

MIL-C-442D
12 June 1968

SUPERSEDING
MIL-C-442C
23 September 1965

MILITARY SPECIFICATION

CABLE, (WIRE), TWO CONDUCTOR, PARALLEL

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

1. SCOPE

1.1 Scope. - This specification covers cables that have two parallel conductors, which can be separated for any desired distance by tearing apart.

1.2 Classification. - Cables shall be of the following types, classes, and grades as specified (see Table I and 6.2).

- Type I - Solid copper wire conductor
- Type II - Stranded copper wire conductor
- Type III - Stranded high tensile copper alloy wire conductor

- Class 1 - Vinyl polymer insulated
- Class 2 - Synthetic rubber insulated
- Class 3 - Natural rubber insulated

- Grade A - Finished cable conforming to flexibility requirements at -55°C
- Grade B - Finished cable conforming to flexibility requirements at -40°C

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the 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)

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Military

MIL-I-3930	Insulating and Jacketing Compounds, Electrical (For Cable, Cords and Wires)
MIL-C-12000	Cable, Cord, and Wire, Electric Packaging and Packing of

STANDARDS

Federal

Fed. Test Method Std. No. 228	Cable and Wire, Insulated; Method of Testing
Fed. Test Method Std. No. 406	Plastics: Methods of Testing
Fed. Test Method Std. No. 601	Rubber; Sampling and Testing Specifications

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-109	Quality Assurance Terms and Definitions
MIL-STD-810	Environmental Test Methods

(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 Construction. - The cable shall be constructed to permit separation of the individual conductors for any given distance and still retain complete insulation coverage when slit at the end and intentionally torn apart. The physical and electrical characteristics of the wire shall be as specified in Table I.

3.2 Material. - The material shall be as specified and when not specifically described shall meet the performance characteristics specified herein.

3.2.1 Conductor.

3.2.1.1 Types I and II. - Types I and II conductors shall be drawn and annealed uncoated copper wire material in accordance with QQ-W-343. When specified, Type II conductors may be coated with commercially pure tin.

TABLE I - PHYSICAL AND ELECTRICAL CHARACTERISTICS

Cable Types	(See 6.2) Conductor A.W.G.	Area c.m. (Nominal)	No. of Strands (Minimum)	Strand Diam. inch (Nominal)	Overall Max Diam.	
					of Cross Sect Width	Inch Height
I	20	1020	Solid	0.032	0.188	0.094
	18	1620	Solid	0.040	.204	.102
II	22	640	16	.0063	.188	.094
	20	1020	26	.0063	.219	.109
	18	1620	41	.0063	.219	.109
III	18	1620	41	.0063	.219	.109

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3.2.1.2 Type III.- Type III conductor shall be composed of high tensile copper alloy (nominal composition of 99% copper and 1% cadmium) strands so as to meet the breaking strength and electrical requirements specified herein.

3.2.1.2.1 Resistance (Type III).- Maximum conductor d.c. resistance at 20°C for Type III conductor shall be 10 ohms/1000 ft.

3.2.2 Size.- Each conductor shall consist of one or an assembly of strands and the conductor size and thickness of insulation surrounding each conductor shall be as specified in Table I and 3.3.

3.2.3 Joints.- Joints in a solid conductor or in any of the individual wires of a stranded conductor shall be so constructed and disposed throughout the conductor that the diameter, configuration, conductor resistance, flexibility, and mechanical strength of the complete conductor are not adversely affected.

3.2.4 Separator.- A separator shall be provided between the conductor and insulation for Class 2 and 3 cable. The separator shall consist of dry, soft, fungus resistant cotton braid and so applied that it will cover the conductor completely. The separator on one conductor shall be colored white and the separator on the other conductor shall be black. When tinned coated copper conductors are specified the separator may be omitted.

3.2.5 Breaking strength (Type III).- The Type III finished cable shall withstand a 175 pound breaking strength without rupture to the insulation or either conductor.

3.3 Insulation (Classes 1, 2, and 3).- The minimum insulation thickness between conductors shall be .0469 inches and the maximum insulation thickness surrounding each conductor shall be .0345 inches and there shall be not less than 0.013 inch of insulation at any point on each conductor when intentionally torn apart. The insulation material shall meet the applicable physical property values specified in Tables II and III accordingly.

3.3.1 Vinyl-polymer compound (Class 1).- The insulation material shall be black, fungus resistant vinyl-polymer compound.

3.3.1.1 Heat resistance.- The vinyl-polymer compound shall not become soft or tacky and shall conform to Sl.B of Fed. Test Method Std. No. 406 when exposed to a temperature of 70 ± 1°C for 48 hours with an applied pressure of 1/3 pounds per square inch (psi).

