sizes 10, 8, and 6; and wire size 0 will qualify wire sizes 4 through 00.

4.3.1.1 Samples and the manufacturer's test report shall be forwarded to the testing laboratory designated in the letter of authorization for qualification inspection. Samples shall be plainly identified by securely attached durable tags marked with the following information:

Samples for qualification inspection
WIRE, ELECTRICAL, SILICONE-INSULATED COPPER, 600-VOLT, 200° C
MS Part No.
Name of manufacturer
Manufacturer's identification (catalog number, brand, code, etc.)
Comprehensive description and prime manufacturer's name and formulation number of the base materials from which the product is made. (This information will not be divulged by the Government.)
Stranding
Primary insulation
Braid
Outside protective coating
Additional information not covered by the above
Sizes conforming to the above construction

4.3.2 Inspection.- Qualification inspection of wire shall consist of all the tests of this specification as specified in 4.6.

4.4 Quality conformance inspection.-

4.4.1 Definitions.- For definitions of quality conformance inspection terms used herein MIL-STD-109 shall apply. For the purpose of this specification, the following definitions shall also apply.

4.4.1.1 Inspection lot.- An inspection lot shall consist of all wire of each size offered for inspection at one time, except that the inspection lot shall not exceed 1,000,000 feet, or 1 week's production, whichever is less. The inspection lot shall be expressed in units of thousands of feet (total footage in inspection lot divided by 1,000).

4.4.1.1.1 Sample.- A sample shall be defined as a group of individual lengths of wire chosen at random from any one inspection lot for the purpose of inspection. The sample size or number of lengths to be chosed from each inspection lot is determined by the sampling plan.

4.4.1.2 Sample unit.- A sample unit shall be defined as one of the individual lengths of the sample. Each sample unit shall be of sufficient length to permit the performance of all applicable inspections.

4.4.1.3 Specimen.- A specimen shall be defined as a piece of one sample unit upon which a particular inspection is to be made.

4.4.2 Inspection.- Quality conformance inspection shall consist of the examinations and tests of table II and as specified in 4.6.

TABLE II. Examination and testing

Examination or test	Requirement paragraph	Test paragraph
Group I tests:		
Stranding	3.2.1 and 3.3.1	4.6.1
Wire outer surface	3.3.3.3	4.6.1
Wire diameter	3.3.3.1	4.6.1
Conductor diameter	Table I	4.6.1
Finished wire weight	3.3.3.2	4.6.4.14
Identification of product	3.4	4.6.1
Elongation (copper conductor)	3.3.1.4	4.6.2.3
Concentricity	3.3.2.1	4.6.3.1
Group II tests:		
Physical properties (primary insulation)	3.3.2.2	4.6.3.2.1
Aging (except oxidation)	3.3.2.2.1	4.6.3.2.2
Cold bend	3.3.4.4	4.6.4.4
Oil absorption	3.3.4.5	4.6.4.5
Abrasion (procedure I only)	3.3.4.9	4.6.4.9.1
Flammability (procedure II only)	3.3.4.8	4.6.4.8.3
Smoke	3.3.4.13	4.6.4.13
Thermal shock resistance	3.3.4.14	4.6.4.15

4.4.3 Sampling.- For each group of tests, a random sample of the size specified shall first be selected from an inspection lot. Then, from each sample unit, specimens of sufficient length shall be selected for the specified tests.

4.4.3.1 Group I inspection.- Sampling inspection for group I tests shall be in accordance with MIL-STD-105, inspection level S-4, Acceptable Quality Level (AQL) of 6.5 percent.

4.4.3.2 Group II inspection.- Sampling inspection for group II tests shall be in accordance with MIL-STD-105, inspection level S-4, AQL 0.65.

4.4.4 Resubmitted inspection lots.- The paragraph titled "Resubmitted lots" of MIL-STD-105 shall apply, except that a resubmitted inspection lot shall be inspected by the contractor, using tightened inspection. Before resubmitting, full particulars concerning the cause of previous rejection and the action taken to correct the defects found in the inspection lot shall be furnished by the contractor to the procuring activity.

