

INCH-POUND

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 SUPERSEDING
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DETAIL SPECIFICATION

CABLES, SPECIAL PURPOSE, ELECTRICAL: LOW-TENSION, HEAVY-DUTY, SINGLE CONDUCTOR AND MULTIPLE CONDUCTOR, SHIELDED AND UNSHIELDED, GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers two types (shielded and unshielded) of insulated, heavy-duty, single and multiconductor, electrical cables for use in low-tension circuits (see 6.1).

1.2 Classification. Cable is of the following types and classes, as specified (see 6.1 and 6.2):

Type I	– Unshielded
Type II	– Shielded
Class A	– Single Conductor
Class B	– Multiconductor

1.2.1 Size and arrangement of conductors. Cable is furnished in the size or combination of sizes and arrangement of conductors shown on the applicable specification sheet or drawing (see 6.2).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the applicable issues of these documents are those listed in the specific issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data that may be of use in improving this document should be addressed to: Defense Logistics Agency, Defense Supply Center, Columbus (DSCC-VAI), P.O. Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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SPECIFICATIONS

FEDERAL

A-A-870	-	Antifreeze/Coolant, Engine: Ethylene Glycol Inhibited, Concentrated
QQ-W-343	-	Wire, Electrical, Copper (Uninsulated)

STANDARDS

FEDERAL

FED-STD-791	-	Lubricants, Liquid Fuels, and Related Products; Methods of Testing
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(Unless otherwise indicated, copies of the above specifications and standard are available from the Defense Automation and Production Service, DoDSSP, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the applicable issues of the documents which have been adopted by the DoD are those listed in the specific issue of the DoDISS cited in the solicitation. Unless otherwise specified, the documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM G21	-	Determining Resistance of Synthetic Polymeric Materials to Fungi (DoD-adopted)
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(Application for copies should be addressed to American Society for Testing and Materials, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Cables furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) at the time of award of contract (see 6.3).

3.2 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet (see 6.2). In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.3 Materials.

3.3.1 Strands. The individual conductor strands (see 6.4) shall be made of soft or drawn and annealed, coated, type S, solid copper wire conforming to the applicable requirements of QQ-W-343. The strands shall be coated as specified therein using any applicable material specified.

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3.3.2 Insulation. The insulation shall be such as to meet the construction and performance requirements specified herein.

3.3.3 Tape or braid. The tape or braid shall be free from any substance that may have a deteriorating effect on the insulation or on the sheath (see 6.4). Further, the tape or braid shall not be adversely affected by the compounding ingredients of the insulation or sheath.

3.3.4 Sheath. The sheath shall be made of material that meets the performance requirements in 3.5.2 through 3.5.12. A polychloroprene-based material is preferred.

3.3.5 Shielding (type II only). The individual strands for the shielding (see 6.4) shall be made of the same material as specified in 3.3.1 for the conductor strands. The American Wire Gage (AWG) size of the individual strands shall be 34.

3.3.6 Separator. The separator shall be made of a fungus resistant material that shall be free of any substance that would have a deteriorating effect on the insulation or conductor. Further, the separator itself shall not be adversely affected by compounding ingredients used in the cable construction or process.

3.3.7 Recycled, recovered, or environmentally preferable materials. Recycled, recovered (see 6.4), or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.4 Construction. Cable construction shall be in accordance with the applicable specification sheet for the military Part or Identifying Number (PIN) specified by the acquisition activity. The length of the cable shall be as specified in the specification sheet or as specified by the acquisition activity (see 6.2, 6.5, and 6.6).

3.4.1 Conductors. Conductors shall consist of individual strands that shall be free from abrasion, kinks, and flats. The conductors shall be continuous throughout their length except joints in individual strands shall be in accordance with 3.4.1.3. The conductor shall be intact and in clean condition for soldering when the separator is stripped from it.

3.4.1.1 Cross section. The cross section of any conductor shall conform to the applicable requirements specified in table I.

3.4.1.2 Stranding. Stranding of the conductor shall be left or right-hand lay and, at the option of the contractor, may be bunched, concentric, or rope lay. When an uninsulated portion is cut, the stranding shall not tend to unlay and the completed conductor shall not tend to spread out.

3.4.1.3 Joints.

3.4.1.3.1 Sizes 0000 to 16. When the conductor is size 0000 to 16, joints shall be made by butt brazing or twisting strands together. Individual joints shall occur no closer together than one foot. In no case shall the whole conductor be spliced at one point.

