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MILITARY SPECIFICATION

WIRE, ELECTRICAL, COPPER AND CONSTANTAN,
THERMOCOUPLE

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers copper and constantan thermocouple wire.

1.2 Classification. Copper and constantan thermocouple wire shall be of the following types and classes, as specified:

Type 1 Solid and stranded conductor
- Class A - Bare (solid conductor)
- Class B - Insulated (solid conductor)
- Class C - Insulated duplex (solid conductor)
- Class D - Insulated (stranded conductor)
- Class E - Insulated duplex (stranded conductor)
- Class F - Insulated duplex (stranded conductors, 120°C range)
- Class G - Insulated duplex (stranded conductors, 230°C range)

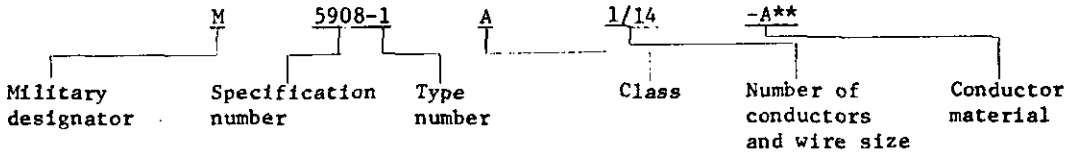
Type 2 Stranded conductor (7 ohms per 200 foot length)
- Class A - Insulated duplex (120°C range)
- Class B - Insulated duplex (230°C range)

Type 3 Stranded conductor (20 gage copper - 18 gage constantan)
- Class A - Insulated duplex (120°C range)
- Class B - Insulated duplex (230°C range)

Type 4 Stranded conductor (20 gage copper - 16 gage constantan)
- Class A - Insulated duplex (120°C range)
- Class B - Insulated duplex (230°C range)

Type 5 Stranded conductor (18 gage copper - 14 gage constantan)
- Class A - Insulated duplex (120°C range)
- Class B - Insulated duplex (230°C range)

1.2.1 Military part number. The military part number shall consist of the letter "M", the basic number of the specification, and an assigned dash number as shown below. Information to be inserted shall be derived from 1.2 and Table I.



**For single conductor wire the wire materials shall follow the wire size preceded by a dash. A = Copper B = Constantan

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 the specification to the extent specified herein.

SPECIFICATIONS

Federal

O-A-548	---Antifreeze, Ethylene Glycol, Inhibited
TT-I-735	---Isopropyl Alcohol
TT-S-735	---Standard Test Fluids; Hydrocarbon

Military

MIL-T-5438	---Tester; Abrasion, Electrical Cable
MIL-L-6082	---Lubricating Oil; Aircraft Reciprocating Engine (Piston)
MIL-C-12000	---Cable, Cord, and Wire, Electric Packaging of

STANDARDS

Military

MIL-STD-129	---Marking for Shipment and Storage
MIL-STD-130	---Identification Marking of U.S. Military Property
MIL-STD-143	---Specifications and Standards Order of Precedence For the Selection of
MIL-STD-687	---Wire, Thermocouple, Identification Marking and Color Code of
MIL-STD-810	---Environmental Test Methods
MIL-STD-831	---Test Reports, preparation of

(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.)

3. REQUIREMENTS

3.1 Preproduction. Unless otherwise specified, preproduction inspection is required and preproduction samples shall meet the requirements specified herein (see 6.2.1).

3.2 MATERIAL

3.2.1 Selection of specifications and standards. Specifications and standards for necessary commodities and services not specified shall be selected in accordance with MIL-STD-143.

3.3 Construction. The wire shall be constructed as follows:

TYPE 1 Class A - Bare solid copper of constantan conductor

TYPE 1 Classes B and D
First - Solid or stranded copper or constantan conductor
Second - Inner wrap (if required)
Third - Primary insulation
Fourth - Layer of braid, fibrous covering or other approved material (if required)
Fifth - Outer protective coating (if required)

TYPE 1 Classes C and E
First - Solid or stranded copper and constantan conductors
Second - Inner wrap (if required) (individual conductors)
Third - Primary insulation (individual conductors)
Fourth - Layer of braid, fibrous covering or other approved material (if required) (individual conductors)

Fifth - Copper and constantan insulated wire laid in parallel and covered with duplexing outer covering

Sixth - Outer protective coating (if required)

TYPE 1 Classes F and G

First - Stranded copper and constantan conductors of the same AWG

Second - Inner wrap (if required) (individual conductors)

Third - Primary insulation (individual conductors)

Fourth - Layer of braid, fibrous covering or other approved material, if required, (individual conductors)

Fifth - Copper and constantan insulated wire laid in parallel and covered with duplexing outer covering

Sixth - Outer protective coating (if required)

TYPE 2, 3, 4, and 5 Classes A and B

First - Stranded copper and constantan conductors

Second - Inner wrap (if required)(individual conductors)

Third - Primary insulation (individual conductors)

Fourth - Layer of braid, fibrous covering or other approved material (if required) (individual conductors)

Fifth - Copper and constantan insulated wire laid in parallel and covered with duplexing outer covering

Sixth - Outer protective coating (if required)

3.3.1 Conductors.

3.3.1.1 Metals. The conductors shall consist of copper or constantan as specified herein. The conductors shall be free from lumps, kinks, splits, abrasions, and scraped or corroded surfaces.