4.5 Process control inspections.- These inspections are of such a nature that either they cannot be performed on the finished wire or do not lend themselves to statistical plans because the total length of the wire is exposed to the inspection. Therefore, these inspections must be performed during the most appropriate stage of the manufacturing operations. The process control inspections shall consist of the inspections listed in table III.

TABLE III. Process control inspections

Examination or test	Requirement paragraph	Test paragraph
Coating continuity	3.3.1.1	4.6.2.1
Conductor material	3.3.1.2	4.6.2
Splices	3.3.1.3	4.6.1
Insulation flaws:		
Primary	3.3.2.3	4.6.3.3
Finished	3.3.4.2	4.6.4.2

4.5.1 Sampling.-

4.5.1.1 Conductor material.- From each week's production of individual strands or from every 1,000 pounds of finished strand, whichever is less, three 10-foot lengths of strand shall be selected in such a manner as to be representative of the material to be used in the finished insulated wire.

4.5.1.2 Splices.- The manufacturer's method of splicing individual strands and members shall be observed at random intervals not exceeding 1 week.

4.5.1.3 Coating.- The sample shall consist of not less than 3-1/2 feet of silver-coated strand, before stranding, which is representative of the strand used in the manufacture of each inspection lot of finished wire. (See 4.4.1.1.)

4.5.2 Rejection and retest.- When the sample selected from a production run fails to meet the specified test, no items still on hand or later produced shall be accepted until the extent and cause of the failure has been determined. After investigation, the contractor shall advise the procuring activity of the action taken and, after corrections have been made, shall repeat all the process control tests. Rejection after corrective action will require that the contractor advise the procuring activity of the details surrounding the retest and cause for rejection.

4.6 Test methods.-

4.6.1 Examination of product.- All samples of wire shall be carefully examined for conformance to those requirements of this specification, which are not covered by tests.

4.6.2 Conductor.-

4.6.2.1 Continuity of coating.- The continuity of coating test for the individual silver-coated strands of the conductor shall be performed in accordance with ASTM B298-64.

4.6.2.2 Thickness of coating.- The thickness of coating test for the individual silver-coated strands of the conductor shall be performed in accordance with ASTM B298-64.

4.6.2.3 Conductors, elongation.- Elongation tests on the copper strand removed from the finished wire shall be performed in accordance with Fed. Test Method Std. No. 228.

4.6.3 Primary insulation.-

4.6.3.1 Concentricity.- The concentricity of the primary insulation shall be determined in accordance with 4.6.3.1.1 and 4.6.3.1.2. All wall thickness measurements shall be determined under suitable magnification.

4.6.3.1.1 Primary insulation (wire sizes 22 through 12).- The concentricity of the primary insulation of wire sizes 22 through 12 shall be determined by first locating and recording the minimum wall thickness of a cross section of the primary insulation. The maximum wall thickness of this same cross section shall be measured and recorded. A wall thickness measurement shall be interpreted to be the minimum distance between the outer rim of the outermost strand of the conductor and the outer rim of the primary insulation. Percent concentricity is defined as 100 times the ratio of the minimum wall thickness to the maximum wall thickness.

4.6.3.1.2 Primary insulation (wire sizes 10 through 00).- The concentricity of the primary insulation shall be determined, on a cross section of the insulation removed from the finished wire, by first locating and recording the minimum wall thickness of the primary insulation. From this point, on the outer rim of the primary insulation at which the minimum wall thickness was measured, three more reference points 90 degrees apart on the outer rim of the primary insulation shall be established. At each of these three reference points, the nearest member of a rope-lay conductor shall be selected and the insulation wall thickness between that member of the rope-lay conductor and the outer rim of the primary insulation shall be measured. The average of the four readings shall be considered to be the average wall thickness. A wall thickness measurement shall be interpreted to be the minimum distance between the outer rim of the primary insulation and the rim of the outermost strand of the stranded member of the rope-lay conductor. Percent concentricity is defined as 100 times the ratio of the minimum wall thickness to the average wall thickness.