3.4.1.3.2 Sizes 18 and 20. When the conductor is size 18 or 20, joints shall be made by butt brazing. Individual joints shall be finished so that the conductor diameter is not increased at the point of brazing. Joints shall not occur closer together than 10 feet. In no case shall the whole conductor be spliced at one point.

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TABLE I. Construction requirements for conductors.

Conductor Size (AWG)	Minimum area (circular mils)	Minimum Number of strands	Maximum diameter of stranded conductor (mils)
20	965	10	41.0
18	1,575	16	52.0
16	2,360	19	61.0
14	3,753	19	76.0
12	5,966	19	96.0
10	10,338	105	132.0
8	16,180	133	176.0
6	25,725	133	218.0
4	40,905	133	272.0
2	65,495	663	345.0
1	80,170	812	384.0
0	101,235	1,033	432.0
00	130,990	1,327	490.0
000	163,985	1,661	548.0
0000	207,715	2,104	615.0

3.4.2 Separator. A mechanical or chemical separator shall be applied between the conductor and the insulation to prevent deterioration of the insulating compound and to provide for its easy removal using commercial stripping procedures.

3.4.3 Insulation. The insulating compound shall form a close fit over the separator without adherence. As applied, the compound shall be seamless and shall be free of any foreign material that, under an illumination of 15 to 25 foot-candles, would be visible to a person having 20/20 normal or corrected vision.

3.4.4 Shielding (type II only). Shielding of cables shall be in accordance with the applicable specification sheet.

3.4.4.1 Splices. Spliced strands shall not occur more than once in any 4 feet of cable length.

3.4.4.2 Coverage. The shielding shall provide not less than 85 percent coverage of the surface of the underlying cable components. Percent of coverage shall be calculated as follows:

$$\text{Percent of coverage} = (2F - F^2) 100$$

$$F = \frac{ND}{P (\cos \text{ angle of advance})}$$

Where: N = Number of parallel strands between successive turns of a selected marker strand plus the selected strand.

D = Diameter of a single strand.

Angle of advance = Angle whose tangent equals P/C.

P = Pitch of braid measured along the axis of the braid.

C = 3.14 (Outside diameter of cable – 2D).

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3.4.4.3 Grounding of shielding (class B only). Shielded insulated conductors (see 6.4) of multiconductor cable shall be electrically connected in such a manner that grounding of the shielding of one insulated conductor will result in grounding of all shielding within the outer sheath.

3.4.5 Concentricity. The minimum thickness of the cross section of the insulation around each conductor and of the cable sheath shall be at least .60 of the corresponding maximum wall thickness.

3.4.5.1 Wall thickness. The maximum wall thickness of an insulated conductor shall be the maximum distance between the inner and outer surfaces of the insulation when measured along a line through the center of the circle defined by the outer surface of the insulation. The minimum wall thickness of the insulation shall be a similar distance measured along the same line, on the opposite side of the conductor.

3.4.5.2 Wall thickness ratio. The ratio of the sheath minimum wall thickness shall be at least .60 of the corresponding maximum wall thickness. (This requirement does not apply to two-conductor cable.)

3.5 Performance.

3.5.1 Insulation flaws. Insulated conductors shall withstand the voltage specified in table II without breakdown.

TABLE II. Voltage requirement for insulated conductors.

Conductor size	Voltage (V rms) ^{1/}
20 to 12	2,000
10 to 8	2,000
6 to 0000	3,000

Note:

^{1/} The frequency shall be 60 Hertz (Hz).

3.5.2 Finished cable flaws. Finished cables shall withstand the voltage specified in table III without breakdown.

TABLE III. Voltage requirement for finished cables.

Conductor size	Voltage (V rms) ^{1/}
<u>Class A cable</u>	
20 to 12	2,000
10 to 8	2,000
6 to 0000	3,000
<u>Class B cable</u>	
All sizes	1,000

Note:

^{1/} The frequency shall be 60 Hz.

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3.5.3 High voltage to ground. Cable shall withstand the voltage specified in Table IV without grounding.

TABLE IV. High voltage to ground voltage requirements.

Conductor size	Voltage (V rms)
<u>Class A cable</u>	
20 to 18	4,000
16	5,000
14 to 12	8,000
10 to 0000	10,000
<u>Class B cable</u>	
All sizes	6,000

3.5.4 High voltage between insulated conductors (class B only). Cables shall withstand an alternating voltage of 6,000V rms at 60 Hz between insulated conductors.