3.3.1.2 Stranding. Stranding may be bunched, concentric, or rope lay, and as specified in table I. The wire size of all strands shall be the same for any one conductor, except for type 2, classes A and B wire where the strand size may vary to facilitate resistance adjustment.

3.3.1.3 Electromotive force. The termperature-electromotive force relationship of the copper and constantan conductors formed together as a thermocouple shall conform to table II within the tolerances listed in table III. (See 4.6.3)

3.3.1.4 Splices. Splices in individual strands of a stranded conductor shall be of the butt type. Splices in strands that are composed of a group of individual strands shall be of the butt type. Butt-type splices shall be brazed with silver solder. Splices shall be so constructed and disposed throughout the conductor that the diameter, configuration, conductor resistance, flexibility, and mechanical strength of the completed conductor are not adversely affected.

3.3.1.5 Size. The area of the conductors for Type 1 shall be as specified in Table I. The area of the conductor shall not exceed 5 percent under or 5 percent over the nominal value specified in Table I.

3.3.1.6 Annealing temperature. Type 1 wire, except classes F and G, shall be annealed at a temperature of +816°C or higher.

3.3.1.7 Tinning. Each strand of copper wire for type 1, classes F and G, and types 2, 3, 4, and 5, classes A and B, wire shall be thoroughly and uniformly coated with commercially pure tin. Continuity of the coating shall be determined by subjecting samples to the tinning test specified herein (See 4.6.2).

3.3.2 Insulation. The wire insulation shall consist of a concentric layer or layers of suitable materials, capable of meeting the requirements specified herein. The insulation shall be readily removed with a conventional wire-stripping machine and shall have a uniform surface and diameter.

3.3.2.1 Inner wrap. The inner wrap, if used, shall consist of a suitable material which shall be braided, woven, or wrapped tightly about the stranded conductor and shall be capable of meeting the requirements specified herein. The material shall not cause corrosion of the conductor when subjected to the temperature requirements of this specification.

TABLE I. Details of Wire Construction

Type	Class	AWG	Nominal conductor diameter (inch)	Nominal conductor area (circular mils)	Maximum diameter of finished wire (inch)	Number of strands (min)	Weight lb. (max)
1	A	14	0.0641	4,107	...	...	...
		16	0.0508	2,583	...	...	...
		18	0.0403	1,624	...	...	...
		20	0.0320	1,021	...	...	...
1	B	14	0.0641	4,107	0.150	...	...
		16	0.0508	2,583	0.130	...	...
		18	0.0403	1,624	0.115	...	...
		20	0.0320	1,021	0.100	...	...
1	C (See Note 1)	14	0.0641	4,107	0.275	...	...
		16	0.0508	2,583	0.250	...	...
		18	0.0403	1,624	0.225	...	...
		20	0.0320	1,021	0.185	...	...
1	D	14	0.080	4,107	0.170	19	...
		16	0.063	2,583	0.150	19	...
		18	0.048	1.624	0.135	7	...
		20	0.039	1,021	0.120	7	...
1	E (See Note 1)	12	0.096	6,530	0.340	19	...
		14	0.080	4,107	0.300	19	...
		16	0.063	2,583	0.260	19	...
		18	0.048	1,624	0.230	7	...
		20	0.039	1,021	0.190	7	...
1	F and G (See Note 1)	12	0.096	6,530	0.355	19	...
		14	0.080	4,170	0.315	19	...
		16	0.063	2,583	0.275	19	...
		18	0.048	1,624	0.245	7	...
2	A and B (See Note 1)	10 (See Note 2)	Resistance per 200 feet of duplex wire = 7.00 ohms, +0.00, -0.80 ohms at +25°C		0.385	19	9.5/100ft
3	A and B (See Note 1)	Copp.20 Const.18	Copp. 0.039 Const. 0.048	... ...	0.225	Copp. 7 Const. 14	29/1,000ft
4	A and B (See Note 1)	Copp.20 Const.16	Copp. 0.039 Const. 0.063	... ...	0.250	Copp. 7 Const. 19	33/1,000ft
5	A and B (See Note 1)	Copp.18 Const.14	Copp. 0.048 Const. 0.080	... ...	0.280	Copp. 14 Const. 39	50/1,000ft

Abbreviations:
Copp. = Copper Const. = Constantan

Note 1. Type 1, Classes C, E, F, and G, and Types 2, 3, 4, and 5 are duplex (2 conductor) wire.

Note 2. Size shown is approximate to facilitate part numbering.