4.6.3.2 Physical properties of extruded primary insulation.-

4.6.3.2.1 Tensile strength and elongation.- Physical properties tests of the primary insulation shall be made on samples removed from the finished wire, and as specified in Fed. Test Method Std. No. 228.

4.6.3.2.2 Aging.-

4.6.3.2.2.1 Air oven (quality conformance test).- Specimens of the primary insulation removed from a finished wire shall be suspended in a gravity-convection type air oven at a temperature of 232° ±5° C for 6 hours. Following this procedure, the tensile strength and elongation of the specimens shall be measured within 16 to 48 hours after removal from the air oven and as specified in Fed. Test Method Std. No. 228.

4.6.3.2.2.2 Air oven (qualification test).- The test specified in 4.6.3.2.2.1 shall be performed as specified, except that the temperature shall be 200° ±5° C and the exposure time 200 hours.

4.6.3.2.2.3 Oxidation (qualification test).- Specimens similar to those employed in the tensile strength and elongation test specified in 4.6.3.2.1 shall be placed in an oxygen bomb (Bierer-Davis, or equivalent) and subjected to an oxygen pressure of 300 psi and a temperature of 80° ±3° C for 7 days. Following this test, the tensile strength and elongation of the specimens shall be measured within 16 to 48 hours after removal from the oxygen bomb, and as specified in Fed. Test Method Std. No. 228.

4.6.3.3 Extruded primary insulation flaws.- After application of the extruded silicone insulation, and prior to the application of any other material, the wire shall be passed through a chain-electrode spark-test device, without breakdown, using the voltage specified in the applicable MS standard for extruded insulation. The electrode shall be of a suitable bead chain of fine mesh construction that will give intimate metallic contact with practically all the wire insulation surface. Electrode length and speed of wire movement shall be such that the insulation is subjected to the test voltage for not less than 0.2 second.

4.6.4 Finished wire.-

4.6.4.1 Conductor resistance.- The dc resistance measurement made on the conductor shall be in accordance with Fed. Test Method Std. No. 228.

4.6.4.2 Finished wire flaws.- The finished wire shall be passed through a suitable chain-electrode spark-test device, without breakdown, using the voltage specified in the applicable MS standard for finished wire. The electrode shall be a suitable bead chain of fine mesh construction that will give intimate metallic contact with practically all the wire insulation surface. Electrode length and speed of wire movement shall be such that the insulation is subjected to the test voltage for a minimum of 0.2 second.

4.6.4.3 Life cycle.-

4.6.4.3.1 Air oven.- One inch of the insulation shall be removed from each end of a 24-inch sample of the finished wire. The central portion of the specimen shall then be bent at least halfway around a cylindrical mandrel having a diameter as specified in the applicable MS standard. Each end of the conductor shall be

loaded in such a manner that the portion of the compound between the conductor and mandrel is under compression while the conductor is under the tension specified in the applicable MS standard. The condition shall be maintained for 120 hours in air maintained at 215° ±5° C. Following the air oven test, the specimen shall be cooled to 25° ±3° C within 1 hour. Following this cooling, the wire shall be freed from tension, removed from the mandrel, and straightened. The specimen shall then be subjected successively to the tests of 4.6.4.3.2, 4.6.4.3.3, and 4.6.4.3.4.

4.6.4.3.2 Bend.- In a temperature of 23° ±3° C, the specimen shall be secured to the mandrel and the other end to the load weight as specified in the applicable MS standard. The mandrel shall be rotated until the length of the specimen is wrapped around the mandrel under the specified tension and with its adjoining coils in contact. The mandrel shall then be rotated in reverse direction until the length of the cable 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 wire.