3.5.5 Fungus resistance. The cable shall be fungus resistant.

3.5.6 High temperature resistance. The cable shall withstand 250 ± 2 degrees Fahrenheit ($^{\circ}\text{F}$) without breakdown of insulation or sheath.

3.5.7 Low temperature resistance. The cable shall withstand -65 ± 3 $^{\circ}\text{F}$ with no evidence of cracking, breaking, separation, or other damage.

3.5.8 Oil absorption. Cable components shall show no evidence of cracking, rupture, or other damage after immersion in oil at 158 $^{\circ}\text{F}$ for 20 hours. For sizes 16 to 20, the outer diameter of the cable shall not swell more than 25% in excess of the original cable diameter. Other size cables shall not swell to more than 20% in excess of the original cable diameters.

3.5.9 Liquid immersion. The cable components shall evidence no cracking, rupture, or other damage after 20 hours of immersion in distilled water, a 5% (by weight) salt water solution, or ethylene glycol conforming to A-A-870.

3.5.10 Flammability. A flame, resulting from application of a gas flame to the cable, shall travel at a rate not exceeding one inch per minute. The cable surface shall not flame for more than one minute after the gas flame is withdrawn. Burning particles shall not fall from the cable.

3.5.11 Ozone resistance. The cable shall evidence no cracking, rupture, or other deterioration, when examined under 7-power magnification, after 300 hours of exposure to an ozone atmosphere in which the concentration of ozone is 50 ± 5 parts of ozone per 100 million parts of air by volume and the temperature is 100 ± 5 $^{\circ}\text{F}$.

3.5.12 Longitudinal shifting (class B only). The longitudinal shifting of the insulated conductor shall be not greater than 0.125 inch.

3.6 Color.

3.6.1 Insulation.

3.6.1.1 Class A. Color marking of single-conductor cable is not required.

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3.6.1.2 Class B. The color of the insulation or cloth braiding of the insulated conductors of multi-conductor cable shall be in accordance with the applicable specification sheet or as specified by the procuring activity (see 6.2). Color coding shall be recognizable.

3.6.2 Sheath. Color of the sheath shall be black.

3.7 Finish. The cable shall have an even, smooth finish on the exterior surface. When the cable is wound on reels or coils or is piled, adjacent layers of the cable shall not adhere to each other.

3.8 Marking. The manufacturer's name or trade mark, CAGE code, date of manufacture, military PIN (see 6.6), size, number of conductors, and the letters "OZ" shall be clearly and legibly marked on the sheath at intervals of not more than 2 feet. If the cable is class B, the number of conductors of each size shall also be marked on the sheath in the same manner. The military PIN shall be as shown on the applicable specification sheet. The date of manufacture shall be indicated by two numbers separated by a dash. The first number (one digit) shall indicate the quarter of the year in which the cable was manufactured and the second number shall indicate the year of manufacture (four digits).

3.9 Age. Unless otherwise specified (see 6.2), the cable shall be not more than nine months old (as determined by the date of manufacture) at the time it is submitted to the Government for acceptance. This requirement shall apply only to direct procurement of bulk cable by the Government.

3.10 Workmanship. Cable shall show no evidence of cracking, breaking, rupture, or illegible marking.

4. VERIFICATION

4.1 Requirements cross-reference matrix. Table V provides a cross-reference matrix of the Section 3 requirements tested or verified in the paragraphs below.

TABLE V. Requirements cross-reference matrix.

Requirement	Verification	Requirement	Verification
3.1	4.4	3.4.5.1, 3.4.5.2	4.7.2, 4.7.3
3.3.1	4.7.1	3.5.1	4.7.4.1.1
3.3.2	4.7.1	3.5.2	4.7.4.1.2
3.3.3	4.7.1	3.5.3	4.7.4.2
3.3.4	4.7.1	3.5.4	4.7.4.3
3.3.5	4.7.2	3.5.5	4.7.4.4
3.3.6	4.7.1	3.5.6	4.7.4.5
3.3.7	4.7.1	3.5.7	4.7.4.6
3.4	4.7.1, 4.7.2	3.5.8	4.7.4.7
3.4.1	4.7.2	3.5.9	4.7.4.8
3.4.1.1	4.7.2	3.5.10	4.7.4.9
3.4.1.2	4.7.2	3.5.11	4.7.4.10
3.4.1.3	4.7.2	3.5.12	4.7.4.11
3.4.2	4.7.2	3.6.1	4.7.2
3.4.3	4.7.2	3.6.2	4.7.2
3.4.4	4.7.1	3.7	4.7.2
3.4.4.1	4.7.2	3.8	4.7.2
3.4.4.2	4.7.2	3.9	4.7.2
3.4.4.3	4.7.1	3.10	4.7.2
3.4.5	4.7.2, 4.7.3		

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

- a. Qualification inspection (see 4.4).
- b. Conformance inspection (see 4.5).
- c. Control tests (see 4.6).