3.3.2 Synthetic rubber compound (Class 2).- The insulation material shall be properly vulcanized copolymer of butadiene and styrene or a blend of synthetic and natural rubber.

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3.3.2.1 Synthetic rubber compound aging.- The insulation material shall meet the physical property values of Table III after being exposed to $70 \pm 1^{\circ}\text{C}$ under sustained oxygen pressure of 290 to 310 psi for a minimum of 96 hours.

3.3.3 Natural rubber compound (Class 3).- The insulation material shall be properly cured natural rubber.

3.3.3.1 Natural rubber compound aging.- The insulation material shall meet the physical property values of Table III after being exposed to $70 \pm 1^{\circ}\text{C}$ under sustained oxygen pressure of 290 to 310 psi for a minimum of 96 hours.

TABLE II - PHYSICAL PROPERTIES

Property	Class 1	Class 2	Class 3
Tensile strength (psi) min	1500	1200	3000
Ult. elongation (percent) min	150	* 300	* 650
Tension set (max) in (2" to 5" stretch)	--	1/2	1/16
* 2 inch gauge length			

TABLE III - PHYSICAL PROPERTIES (AFTER AGING)

Property	Class 2	Class 3
Tensile strength (psi) min	900	2500
Ult. elongation (percent) min	* 195	* 455
* 2 inch gauge length		

3.4 Finished cable.

3.4.1 Dielectric strength.- The cable shall show evidence of breakdown when subjected to a potential of 1000 volts, 60 cycles, for a period of one minute.

3.4.2 Insulation resistance.- The minimum resistance value per 1000 feet of cable shall be 50 megohms when a d.c. voltage of between 200 to 500 volts is applied for one minute.

3.4.3 Flexibility.- The cable shall withstand temperatures of -40°C or -55°C as specified (see 6.2) without evidence of cracking, chipping, or otherwise being damaged.

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3.4.4 Ozone resistance (Class 2 and 3).- Insulation shall conform to the ozone resistance requirements of MIL-I-3930.

3.4.5 Identification of product.- The reel shall be marked for identification with the following: Type, grade, class per MIL-C-442D, date, name of manufacturer and number of feet.

3.5 Workmanship.- The cable shall be clean, smooth, uniform in cross section and free from cracks or any defect not representative of high grade cable manufacturing technique.

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.

4.1.1 General provisions.- The quality assurance provisions of this specification and of other documents referenced herein form the basis for inspection to be performed by the supplier. Inspection shall be in accordance with 4.2.2. Definitions of inspection terms not otherwise defined herein shall be as listed in MIL-STD-109.

4.2 Lot acceptance inspection.

4.2.1 Inspection lot.- Unless otherwise specified by the contracting officer, an inspection lot shall consist of reels or spools of one type, class, grade, and conductor AWG produced under essentially the same conditions and offered for inspection at one time. The unit of product for determining lot size shall be one spool or reel. The sample unit shall be a length of cable sufficient for performing all required tests.

4.2.2 Examination and tests.- Examinations and tests related to Section 3 herein shall be performed on a defect (individual characteristic) basis in accordance with MIL-STD-105. Examinations and tests for packaging, packing and marking shall be in accordance with MIL-C-12000 and Section 5 herein. The tabulated classification of defects shall constitute the minimum inspection to be performed by the supplier prior to Government acceptance or rejection by lot. The Government reserves the right to inspect for any applicable requirement, and to reject individual non-conforming items.

TABLE IV - CLASSIFICATION OF DEFECTSCRITICAL: NONE

<u>MAJOR:</u> AQL 1.0% Inspection Level II	<u>Requirement</u>	<u>Test Procedures</u>
101. Resistance (Type III)	3.2.1.2.1	4.5.3
102. Size	3.2.2	4.5.5
103. Separator (colors)	3.2.4	4.5.6
104. Breaking strength (Type III)	3.2.5	4.5.7
105. Insulation (thickness)	3.3	4.5.8
106. Vinyl-polymer compound (color)	3.3.1	4.5.8.1
107. Dielectric strength	3.4.1	4.5.9.1
108. Insulation resistance	3.4.2	4.5.9.2
109. Flexibility	3.4.3	4.5.9.3
110. Ozone resistance	3.4.4	4.5.9.4
111. Identification of product	3.4.5	4.5.10
112. Workmanship	3.5	4.5.11

MINOR: NONE

4.2.3 Disposition of nonconforming product.- Rejected lots shall be screened for all defective characteristics. Removal or correction of defective units and resubmittance of rejected lots shall be in accordance with "Acceptance and Rejection" as specified in MIL-STD-105.