4.6.4.3.3 Dielectric.- The end of the specimen shall be fastened in metallic contact to a metal bar. The distance between the two uninsulated ends of the wire shall be not greater than the diameter of the mandrel specified in the applicable MS standard. The specimen shall be immersed in a solution consisting of 95 parts water to 5 parts sodium chloride at a temperature of 23° ±3° C so that the insulation protrudes 1-1/2 inches from the surface of the liquid. After submersion for 5 hours, 1,500 volts rms at 60 Herts frequency shall be applied between the conductor and an electrode in contact with the liquid. This voltage shall be increased at a uniform rate from 0 to 1,500 volts within 1/2 minute and maintained at 1,500 volts for 5 minutes.

4.6.4.3.4 Pitting.- The insulation of the specimen shall be removed and the conductor examined for pitting.

4.6.4.4 Cold bend.- One end of a previously untested specimen of suitable length shall be secured to the mandrel as specified in the applicable MS standard and the other end to the load weight specified in the applicable MS standard. The wire and mandrel assembly shall be lowered to -55° ±3° C at a rate not to exceed 50° C per minute. After maintaining this temperature for 4 hours, and while still at this low temperature, the cable shall be wrapped around the mandrel for 180 degrees without opening the cold chamber. A revolving mandrel inside the cold chamber and operated by a control external to the chamber shall be used. The time required for bending the sample around 180 degrees of the mandrel shall be 30 seconds and the bending shall be performed at a uniform rate of speed. The specimen shall then be examined for cracks. (See 3.3.4.4.) The insulation shall be removed for a distance of 1 inch from each end of the specimen and the specimen subjected to the test specified in 4.6.4.3.3 with the bent portion submerged.

4.6.4.5 Oil absorption.- A specimen of untested wire not less than 24 inches long shall be immersed to within 1-1/2 inches from each end in a liquid containing equal parts of kerosene and aircraft-engine lubricating oil, and at a temperature of 50° ±5° C, for 20 hours. The specimen shall then be examined for increase in diameter, after which it shall be successively subjected to the tests specified in 4.6.4.3.2 and 4.6.4.3.3.

4.6.4.6 Immersion.- Separate specimens of wire not less than 24 inches long shall be immersed to within 6 inches of each end in each of the fluids listed in table IV for a period of 20 hours at normal room temperature.

TABLE IV. Immersion tests

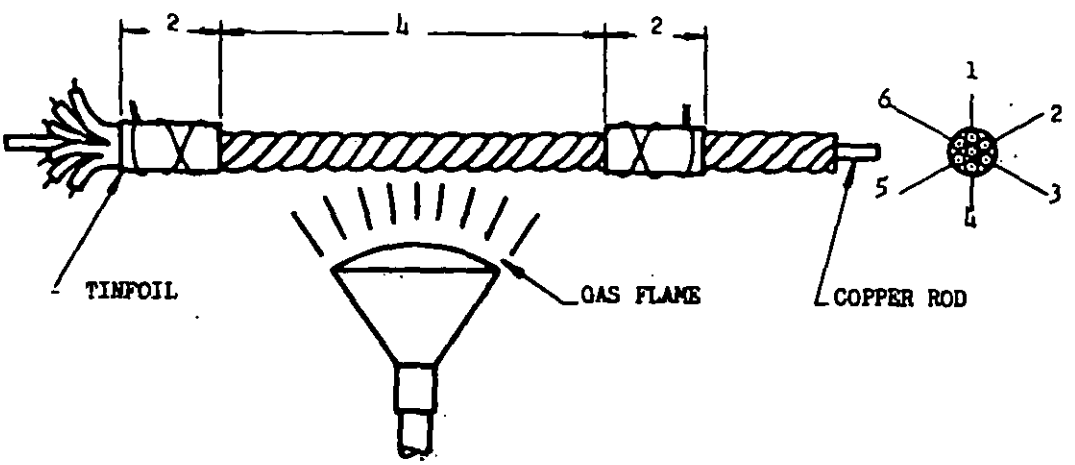
Fluid	Specification
Lubricating oil	MIL-L-7808
Hydraulic fluid (petroleum base)	MIL-H-5606
Hydraulic fluid (nonpetroleum base)	MIL-H-8446
Jet fuel (grade JP-4)	MIL-T-5624
Isopropyl alcohol	TT-I-735

Upon removal from the fluid, the specimen shall remain for 1 hour in free air at normal room temperature. The insulation shall be removed for a distance of 1 inch from each end of the specimen and the specimen subjected to the test specified in 4.6.4.3.3. During immersion tests, the bend of the wire shall be not less than 14 times the maximum specified diameter of that particular size wire.