TABLE II. Corresponding values of temperature and electromotive force, reference junction temperature 0°C

Temperature °C	Temperature °F	Electromotive force - mv	Temperature °C	Temperature °F	Electromotive force - mv	Temperature °C	Temperature °F	Electromotive force - mv
-200	-328	-5.539	0	+32	0.000	+200	+392	+9.285
-190	-310	-5.378	+10	50	+0.389	210	410	9.820
-180	-292	-5.204	20	68	0.787	220	428	10.360
-170	-274	-5.016	30	86	1.194	230	446	10.905
-160	-256	-4.815	40	104	1.610	240	464	11.455
-150	-238	-4.602	50	122	2.034	250	482	12.010
-140	-220	-4.376	60	140	2.467	260	500	12.571
-130	-202	-4.137	70	158	2.908	270	518	13.136
-120	-184	-3.886	80	176	3.356	280	536	13.706
-110	-166	-3.623	90	194	3.812	290	554	14.280
-100	-148	-3.349	+100	212	4.276	300	572	14.859
- 90	-130	-3.063	110	230	4.747	310	590	15.443
- 80	-112	-2.765	120	248	5.225	320	608	16.030
- 70	- 94	-2.456	130	266	5.710	330	626	16.621
- 60	- 76	-2.137	140	284	6.202	340	644	17.216
- 50	- 58	-1.807	150	302	6.700	350	662	17.815
- 40	- 40	-1.466	160	320	7.205	360	680	18.418
- 30	- 22	-1.114	170	338	7.716	370	698	19.025
- 20	- 4	-0.752	180	356	8.233	380	716	19.635
- 10	+ 14	-0.381	190	374	8.756	390	734	20.248
						400	752	20.865

TABLE III. Electromotive force tolerances

Type	Class	Temperature range	Tolerance - mv
1	A,B,C,D, and E	-70°C (-94°F) to but not including +300°C (+572°F) +300°C (+572°F) to +400°C (+752°F)	±0.06 ±0.12
1	F	-70°C (-94°F) to +100°C (+212°F)	±0.12
1	G	-70°C (-94°F) to but not including +100°C (+212°F) +100°C (+212°F) to +230°C (+446°F)	±0.12 ±0.24
2,3,4, and 5	A	-70°C (-94°F) to +100°C (+212°F)	±0.12
2,3,4, and 5	B	-70°C (-94°F) to but not including +100°C (+212°F) +100°C (+212°F) to +230°C (+446°F)	±0.12 ±0.24

3.3.2.2 Primary insulation. Each conductor shall have a primary insulation consisting of a concentric layer of felted asbestos, asbestos braid or wrap, glass fibers, or a multiple layer wrap of a suitable synthetic resinous tape or other material capable of meeting the requirements specified herein. Where a fibrous primary insulation is used, the material shall be impregnated with a silicone resin or other suitable compound so applied that it will not enter the conductor strands and affect good electrical contact. The impregnating compound shall bond the insulation sufficiently to prevent fraying under normal conditions of installation.

3.3.2.3 Covering (individual conductors)

3.3.2.3.1 General. The covering, if used, shall consist of a braid, fibrous covering, or other approved material placed over the primary insulation. The covering shall be saturated with a nonhygroscopic and flame-retardant compound which will not affect the color of the braid to such an extent that the colors cannot be easily distinguished. The saturating compound shall bond the covering sufficiently to prevent fraying under normal conditions of installation.

3.3.2.3.2 Color. The covering of the conductors or the primary insulation where the covering is not used shall be color coded in accordance with MIL-STD-687 for Air Force Applications.

3.3.2.4 Duplexing outer covering.

3.3.2.4.1 General. Each duplex wire shall have the individual insulated conductors laid side by side and covered with a braid, fibrous covering, or other approved material.

3.3.2.4.2 Color. The duplexing outer covering of the wire shall be color coded in accordance with MIL-STD-687 for Air Force Applications.

3.3.2.5 Outer protective coating. The other surface of the wire shall be coated with a compound that is transparent, flexible, non-flammable or slow-burning, and not materially affected by oil, salt water, ethylene glycol, motor fuels, or alcohol. Adjacent layers of the wire wound on reels shall not stick to one another at any and all temperatures up to and including 70°C. The finished wire shall have an even smooth finish.

3.3.3 Finished wire.

3.3.3.1 Length.

3.3.3.1.1 Type 1, classes A, B, C, D, and E. The quantity of wire specified in the contract or purchase order shall be furnished in one continuous length, unless otherwise specified by the procuring activity. Classes A, B, and D copper and constantan wire comprising the lot on order shall be furnished by the same manufacturer and shall be furnished on separate coils or reels.

3.3.3.1.2 Type 1, classes F and G, types 2, 3, 4, and 5. The wire shall be furnished in coils or reels of continuous length of 500 to 1,000 feet, unless otherwise specified by the procuring activity.

3.3.3.1.3 Tolerance. The length of the wire supplied in each coil or reel shall not vary more than -5 to +10 percent of the value specified.

3.3.3.2 Color. All colors of finished wire shall be distinctive, reasonably permanent, and resistant to the solvents listed in section 4. If the colors can be distinguished they shall not be considered as faded.

3.3.3.3 Resistance. The resistance of finished Type 2, classes A and B, wire when calculated to two decimal places, shall be as specified in table I. (see 4.6.4).