4.3 Inspection conditions. Unless otherwise specified herein or in the contract or purchase order (see 6.2), all inspections shall be conducted under the following conditions:

- a. Air temperature: 77 ± 18 °F.
- b. Barometric pressure: Site pressure.
- c. Relative humidity: Uncontrolled room ambient.

4.4 Qualification Inspection. Qualification inspection shall consist of the inspections specified in table VI. Cable, submitted in accordance with 4.4.1, shall be cut into a 4-foot length of cable and into the specimen lengths specified in table VII. The 4-foot length of cable shall be examined as specified in 4.7.2 and table VIII. The other specimens shall be subjected to the corresponding group of tests specified in table VII in the order listed therein.

4.4.1 Qualification samples. A sample (see 6.4) of cable no less than 75 feet in length, of each type and class, of the applicable military PIN shall be furnished for testing. Cable shall be representative of the product proposed to be furnished under the contract.

4.4.2 Qualification failure. Failure of any cable to pass the examination or any test in 4.4 may be cause for the Government to refuse to conduct additional tests until the faults revealed by the inspection have been corrected.

4.5 Conformance inspections. Conformance inspections shall consist of:

- a. Individual inspection (see 4.5.1).
- b. Sampling inspection (see 4.5.2).

4.5.1 Individual inspection. All cable submitted for acceptance shall be subjected to the individual tests specified in table VI.

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TABLE VI. Classification of inspections.

Title	Requirement	Verification	Qualification ^{1/}	Conformance inspection		Control tests
				Individual tests	Sampling tests	
Materials and construction	3.3 thru 3.3.4, 3.3.6, 3.3.7, 3.4, 3.4.4, & 3.4.4.3	4.7.1	X			
Materials and construction (see table VIII)	3.3.5, 3.4 thru 3.4.3, 3.4.4.1, 3.4.4.2, 3.4.5, & 3.6 thru 3.10	4.7.2	X		X	
Concentricity	3.4.5	4.7.3	X		X	
Insulation flaws	3.5.1	4.7.4.1.1		X		
Finished cable flaws	3.5.2	4.7.4.1.2		X		
High voltage to ground	3.5.3	4.7.4.2	X			X
High voltage between insulated conductors (class B only)	3.5.4	4.7.4.3	X			
Fungus resistance	3.5.5	4.7.4.4	X			
High temperature resistance	3.5.6	4.7.4.5	X			X
Low temperature resistance (cold bend)	3.5.7	4.7.4.6	X			X
Oil absorption	3.5.8	4.7.4.7	X			
Liquid immersion	3.5.9	4.7.4.8	X			X
Flammability	3.5.10	4.7.4.9	X			
Ozone resistance	3.5.11	4.7.4.10	X			X ^{2/}
Longitudinal shifting (class B only)	3.5.12	4.7.4.11	X			

Notes:

^{1/} Also see table VII.^{2/} This test may be conducted at a reduced level than that used in qualification testing (see 4.7.4.10).

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TABLE VII. Qualification test schedule.

Number of specimens	Length	Inspection	Title
1	3 feet	4.7.4.6 4.7.4.2	Low temperature resistance (cold bend) High voltage to ground
1	3 feet	4.7.4.7 4.7.4.6 4.7.4.2	Oil absorption Low temperature resistance (cold bend) High voltage to ground
1	2 feet	4.7.4.8 4.7.4.6 4.7.4.2	Liquid immersion (salt water) Low temperature resistance (cold bend) High voltage to ground
1	2 feet	4.7.4.8 4.7.4.6 4.7.4.2	Liquid immersion (distilled water) Low temperature resistance (cold bend) High voltage to ground
1	2 feet	4.7.4.8 4.7.4.6 4.7.4.2	Liquid immersion (ethylene glycol) Low temperature resistance (cold bend) High voltage to ground
1	3 feet	4.7.4.5 4.7.4.2	High temperature resistance High voltage to ground
1	2 feet	4.7.4.2 4.7.4.3	High voltage to ground High voltage between insulated conductors (class B only)
1	20 inches	4.7.4.9	Flammability
5	3 feet	4.7.4.4 4.7.4.2	Fungus resistance High voltage to ground
1	3 feet	4.7.4.10 4.7.4.6 4.7.4.2	Ozone resistance Low temperature resistance (cold bend) High voltage to ground
1	1 foot	4.7.4.11	Longitudinal shifting (class B cable only)