4.6.4.7 High temperature endurance.- The wire shall be subjected to the current loading specified for single cables in free air as specified in the table titled "Current-carrying capacity of wires and cables" of MIL-W-5088, except that the ambient temperature shall be 150° ±5° C for 200 hours. Separate samples of the wire shall then be tested in accordance with and shall meet the requirements of the tests specified in 4.6.4.3.3, 4.6.4.4, and 4.6.4.5.

4.6.4.8 Flammability.-

4.6.4.8.1 Apparatus.- A Bunsen burner having a 1/4-inch inlet, a nominal bore of 3/8 inch, and a stem or burner length of approximately 4 inches above the air inlets shall be used for the tests. The Bunsen burner shall be of the type having a needle valve for gas adjustment built into the bottom of the burner. A wing-top flame spreader having a 1/16- by 2-inch opening shall be fitted on the top of the burner. The air inlet valve and the gas needle valve shall be adjusted so that a 2-inch-high all-blue flame is obtained having a temperature of 870° ±30° C at the top. It is optional to use a 2-inch-high flame having an inner cone one-third its height, provided the tip of the inner cone shall have the specified temperature. The shape of the 2-inch flame spreader and the flame shall be as illustrated in figure 1.



DIMENSIONS IN INCHES.

FIGURE 1. Flammability test, procedure I

4.6.4.8.2 Flammability test - procedure I.- Six specimens of wire, each of the same size and approximately 15 inches in length, shall be wound around a solid copper core of a diameter approximately equal to that of an individual specimen. Tinfoil strips, 2 inches wide, shall be wrapped around each end of the assembly in such a manner that the center 4-inch portion of the assembly is exposed (see figure 1). The assembly shall be held or suspended in a horizontal position within an enclosure which allows a flow of sufficient air for combustion but is free from drafts. The top of the 2-inch all-blue flame or the top of the inner cone of the optional flame shall be applied directly under the center of the exposed 4-inch center section of the assembly for a period of 5 minutes. The stem of the burner shall be in a vertical position and the flame-spreader opening shall be parallel to the assembly. The position of the apparatus in relation to the assembly shall be in accordance with figure 1. After removal of the flame, the assembly shall be cooled to room temperature and shall then withstand, without breakdown, the following dielectric tests:

(a) A potential of 800 volts rms, 60 Hertz., applied for 5 minutes between the conductors of the wire specimens, electrically connected together, and the metal rod (the tinfoil strips common with the rod).

(b) A potential of 800 volts rms, 60 Hertz., applied for 5 minutes between conductors of alternate wire specimens. Conductors 1, 3, and 5 shall form one electrode and conductors 2, 4, and 6 shall form the other (see figure 1).

(c) The specimen assembly shall be placed on a metal plate that is in intimate contact with and supports the 4-inch center-burned section. A potential of 800 volts rms, 60 Hertz., shall be applied for 5 minutes between the conductors of the wire specimens, electrically connected together, and the metal plate.

4.6.4.8.3 Flammability test - procedure II.- A specimen of completed wire of sufficient length shall be suspended taut in a horizontal position within an enclosure which allows a flow of sufficient air for combustion but is free from drafts. The tension applied to the specimen shall be sufficient to prevent sagging of the specimen during application of the flame. A piece of facial tissue paper, as specified in UU-T-450, shall be suspended taut and horizontal 9-1/2 inches directly below the cable and at least 1/2 inch away from the table top. Melted or dripping material from the wire specimen shall fall on the tissue paper. The top of the 2-inch flame or the top of the inner cone of the optional flame is applied directly under the center section of the specimen for a period of 15 seconds for wire sizes 22 through 10 and 30 seconds for wires size 8 and larger. The stem of the burner shall be in a vertical position and the flame-spreader opening shall be parallel to the wire specimen. The position of apparatus in relation to the specimen shall be in accordance with figure 1. Before removal of the gas flame from the specimen and at the end of the ignition period, a marking wire or indicator shall be placed approximately 1/2 inch away

from the wire, locating on the burning specimen the outer edge of burning at each side of the flame. The rate of flame travel and self-extinguishing time shall be measured from both indicating points. During the entire flame test, the Bunsen burner supporting rack shall remain stationary.