3.3.3.4 Diameter. The diameter of this finished wire shall not exceed the dimensions given in Table I.

3.3.3.5 Weight. The weight of the finished wire shall not exceed the values given in table I.

3.4 Performance.

3.4.1 Dielectric strength. The wire shall be capable of withstanding a potential of 350v rms at a commercial frequency for 5 minutes without breakdown or flashover when tested as specified (see 4.6.5).

3.4.2 Insulation resistance. The insulation resistance of the finished wire shall be not less than 100 megohms for 1,000 feet at a temperature of 15.5°C when tested as specified (see 4.6.6).

3.4.3 Temperature aging. The wire shall be aged for a period of 96 hours as specified (see 4.6.7). After which the wire shall be subjected to the bend test (see 4.6.8) and then meet the requirements of 3.4.1 and 3.4.2.

3.4.4 Cold bend. The wire shall withstand a temperature of -55°C ±2°C without cracking of the insulation or of the outer protective coating when tested as specified (see 4.6.9). After which the wire shall meet the requirements of 3.4.1.

3.4.5 Heat resistance.

3.4.5.1 Type 1 class F and types 2, 3, 4, and 5 class A. Type 1 class F and types 2, 3, 4, and 5 class A wire shall withstand a temperature of 120° ±2°C without cracking of the insulation or outer protective coating when tested as specified (see 4.6.10.1). After which the wire shall meet the requirements of 3.4.1.

3.4.5.2 Type 1 class G and types 2, 3, 4, and 5 class B. Type 1 class G and types 2, 3, 4, and 5 class B wire shall withstand a temperature of 230° ±2°C without cracking of the insulation or outer protective coating when tested as specified (see 4.6.10.2). After which the wire shall meet the requirements of 3.4.1.

3.4.6 Flammability. When tested as specified (see 4.6.11) the rate of burning shall not exceed 1 inch per minute and during the test no burning or charred particles shall fall from the wire.

3.4.7 Solvent resistance. When tested as specified (4.6.12) there shall be no deterioration of the insulation or of the outer protective coating. After which the wire shall meet the requirements of 3.4.1 and 3.4.2.

3.4.8 Fungus resistance. The wire shall show no evidence of fungus growth when tested as specified (see 4.6.13). After which the wire shall meet the requirements of 3.4.1.

3.4.9 Abrasion resistance. The wire shall have abrasion resistance sufficient to withstand the test specified (see 4.6.14) without exposing the conductor.

3.5 IDENTIFICATION OF PRODUCT.

3.5.1 Nameplate. Each coil or reel shall be marked with a durable tag, securely attached to the wire, containing the information in accordance with MIL-STD-130. In addition, the following information shall be included.

Wire, Electrical, Copper, Thermocouple

or

Wire, Electrical, Constantan, Thermocouple

or

Wire, Electrical, Copper and Constantan, Thermocouple (as applicable)

Specification MIL-W-5908

Military Part Number

Type

Class

Length feet

Manufacturer's Lot No. (Type 1, Classes A, B, and D only)

3.6 Workmanship. The wire shall be constructed and finished in a thoroughly workmanlike manner. Particular attention shall be given to neatness and to freedom of parts from burrs and sharp edges.

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 (see 6.3).

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Preproduction inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified, all inspections shall be performed at room ambient with results corrected to +25°C.

4.4 Preproduction inspection. Unless otherwise specified in the contract or purchase order, preproduction inspection shall be performed by the supplier, after award of contract and prior to production, at a location acceptable to the Government. Preproduction inspection shall be performed on sample units which have been produced with equipment and procedures normally used in production. Preproduction approval is valid only on the contract or purchase order under which it is granted, unless extended by the Government to other contracts or purchase orders (see 6.2).

4.4.1 Sample size. Preproduction inspection sample(s) shall consist of 50 feet of each type and class of wire on contract or purchase order.

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in Table IV as described under 4.6 Methods of examination and test.

Table IV. Preproduction Inspection Routine

Tests	Types and classes	
	Type I Classes A B C D E F G	Types 2, 3, 4, and 5 Classes A B
General inspection	X X X X X X X	X X
Conductor tinning	X X	X X
Electromotive force	X X X X X X X	X X
Resistance (Type 2 wire only)		X X
Dielectric strength	X X X X X X X	X X
Insulation resistance	X X X X X X X	X X
Temperature aging	X X X X X X X	X X
Bend	X X X X X X X	X X
Cold bend	X X X X X X X	X X
Heat resistance (+120°C)	X	X
Heat resistance (+230°C)	X	X
Flammability	X X X X X X X	X X
Solvent resistance	X X X X X X X	X X
Fungus resistance	X X X X X X X	X X
Abrasion resistance	X X X X X X X	X X

X = Applicable test

4.4.3 Preproduction test report. A preproduction test report in accordance with MIL-STD-831 shall be submitted to the procuring activity with the preproduction inspection sample for approval after completion of testing. The contractor shall not begin production until the test report and samples are approved by the procuring activity (see 6.2).

4.5 Quality conformance inspection. Quality conformance inspection shall consist of:

a. Individual inspections (see 4.5.1).

b. Sampling plans and tests (see 4.5.2).