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TABLE VIII. Visual and mechanical inspection.

Inspection	Method of examination
Shielding material (type II only) (see 3.3.5).	Visual & SIE ^{1/}
Cable diameter or length (see 3.4).	SIE
Insulation diameter (see 3.4).	SIE
Conductor cross-section or stranding (see 3.4.1, 3.4.1.1, and 3.4.1.2).	Visual, removing insulation as necessary, counting strands if practical, measuring several strand diameters
Joints (see 3.4.1.3).	Visual
Strippability (see 3.4.2).	Visual
Insulation and fit (see 3.4.3).	Visual
Concentricity of sheath (see 3.4.5).	See 4.7.3
Concentricity of insulation (see 3.4.5).	See 4.7.3
Finish or color of sheath (see 3.6.2 and 3.7).	Visual, pushing shielding back as necessary
Age limit (see 3.9).	Same as above
Splices in shielding strands (type II only) (see 3.4.4.1).	Visual
Coverage of shielding (type II only) (see 3.4.4.2).	Measuring pitch, and cable diameter, computation
Color of insulation (class B only) (see 3.6.1.2).	Visual
Marking on sheath (see 3.8).	Visual, pushing shielding back as necessary
Workmanship (see 3.10).	Visual, pushing shielding back as necessary

Note:

^{1/} SIE = Standard Inspection Equipment.

4.5.2 Sampling inspection.

4.5.2.1 Lot formation. Unless otherwise specified (see 6.2), a lot shall consist of the minimum of the following two quantities: all units of product (see 6.4) of the same military PIN produced by one manufacturer during one month; or 300 units of product of the same military PIN.

4.5.2.2 Sampling. Unless specified otherwise in the acquisition documents (see 6.2), sampling inspection shall consist of the tests specified in table VI. These tests shall be performed on a production lot basis. The inspection sample shall be product selected at random from the production lot without regard to quality and shall be of the size specified in table IX. A 4-foot length shall be cut from the end of each sample in order to conduct the tests specified in tables VI and VIII and 4.5.2.2.1. If one or more defects are found in the inspection sample, then the production lot shall be inspected for that particular defect and defects removed. A second inspection sample shall be selected from the production lot and all sampling tests again performed. If one or more defective items are found in the second inspection sample, the production lot shall be rejected and shall not be supplied to this specification.

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TABLE IX. Inspection sample.

Production lot size ^{1/}	Sample size
1	1
2 to 8	2
9 to 15	3
16 to 25	5
26 to 50	8
51 to 90	13
91 to 150	20
151 to 280	32
281 to 500	50
501 to 1200	80
1201 to 3200	125
3201 to 10000	200
10001 to 35000	315

Note:

^{1/} Lot size will be based on number of reels, spools, or coils of product.

4.5.2.2.1 Type II cables. During examination of type II cables for material, splices, and coverage of shielding, the sheath shall be removed from the cable, and inspection of shielding shall be performed in accordance with table VIII. Examination for insulation diameter and color, and conductor cross-section shall be accomplished by cutting the sheath, tape, and filling compound away as necessary and inspecting as indicated in table VIII.

4.6 Control tests.

4.6.1 Sampling. Unless otherwise specified (see 6.2), a sample of cable of length sufficient to perform the tests indicated in 4.6.2 shall be selected after the first 500 feet of cable of a given military PIN has been produced. Thereafter, two samples of the length specified above shall be selected every month throughout the duration of the contract, except that a length shall not be selected for control testing until 50,000 feet of cable, having the same military PIN has been produced since the last control sample length was taken. If there has been limited production for a specific product for a period of two years, the qualifying activity has the option of requiring the manufacturer to perform periodic control tests. If there has been no production for a specific product for a period of two years, the qualifying activity has the option of requiring the manufacturer to perform periodic control tests prior to the next shipment of product.