4.3 Process control tests.

4.3.1 General.- One reel or spool shall be selected at random as a control sample from each 200 produced, or from each month's production, whichever occurs first. The control sample shall have successfully met all other acceptance tests specified herein, and shall then meet the following requirements and tests:

<u>Control Test</u>	<u>Requirement</u>	<u>Test Procedures</u>
301. Construction	3.1	4.5.1
302. Material	3.2	4.5.2
303. Conductor	3.2.1	4.5.2.1
304. Separator (fungus test)	3.2.4	4.5.6
305. Insulation (physical property values)	3.3	4.5.8
306. Vinyl-polymer compound (fungus resistance)	3.3.1	4.5.8.1

4.3.2 Environmental.- One reel or spool shall be selected at random as a control sample from each 100 produced, or from each month's production, whichever occurs first. The control sample shall have met all other acceptance tests specified herein, and shall meet the following requirements and tests:

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<u>Control Test</u>	<u>Requirement</u>	<u>Test Procedures</u>
307. Heat resistance	3.3.1.1	4.5.8.2
308. Synthetic rubber compound aging	3.3.2.1	4.5.8.3
309. Natural rubber compound aging	3.3.3.1	4.5.8.4

4.3.3 Control test failure.- Should any one item of a control test sample fail to meet the specified test requirements, acceptance of the product will be suspended by the Government until necessary corrections have been made by the contractor and the resubmitted samples have been approved.

4.4 Test equipment and inspection facilities.- The test equipment and inspection facilities shall be of sufficient accuracy, quality and quantity to permit performance of the required inspection. The supplier shall establish calibration of the test equipment to the satisfaction of the Government.

4.5 Test methods and procedures.

4.5.1 Construction.- Construction of the cable to permit separation of the individual conductors shall be tested by taking a two-foot specimen and slitting the end approximately 1/2 inch in length between the two conductors. Grasp each conductor and tear the entire two foot length. The cable should separate cleanly without exposing any bare wire.

4.5.2 Material.- The materials as specified in 3.2.1, 3.3.1, 3.3.2, and 3.3.3 shall be in accordance with 3.2. The contractor shall supply the Government with certification of compliance for all materials.

4.5.2.1 Conductor.- The material for Types I and II conductors shall be inspected in accordance with QQ-W-343 to meet the requirements of 3.2.1.1 and Type III conductor shall meet the requirements of 3.2.1.2.

4.5.3 Conductor resistance (Type III).- Resistance of the Type III conductor of the finished cable shall be tested in accordance with Method 6021 of Fed. Test Method Std. No. 228 and in accordance with 3.2.1.2.1.

4.5.4 Joints.- The joints will be considered acceptable when the diameter, conductor resistance, flexibility and tensile strength tests have been successfully met in accordance with 3.2.3.

4.5.5 Size.- Conductor diameter, either stranded or solid conductor shall be inspected in accordance with Table I and QQ-W-343 in accordance with 3.2.2.

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4.5.6 Separator. - The separator when used for Class 2 and 3 cable shall be checked visually to ascertain its presence and color in accordance with 3.2.4. Fungus resistance shall be in accordance with Method 508 of MIL-STD-810.

4.5.7 Breaking strength (Type III). - The breaking strength of the Type III finished cable shall meet the requirements of 3.2.5 and be determined by using a specimen of full cross section with the insulation intact. The ends of the specimen shall be secured to the fixtures attached to the stationary and movable heads of the testing machine by wrapping the specimen once around the fixture and making the end fast to the fixture. The fixtures shall be cylindrical, not less than 1/2 inch in diameter and positioned with their axes normal to and about 1/2 of the radius from the centerline of pull of the machine. The distance between centers of the fixtures at the start of the test shall be approximately 10 inches with the sample taut. The speed of travel of the movable head, without load shall be not more than 1/2 inch per minute.

4.5.8 Insulation (Classes 1, 2 and 3). - Insulation thickness shall be inspected to Method 1013 of Fed. Test Method Std. No. 228 to the tolerances as specified in 3.3. The physical property values as specified in Tables II and III shall be tested in accordance with Table V using dumbbell specimens cut from sheets of the same material.

TABLE V

<u>Test</u>	<u>Test Method of Fed. Std. No. 601</u>
Tensile strength	4111
Elongation, ultimate	4121
Tension set	4411
Accelerated aging	7001

4.5.8.1 Vinyl-polymer compound (Class 1). - The color of the insulating material shall be visually checked, and the fungus resistant requirement of 3.3.1 shall be tested and evaluated in accordance with Method 6091 of Fed. Test Method Std. No. 406 - Rating 1.