4.5.1 Individual inspection. The wire shall be subjected to the following inspections as described under 4.6 Methods of examination and test:

a. Examination of product

b. Conductor tinning

c. Electromotive force

d. Resistance (Type 2 wire)

e. Dielectric strength

f. Insulation resistance

4.5.2 Sampling plans and tests.

4.5.2.1 Sampling plan A. Unless otherwise specified by the procuring activity, for each 50,000 feet of wire for controlled inspected stocks on contract(s) or order(s), a total of 12 samples shall be selected at random from the shipping coils and reels. Not more than 3 samples shall be selected from any one coil or reel if 4 or more coils or reels are supplied. The number of samples for each test shall be as specified in the test methods. The samples shall be subjected to the tests listed below. Any number of contracts or orders may be supplied on the basis of the results of one series of sampling tests provided that all of the wire is of the same type and class, is part of a batch previously sampled, and is submitted for shipment within 24 months after the sampling tests are conducted. If identical insulation is used on a number of classes of wire that are manufactured and submitted for test at substantially the same time, the inspector shall so select the samples as to get at least 3 samples from each class of wire. Only one series of sampling tests is required for each 50,000 feet total of the various classes of wire.

a. Individual inspection

b. Temperature aging

c. Heat resistance

d. Flammability

e. Solvent resistance

4.5.2.2 Sampling plan B. Unless otherwise specified by the procuring activity, the following tests shall be conducted on 9 samples, 3 samples for each test selected at random from each 100,000 feet of wire submitted for acceptance. The samples may be taken from more than one contract or order provided that the total number of samples shall not exceed 9. The conditions specified in sampling plan A for samples from two or more contracts or orders and two or more classes of a given type shall apply. Shipments on orders or contracts for the wire from which the samples are taken shall not be delayed pending these tests. However, in the event one or more samples fail any one of the tests that test shall immediately revert to sampling plan A until 50,000 feet of wire of that type and class have been manufactured with satisfactory test results. These tests shall be completed with satisfactory results prior to any additional shipments of wire in excess of 100,000 feet of the type and class(es) sampled.

a. Sampling plan A tests

b. Cold bend

c. Fungus

d. Abrasion resistance

4.5.2.3 Rejection and retest: When one sample selected from a production run fails to meet the specification, no wire from which the sample was taken shall be accepted until the extent and cause of failure are determined. This applies to all wire of the same batch or lot for individual and sampling plan A tests.

4.5.2.3.1 Individual tests may continue. For operational reasons, individual tests may be continued pending the investigation of a sampling test failure. But final acceptance of items on hand or later produced shall not be made until it is determined that the wire meets all the requirements of individual and sampling plan A tests. Additional sampling tests shall be conducted. If a failure occurs during these tests the sampling test shall immediately revert to individual tests until the batch is tested.

4.5.3 Defects in items already accepted. The investigation of a test failure could indicate that defects may exist in items already accepted. If so, the contractor shall fully advise the procuring activity of all defects likely to be found and methods of correcting them.

4.6 *Methods of examination and test.*

4.6.1 Examination of product. The wire shall be subjected to a thorough general inspection to ascertain that the materials, workmanship, and design are in strict conformity with the requirements of this specification. The general inspection shall cover the requirements such as dimensions, color coding, weight, conformity of materials to specification requirements, and ease of insulation stripping.

4.6.2 Conductor tinning. The continuity of the tin coating of the unassembled strand of copper wire shall be determined for three specimens (see 3.3.1.7). The specimens shall be approximately 6 inches in length and shall be tagged or marked to identify them with the coil or reel from which they were cut.

4.6.2.1 Treatment of specimens. The specimens shall be thoroughly cleaned by immersion in benzine, redistilled petroleum ether or ether for at least 3 minutes, then removed and wiped dry with a clean soft cloth. The specimens thus cleaned shall be kept wrapped in a clean soft cloth. That portion of the specimen to be immersed in the test solution shall not be handled. Care shall be taken to avoid abrasion by the cut ends.

4.6.2.1.1 Preparation of test solutions.

4.6.2.1.1.1 **Sodium-Polysulfide solution.** A concentrated solution shall be made by dissolving sodium-sulfide crystals in distilled water at about 21°C until the solution is saturated, adding about 250 g of flowers of sulfur per liter, and allowing to stand for at least 24 hours. The test solution shall be made by diluting a portion of the concentrated solution with distilled water to a specific gravity of 1.142 at 15.5°C. The test solution shall have sufficient strength to blacken thoroughly a piece of clean untinned copper wire in 5 seconds. A portion of the test solution used for testing the samples shall not be considered exhausted until it fails to blacken a piece of clean copper as described above.

4.6.2.1.1.2 *Hydrochloric - acid solution.* *Commercial hydrochloric acid shall* be diluted with distilled water to a specific gravity of 1.088 at -15.5°C.