4.6.4.9 Abrasion.-

4.6.4.9.1 Abrasion - procedure I.- This test shall be performed on an abrasion testing machine conforming to MIL-T-5438. One inch of the insulation shall be removed from one end of a 36-inch sample of the finished wire. The specimen shall be placed in the test machine and subjected to the tension load specified in the applicable MS standard. Using the weight support bracket and weight specified in the applicable MS standard, the sample shall then be subjected to the abrasion test. After each reading, the specimen shall be moved forward 2 inches and rotated clockwise 90 degrees. Eight readings shall be obtained for each sample. An average shall be obtained by calculating the arithmetic mean of all those readings for that wire which is individually less than the arithmetic mean of all the eight readings per wire. This average shall define the abrasion resistance of the wire under test.

4.6.4.9.2 Abrasion - procedure II.- Previously untested specimens of wire, each 36 inches long, shall be immersed in fluids in accordance with the procedure specified in 4.6.4.6. After removal from the fluids, the specimens shall be air-dried at 25° ±4° C for 24 hours and shall then be subjected to procedure I, 4.6.4.9.1.

4.6.4.10 Humidity resistance.- A 52-foot sample of wire shall be subjected to the test specified in 4.6.4.10.2 for not less than 14 days, following which the wire shall be subjected to the test specified in 4.6.4.10.3.

4.6.4.10.1 Apparatus.- The apparatus shall consist of a test chamber capable of maintaining an internal temperature of 71° ±2° C and an internal relative humidity of 95 ±5 percent. The test chamber shall be capable of being sealed in order to retain the total moisture content in the test space. The heat loss from the chamber shall be sufficient to reduce the internal temperature from the preceding operating temperature to not greater than 38° C within 16 hours from the time of removal of the source of heat. Distilled or demineralized water shall be used to obtain the required humidity.

4.6.4.10.2 Procedure.- The specimen shall be placed in the test chamber and the temperature and relative humidity raised to the specified values and maintained for 6 hours. At the end of the 6-hour period, the heat shall be shut off. During the following 16-hour period, the temperature shall be reduced to not greater than 38° C. At the end of the 16-hour period, heat shall again be supplied for an additional 2-hour period and the temperature stabilized to 71° ±2° C. This cycle shall be repeated a sufficient number of times to extend the total time of the test to 360 hours (15 cycles).

4.6.4.10.3 Insulation resistance measurements.- Insulation resistance measurements shall be made with the external surface of the wire grounded and the conductor remaining at elevated potential. The insulation resistance shall be determined after a 1-minute electrification with a direct-current potential of 250 to 500 volts. Where the wire is shielded, connections shall be made to the shielding and the conductor. Unshielded wires shall be submerged in a 5 percent solution of sodium chloride and water. The insulation resistance measurements test shall be conducted at 22° ±3° C.

4.6.4.11 Insulation resistance.- A 52-foot specimen with its center 50-foot section shielded in accordance with MIL-C-7078, but with not less than 95 percent coverage, shall be coiled and suspended in a gravity-convection type air oven adjusted to 200° ±5° C and held for 100 hours. At the end of this period and while at this temperature, the insulation resistance shall be measured between the conductor and the shield.