4.5.8.2 Heat resistance. - Heat resistance shall be determined by the "Blocking Test," in accordance with Method 1131 of Fed. Test Method Std. No. 406, and the requirements of 3.3.1.1. The test specimens shall be cut from the sheet used to obtain the tensile strength specimens of Table V.

4.5.8.3 Synthetic rubber compound aging. - Prior to the physical property tests of Table III, the synthetic rubber compound shall be given the "Oxygen Pressure Test," Method 7111 of Fed. Test Method Std. No. 601 to the requirements of 3.3.2.1.

4.5.8.4 Natural rubber compound aging. - This material shall be given the "Oxygen Pressure Test" as specified in 4.5.8.3 to the requirements of 3.3.3.1, prior to the tests specified in Table V.

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4.5.9 Finished cable.

4.5.9.1 Dielectric strength.- This test shall be performed in accordance with Method 6111 of Fed. Test Method Std. No. 228 and the requirements of 3.4.1.

4.5.9.2 Insulation resistance.- This test shall be performed at a temperature of 15.6°C in accordance with Method 6031 of Fed. Test Method Std. No. 228 and the requirements of 3.4.2. This test shall be performed as soon as possible after the dielectric strength test.

4.5.9.3 Flexibility.- This test shall be performed on a specimen of finished cable approximately 7-1/2 inches long. The specimen shall be in a non-flexed position while exposed to the temperatures specified in 3.4.3. After thermal equilibrium is reached, a 1 inch mandrel shall be securely clamped at both ends in a horizontal position to prevent rotation and the specimen wrapped twice around the mandrel. A 5 kilogram weight shall be suspended from one end of the specimen from the mandrel. The two turns of the specimen shall be completely in contact with the mandrel prior to releasing the weight so that the specimen will be kept taut when unwinding. The free end shall not be longer than 1/2 inch to permit rapid unwinding of the specimen from the mandrel to occur. The mandrel shall be positioned at sufficient height to permit the specimen to drop free after unwinding from the mandrel. The specimens and test equipment shall be maintained at the specified temperature during the test, and the specimens shall be left undisturbed at that temperature for 5 minutes thereafter. The specimens shall then be visually examined for any cracks, chips or otherwise being damaged.

4.5.9.4 Ozone resistance.- Cable shall be tested in accordance with the ozone resistance test of MIL-I-3930 and examined for compliance with 3.4.4.

4.5.10 Identification of product.- Inspection for identification of product shall be by examination for conformance with 3.4.5.

4.5.11 Workmanship.- Inspection for workmanship shall be visual in accordance with the requirements of 3.5.

5. PREPARATION FOR DELIVERY

5.1 Levels A, B, and C.

5.1.1 Packaging and packing.- The cable shall be cleaned, preserved, packaged, packed, and marked in accordance with MIL-C-12000.

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6. NOTES

6.1 Intended use.- Cable covered by this specification are intended for use as follows:

	Intended Use	Type	Class	A.W.G.
1.	Lead wire in firing explosive charges electrically in demolition operation	I	1	20
		II	1	18
		III	1	18
2.	Rocket connectors	II	2	22, 20
3.	General military application where voltage does not exceed 300 volts	I, II	1, 2, 3	20, 18

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

- (a) Title, number, and date of this specification.
- (b) Cable type, class, grade, and conductor A.W.G. (see 1.2 and Table I).
- (c) Quantity required.
- (d) Selection of applicable levels of preservation, packaging, and packing (see 5.1).

6.3 Cross-reference of classifications.- The following table shows all items of older classifications and their equivalent in this issue.

Old		New		
Type	A.W.G.	Type	Class	A.W.G.
I	20	I	1	20
II	18	II	1	18
III	18	III	1	18
IV	20	II	2	20
V	22	II	2	22
VI	18	II	2	18
Class 1		Grade A		
Class 2		Grade B		

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6.4 A heavy duty battery clip is required to suspend the weight from the specimen (4.5.9.3) since at low temperatures the surface of the coating becomes too hard to permit any other type of attachment to be effective. For this purpose, a No. 21 Mueller Universal battery clip has been satisfactory in the past.

Custodians:

Army - MU
Navy - OS
Air Force - 85

Preparing activity:

Army - MU

Project No. 6145-0446

Review activities:

Army - MU, MI, EL
Navy - OS
Air Force - 85
Other - NSA

User activities:

Army - ME, AV, AT
Navy - MC
Air Force - None

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)
b. ADDRESS (Street, City, State, ZIP Code)	<input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> 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)

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