4.6.2.2 Procedure. At least 4 1/2 inches of the cleaned specimen shall be immersed in accordance with the following cycles in test solutions maintained between 15.5° and 21°C:

a. Immerse for 1 minute in the hydrochloric-acid solution, wash in clean water, and wipe dry with a clean soft cloth.

b. Immerse for 30 seconds in the sodium-polysulfide solution, wash, and wipe dry as before.

c. Repeat a.

d. Repeat b.

No attention shall be paid to blackening within 1/2 inch of a cut end. A specimen shall be considered to have failed if copper exposed through openings in the tin coating has been blackened by the action of the sodium-polysulfide test solution.

4.6.3 Electromotive force.

4.6.3.1 Type 1, classes A, B, C, D, and E wire. A thermocouple shall be formed from a specimen of the wire taken from each coil or reel. The electromotive force characteristics of the wire shall be determined at temperatures of -50°, 0°, +100°, +200°, +300°C. The measured electromotive force shall be as specified in table III.

4.6.3.2 Type 1, classes F and G, and types 2, 3, 4, and 5, classes A and B. A thermocouple shall be formed from a specimen of the wire, and the electromotive force characteristics of the wire shall be determined at temperatures of 0°, +50°, and +100°C. The measured electromotive force shall meet the tolerance listed in table III. One specimen shall be taken from each coil or reel.

4.6.4 Resistance. The total resistance (copper and constantan conductor) of each finished coil or reel of wire shall be determined at, or the determined resistance corrected to, +25°C and shall be expressed at resistance per 200 feet for type 2 wire (see 3.3.3.3). A certificate showing the results of the resistance test shall be furnished by the contractor with each coil or reel. The certificate shall state the resistance to two decimal places calculated for a length of 200 feet for +25°C, date of test, and name of person performing the test. In making this test, care shall be exercised that any thermal emf developed by joining the copper and constantan wire does not affect the results. The resistance of the wire shall conform to table I. The following expressions may be used for converting resistances measured at temperatures other than +25°C to resistances at +25°C:

Copper conductor

$$R_{25} \quad \frac{259.5Rt}{234.5 + t}$$

Constantan conductor

$$R_{25} \quad \frac{500,000Rt}{499,975 + t}$$

Where R_{25} = Resistance at 25°C

Rt = Resistance at temperature (t) in ohms

t = Temperature at which resistance was measured, in degrees Centigrade

4.6.5 Dielectric strength. One inch of the insulation shall be removed from each end of three 36-inch specimens of the wire. The samples shall be immersed in a saturated solution of salt water, at a temperature of 25°C, to a point 6 inches from each end of the insulation for a period of 20 hours. Following this period, a potential of 350V rms at a commercial frequency shall be applied to the specimen. The potential shall be applied to the specimen through grounding the outer surface of the insulation by immersion in the salt solution at not over 30°C and the voltage applied between each conductor and ground. The wire shall be capable of withstanding this potential for 5 minutes without breakdown (See 3.4.1).

4.6.6 Insulation resistance. The samples of wire, subjected to the dielectric strength test shall then be subjected to the insulation resistance test. Insulation resistance measurements shall be made with a megohm bridge or with a galvanometer and a suitable source of direct current. The measurement shall be made with the specimen immersed in a saturated solution of salt water, at a temperature of 25°C, to a point 6 inches from each end of the insulation. The insulation resistance shall be determined between each conductor and ground after 1 minute electrification with a potential of not less than 200 nor more than 500V dc. During this test, the temperature of the wire shall be as nearly uniform as practicable. The measured insulation resistance shall be corrected to a reference temperature of 15.5°C by multiplying the measured value of insulation resistance by a coefficient corresponding to the temperature of the measurement. These temperature coefficients are shown in table V. For temperature values between those tabulated, the coefficients for the next higher temperature shall be used when above 15.5°C and that of the next lower temperature shall be used when below. For approved insulating materials possessing temperature coefficients not within the limits set by this reference characteristics the values applicable thereto may be used when specifically approved by the procuring activity (see 3.4.2).

TABLE V. Temperature Coefficients

Temperature		Temperature Coefficients of insulation	Temperature		Temperature Coefficients of insulation
Degrees F	Degrees C		Degrees F	Degrees C	
32	0.0	0.032	65	18.3	1.80
35	1.7	0.047	68	20.0	2.50
38	3.3	0.071	71	21.7	3.50
41	5.0	0.098	74	23.3	5.00
44	6.7	0.140	77	25.0	6.60
47	8.3	0.25	80	26.7	8.30
50	10.0	0.29	83	28.3	11.0
53	11.7	0.45	86	30.0	17.5
56	13.3	0.78	89	31.7	24.5
59	15.0	0.91	92	33.3	34.0
60	15.6	1.00	95	35.0	48.0
62	16.7	1.26			

4.6.7 Temperature aging. One inch of the insulation shall be removed from each end of a 36-inch specimen of the finished wire. The specimen shall be suspended in a suitable test chamber without touching the walls of the chamber. The chamber shall be maintained at a temperature of 100° ±2°C. The heated air, at atmospheric pressure, in the chamber shall be circulated so as to maintain a uniform temperature. The specimen shall be subjected to this temperature for a period of 96 hours and then subjected to the bend, dielectric, and insulation resistance tests, respectively (see 3.4.3).