4.6.4.12 Surface resistance.- Specimens shall consist of 6-inch lengths of finished wire and provided with two 1/4-inch ring-type metal foil electrodes, or for small wires, several turns of fine tin-coated copper wire, spaced 1.0 inch apart between the nearest edges near the center of the specimen length, wrapped snugly around axis of the specimen and bound with the takeoff leads for electrical testing of the surface between the electrodes. After conditioning these specimens for 96 hours at a relative humidity of 95 ±5 percent and a temperature of 25° ±5° C, the resistance between the electrodes shall be measured using a dc potential of 200 to 500 volts while the specimens are still within the conditioning chamber and after a 1-minute electrification. The surface resistance shall be computed by multiplying the measured resistance value by the measured overall diameter of the specimen in inches. Following the initial resistance measurement, the potential specified in the applicable MS standard shall be applied between the electrodes for 1 minute. After a discharge interval of 15 to 20 minutes following the potential test, the surface resistance shall be remeasured and computed.

4.6.4.13 Smoke.- This test shall be performed in still air at a normal room temperature. A specimen of the wire approximately 15 feet long shall be so suspended that a section no less than 10 feet long is horizontal and unsupported. One end of the wire shall be suitably weighted in order that no sagging will occur throughout the test. An electric current shall be applied to the wire, and the voltage drop measured over the 10-foot portion. From the current and voltage values, the resistance of the cable shall be calculated. The temperature of the cable conductor shall be determined from the change in resistance. The current shall be so adjusted that the conductor temperature stabilizes at 210° ±5° C. This conductor temperature shall be maintained for 15 minutes. A flat-black background shall be used.

4.6.4.15 Wire weight.- The weight of each lot of finished wire shall be determined by procedure I of 4.6.4.14.1. Lots failing to meet the wire weight requirements of 3.3.3.2 when tested in accordance with procedure I shall then be

submitted to procedure II of 4.6.4.14.2, and all reels or spools failing to meet the weight requirement of 3.3.3.2 shall be finally rejected. Group I sampling shall not apply to procedure II.

4.6.4.14.1 Wire weight - procedure I.- The length and weight of a specimen at least 10 feet long shall be accurately measured with the resultant measurement transposed to pounds per 1,000 feet.

4.6.4.14.2 Wire weight - procedure II.- The net weight of the finished wire on each reel or spool shall be obtained by subtracting the tare weight of the reel or spool from the gross weight of the reel or spool containing the finished wire. The net weight of wire on each reel or spool shall be divided by the accurately determined length of finished wire on that reel or spool and the resultant transposed to pounds per 1,000 feet. When wood or other moisture-absorbent materials are used for reel or spool construction, weight determinations shall be made under substantially the same conditions of relative humidity.

4.6.4.15 Thermal shock resistance.-

4.6.4.15.1 Preparation of specimen.- A specimen of wire, 5 feet long, shall be prepared by carefully removing 1 inch of insulation from each end of the wire. (For purposes of this test, insulation is defined as all layers of nonconducting material covering the electrical conductor, e.g., primary insulation, all tapes and braids, and the jacket.) A razor blade or equivalent, held perpendicular to the axis of the wire, shall be used to cut the insulation for the removal operation. The length of exposed conductor at each end of the specimen shall be measured to the nearest 0.01 inch. The specimen shall be formed into a loose coil not less than 1 foot in diameter and shall be laid on a wire screen for handling throughout the test.

4.6.4.15.2 Test procedure.- The specimen shall be placed for 30 minutes in a preheated air-circulating oven at the temperature specified in the applicable MS or specification sheet, or at the rated temperature of the wire if no oven temperature for the test is specified in the applicable MS or specification sheet. It shall then be removed from the oven and, within 2 minutes, placed in a chamber which has been precooled to -55° ±2° C (-67° ±4° F). The specimen shall be exposed to this temperature for 30 minutes, after which it shall be removed and allowed a minimum of 30 minutes to return to room temperature, 20° to 25° C (68° to 77° F). At the conclusion of this cycle, the distance from the end of each layer of insulation to the end of the conductor shall be measured to the nearest 0.01 inch. This thermal shock cycle and the measurements shall be repeated for an additional three cycles (a total of four cycles). Any measurement varying from the original measurement by more than the amount specified in the applicable MS or specification sheet, or by more than 0.06 inch, if no amount is specified, shall constitute failure. Any flaring of any layer shall also constitute failure.