4.6.8 Bend. One end of the specimen shall be secured to a mandrel and the other end to the load weight specified in table VI. 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 is wrapped around the mandrel as before, except that the reverse surface of the wire is in contact with the mandrel. This procedure shall be repeated until two bends in each direction have been formed in the same section of the wire. When this test is conducted on duplex wire, the bend shall be made on the minor diameter of the wire.

TABLE VI. Bend diameters and load

Specimen	Mandrel diameter (inches) Bend test and Cold bend test	Max test load (lb) Bend test
Type 1, Gage 12	3.0	1.0
Type 1, Gage 14	3.0	1.0
Type 1, Gage 16	3.0	1.0
Type 1, Gage 18	2.0	1.0
Type 1, Gage 20	2.0	0.75
Type 2, Classes A and B	3.0	1.0
Type 3, Classes A and B	2.0	1.0
Type 4, Classes A and B	3.0	1.0
Type 5, Classes A and B	3.0	1.0

4.6.9 Cold bend. Three straight specimens of the finished wire shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The wire shall be subjected to a temperature of -55°C for a period of 4 hours. At the end of this period and while still at -55°C, the specimens shall be wrapped about a mandrel mounted within the cold chamber as specified in table VI, at the rate of one turn in 4 seconds, for a sufficient number of turns so that the center portion of the wire is subjected to at least two complete turns. The specimen shall be unwrapped and rewrapped in the opposite direction in a similar manner. Either a revolving or stationary mandrel may be used. The specimen shall then be removed from the mandrel and, without straightening, shall then be subjected to and meet the requirements of the dielectric test as specified herein. When the test is conducted on duplex wire, the bend shall be made on the minor diameter of the wire (see 3.4.4).

4.6.10 Heat resistance.

4.6.10.1 *Type 1, class F and types 2, 3, and 4 and 5 class A.* A specimen of finished wire shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The specimen shall be placed in an oven maintained at +120°C ±2°C for 24 hours. At the end of this time, the specimen shall be removed and allowed to return to room temperature. The specimen shall then be wound tightly around a mandrel three times the major diameter of the wire for five close turns and removed without straightening. The coiled section shall then be subjected to and meet the requirements of the dielectric test as specified herein. (see 3.4.5.1)

4.6.10.2 Type 1, class G and types 2, 3, 4, and 5 class B. A specimen of finished wire shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The specimen shall be placed in an oven maintained at 230° ±5°C for 24 hours. At the end of this time, the specimen shall be removed and allowed to return to room temperature. The specimen shall then be wound tightly around a mandrel three times the outside diameter of the wire for five close turns and removed without straightening. The coiled section shall then be subjected to and meet the requirements of the dielectric test as specified herein (see 3.4.5.2).

4.6.11 Flammability. A 20-inch length of the finished wire shall be marked with fine threads at distances 5 and 11 inches from one end of the specimen to designate a 6-inch test length. The specimen shall be held tautly in a horizontal position within a chamber approximately 2 by 1 foot, open at the *top and one long side, and which allows sufficient flow of air for complete com*bustion but which is free from drafts. A flame from a Bunsen burner shall be applied for 30 seconds to the end of the specimen from which distances were measured, and then removed. The Bunsen burner shall have a 1/4 inch inlet, a nominal bore of 3/8-inch, and a length of approximately 4 inches from top to primary inlets. The burner shall be adjusted to produce a 2-inch flame with an inner cone 1/3 of the flame height. The burner height shall be so adjusted that the hottest portion of the flame is applied to the wire. The time of burning shall then be recorded as the time required for the flame to progress along the marked 6-inch length (see 3.4.6).

4.6.12 Solvent resistance. Five specimens of finished wire, each 2 feet long, shall be prepared by removing 1 inch of insulation at each end to the bare conductor. The center 1-foot section of the specimen shall be immersed in the solvents listed in table VII for 24 hours at 25°C, removed, and wiped clean with a dry cloth. Any one specimen shall not be immersed in more than one solvent. The center 1-foot section shall be subjected to and meet the requirements of the dielectric and insulation resistance tests specified herein. All specimens shall be immersed in the salt water specified for dielectric test and *tested immediately with no soaking required (see 3.4.7).*

TABLE VII. Test Solvents

Solvent	Specification
Saturated solution of salt water	----------
Ethylene glycol	O-A-548
Isopropyl alcohol	TT-I-735
Standard test fluid Type II	TT-S-735
Engine Oil Grade 1065	MIL-L-6082

4.6.13 Fungus. Three specimens of finished wire, each 2 feet long, shall be prepared by removing 1 inch of insulation from each end to the bare conductor. The specimens shall be subjected to the fungus test, Method 508, in accordance with MIL-STD-810. At the completion of the exposure period, the specimen shall be examined for evidence of fungus growth. There shall be no evidence of fungus growth on the specimen. The center 1-foot section, within 15 minutes after removal from the test chamber, shall be subjected to and meet the requirements of the dielectric test as specified herein (see 3.4.8).

4.6.14 Abrasion resistance. Three specimens of finished wire, each 2 feet long, shall be subjected to the abrasion test. The specimens shall be tested with an abrasion tester conforming to MIL-T-5438. The length of abrasive tape, the weight applied and support bracket used shall be as specified in Table VIII. Only the finished insulation of the individual conductors, not duplexing outer covering, of duplex wire shall be subjected to the abrasion resistance test (see 3.4.9).

TABLE VIII. Abrasion resistance

AWG	Length of tape - inches	Weight lb	Support bracket
26	16	1.0	A
24	16	1.0	A
22	16	1.0	A
20	16	1.0	A
18	16	1.0	A
16	22	1.0	A
14	10	3.0	B
12	10	3.0	B
10	15	3.0	B
8	19	3.0	B
6	21	3.0	C

4.7 Inspection of the preservation, packaging, packing and marking for shipment and storage. The inspection of the preservation, packaging, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PREPARATION FOR DELIVERY

5.1 Preservation, packaging and packing. Wire shall be prepared for delivery in accordance with preservation, packaging and packing conforming to Level A, B, or C requirements of MIL-C-12000 unless otherwise specified in the procurement document. (See 6.2.)

5.2 MARKING

5.2.1 Reels, coils and interior packages. Reels, coils, and interior packages shall be marked in accordance with MIL-STD-129 and shall contain, as applicable information listed below. When paper labels are used they shall be protected by a transparent coating to prevent deterioration of marking.

(1) Federal Stock Number (FSN).

(2) Wire, Electrical, Copper, Thermocouple
or
Wire, Electrical, Constantan, Thermocouple
or
Wire, Electrical, Copper and Constantan, Thermocouple (as applicable)
MIL-W-5908, TYPE___*___Class___*___
CONDUCTOR QTY___*___& SIZE___*___(Type 1 only)
*Apply information as applicable.

(3) Quantity and unit of issue (E.G. 550 ft).

(4) Federal Supply Code of Manufacturers (FSCM) and Manufacturer Part Number.

(5) Contract or order number.

(6) Level of preservation-packaging and data (month and year).

(7) Date of manufacture.

(8) Manufacturer lot number (Type 1, Classes A, B, D only)

(9) Military part number

(10) Manufacturer's name or trade mark (unless coded in (4) for FSCM above).

(11) Name of contractor (if not the manufacturer).

(12) Additionally, Type 1 Classes A, B, and D shall contain markings as follows:

"Caution: Copper and constantan wire contained herein is calibrated for use together in fabricating thermocouples. If different lot numbers are used recalibration of wire will be required."

6. NOTES

6.1 Intended use.

6.1.1 Type 1, classes A, B, C, D, and E wire. Type 1, classes A, B, C, D, and E wire are intended for use in fabricating thermocouples.

6.1.1.1 Type 1, classes F and G wire. Type 1, classes F and G wire are intended for fabricating thermocouple extension leads for aircraft use. Class F is intended for applications where temperatures of 120°C are to be encountered, and class G is intended for applications where temperatures of 230°C are to be encountered.

6.1.2 Types 2, 3, 4, and 5, class A wire. Types 2, 3, 4, and 5, class A wire are intended for fabricating thermocouple extension leads for aircraft use. The wire is intended for applications where temperatures of +120°C are to be encountered.

6.1.3 Types 2, 3, 4, and 5, class B wire. Types 2, 3, 4, and 5, class B wire are intended for fabricating thermocouple extension leads for aircraft use. The wire is intended for applications where temperatures of +120°C are to be encountered.

6.2 Ordering data. Procurement documents should specify the following:

6.2.1 Procurement requirements.

a. Title, number and date of this specification.

b. Military part number. (see 1.2.1.)

c. Unless otherwise specified, a preproduction test sample is required. (see 3.1.)

d. Unless otherwise specified, sampling plan A tests will be conducted. (see 4.5.2.1.)

e. Levels of preservation, packaging, and packing. (see 5.1.)

f. Type 1, classes A, B, and D copper and constantan wire comprising the lot or order should be procured from the same manufacturer to insure that calibation requirements are met. (see 3.3.3.1.1.)

6.2.2 Contract data requirements. Data conforming to Data Item Description DI-T-3718/T-119-2 will usually be required for delivery in connection with this specification. When so required, such data will be specified for delivery on a DD Form 1423 included in the contract or purchase order. (see 4.4.3.)

6.3 Preproduction. The preproduction sample shall be examined and tested for approval at the contractor's plant or at an independent commercial testing laboratory acceptable to the procuring activity. Preproduction tests shall be witnessed by a Government representative of the procuring activity. Approval of the preproduction sample shall be by the contracting officer.

6.4 Marginal indicia. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - EL
Navy - AS
Air Force - 80

User activities:
Army - AT, MU
Navy - OS

Review activities:
Army - GL
Navy - OS
DSA - IS

Preparing activity:
Air Force - 80

(Project 6145-0632)

☆ U. S. GOVERNMENT PRINTING OFFICE: 1973-713-159/561

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
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

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.

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)