4.6.4.16 Durability of color markings.- The durability of product identification or color strippings applied to the wire for coding shall be evaluated at 20° C to 25° C (68° F to 77° F) as follows:

4.6.4.16.1 Durability testing apparatus.- The markings durability tester shall be designed to hold a short specimen of finished wire firmly clamped in a horizontal position with the upper longitudinal surface of the specimen fully exposed. The instrument shall be capable of rubbing a small cylindrical steel mandrel (usually a needle), 0.025 inch in diameter, repeatedly over the upper surface of the wire, in such position that the longitudinal axes of the mandrel and the specimen are at right angles to each other with cylindrical surfaces in contact. A weight affixed to a jig above the rubbing mandrel shall control the thrust exerted normal to the surface of the insulation. A motor-driven, reciprocating cam mechanism and counter shall be used to deliver an accurate number of abrading strokes in a direction parallel to the axis of the specimen. The length of the stroke shall be 3/8 inch and the frequency of the stroke shall be 120 strokes (60 stroking cycles) per minute.

4.6.4.16.2 Durability testing procedure.- In performing the test, a specimen of wire shall be mounted in the specimen clamp and the applicable total weight shall be applied through the rubbing mandrel to the marked surface. The counter shall be set at zero and the drive motor started. The specimen shall be observed throughout the progress of the test and, as soon as a continuous line of the printed marking is removed under the mandrel, the number of cycles shall be recorded. Three specimens from each sample unit shall be tested and the results from the three specimens shall be averaged.

4.7 Packaging, packing, and marking.- Preparation for delivery shall be examined for conformance to section 5.

5. PREPARATION FOR DELIVERY

5.1 Packaging.-

5.1.1 Unless otherwise specified, wire shall be packaged in accordance with MIL-C-12000, level A or C, as applicable.

5.1.2 Wire shall be delivered wound on reels or spools, each having an appropriate diameter for the respective size. In no case shall the barrel of the reel or spool be less than 5-1/2 inches in diameter. Unless otherwise specified in the order, the wire lengths shall conform to table V.

TABLE V. Wire lengths

Wire sizes	Nominal length on reel or spool (feet)	Minimum acceptable length (feet)
22 to 6, incl.	500	100
4 to 2, incl.	250	50
1 to 0000, incl.	100	25

5.1.3 Not less than 85 percent of the total quantity of each size of wire ordered shall be in lengths equal to or greater than the nominal length given in table V. No cable will be accepted in lengths shorter than the given minimum acceptable length. The maximum quantity of wire in a single length shall be limited only by manufacturing and handling facilities. Special lengths, when required, shall be indicated by the purchaser in the bid invitation. (See 6.2.)

5.2 Packing.- Unless otherwise specified, packing shall be in accordance with MIL-C-12000, level A or C, as applicable.

5.3 Marking of shipments.- Each reel, spool, and container shall be marked in accordance with MIL-STD-129, and shall also include the MS part number. Marking shall be on metal tags or plates when practical.

6. NOTES

6.1 Intended use.- The electric wire covered by this specification is intended for installation on aircraft and missile electrical systems where the potential does not exceed 600 volts rms. For applications at altitudes above 60,000 feet, the voltage ratings for the respective wire should be reviewed for each specific application.

6.2 Ordering data.- Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) MS Part No. of the wire desired.
(c) Level of packaging and packing desired (see 5.1 and 5.2).
(d) Special lengths (see 5.1.3).

6.3 Qualification.- With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio 45433, and information pertaining to qualification of products may be obtained from that activity.

6.4 International standardization agreement.- Certain provisions (1.1 and table I) of this specification are the subject of international standardization agreement ASCC 12/5 and STANAG 3317. When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

Custodians:
Navy - AS
Air Force - 11

Reviewer activities:
Navy - AS
Air Force - 85

User activities:
Air Force - 14, 17

International interest (see 6.4)

Preparing activity:
Air Force - 11

Project No. 6145-F001

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.