4.6.2 Control Tests. Each sample selected in accordance with 4.6.1 shall be identified as to production period and shall be cut into three 2-foot specimens and two 3-foot specimens. Each 2-foot specimen shall be subjected to a different test specified in 4.7.4.8 and subsequently to the tests specified in 4.7.4.6 and 4.7.4.2 in that order. One 3-foot specimen shall be subjected to the tests specified in 4.7.4.5 and 4.7.4.2 in that order. The other 3-foot specimen shall be subjected to the test specified in 4.7.4.10 and subsequently to the test specified in 4.7.4.2.

4.6.3 Failure. If a sample fails to pass any periodic control test, the manufacturer shall immediately notify the qualifying activity and cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken.

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After the corrective action has been taken, the periodic control test shall be repeated on additional samples (all inspections, or the inspection which the original sample failed, at the option of the qualifying activity). Sampling tests (and periodic control tests, if applicable) may be reinstituted; however, final acceptance shall be withheld until the periodic control tests have shown that the corrective action was successful. In the event of failure after inspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.7 Methods of inspection.

4.7.1 Materials and construction. Use of proper materials and construction methods shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.7.2 Examination. The cable shall be examined for proper construction as specified in table VIII.

4.7.3 Concentricity. The maximum and minimum wall thickness of each insulator and the sheath shall be measured at one end of the test sample. Suitable magnification shall be used if necessary. The ratio of each minimum wall thickness to the corresponding maximum wall thickness shall also be computed. (If the cable has two conductors, the sheath measurements shall be omitted.)

4.7.4 Performance.

4.7.4.1 In-process.

4.7.4.1.1 Insulation flaws. Each length of insulated conductor shall be passed through the suspended chains of the test electrode prior to being assembled into a finished cable. An alternating voltage, as specified in table II, shall be applied between the conductor and the test electrode (chains) so that each point on the insulated conductor surface shall be within a fraction of an inch of at least one chain for not less than 0.15 second. A length of insulated conductor completely surrounding each insulation flaw revealed by this procedure shall be removed.

4.7.4.1.1.1 Test electrode. The test electrode shall be an arcing electrode especially designed for detecting insulation flaws in finished cable and cable components. It shall contain closely spaced bead chain or fine link mesh, suspended from one end. The chains shall be electrically connected and cover an area of sufficient dimensions so that all of the surface of the cable or insulated conductor is within a fraction of an inch of at least one chain for the length of time specified in the respective test.

4.7.4.1.2 Finished cable flaws. All finished cable shall be tested as specified herein. The cable conductors shall be connected electrically. The cable shall be passed through the suspended chains of the test electrode in the same manner specified for the insulated conductor in 4.7.4.1.1. Each point on the sheath surface shall be within a fraction of an inch of at least one chain for at least .15 second. While the cable is passing through the electrode (chains), an alternating voltage, as specified in table III, shall be applied between the (uninsulated) conductors and the test electrode. A length of finished cable completely surrounding each finished cable flaw shall be removed.

4.7.4.2 High voltage to ground. The separator, insulation, braid, tape or wrap, sheath, and shielding shall be removed from each end of the test specimen leaving the conductor ends bare for a length of one to two inches. The specimen shall be formed into a loop with the ends of the conductors twisted together. If class B cable is being tested, the individual conductors shall be electrically connected. The loop shall be immersed in salt water containing 5% sodium chloride, by weight. No less than 3 inches nor more than 6 inches of each end of each specimen shall protrude above the surface of the salt water. Except as specified in 4.7.4.8.1 for the liquid immersion test (salt-water specimens), the specimen shall be conditioned in the salt water for five hours. An alternating voltage with a frequency of 60 Hz shall be applied between the (uninsulated) conductor(s) and the water for not less than one minute. The voltage

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shall be as specified in table IV. Cables which have two or more conductors of different sizes falling under different test voltages in table IV shall be tested at the higher voltage. The specimen shall be observed for physical signs of breakdown.

4.7.4.3 High voltage between insulated conductors (class B only). After external shielding is removed, the sheath, tape or wrap, and filling compound shall be removed from both ends of the specimen for a length sufficient to perform the test. Any internal shielding or cloth braid that becomes exposed shall be removed also. A length of insulation and separator sufficient to make electrical contact shall be stripped from all the loose, insulated conductors on one end. Suitable electrical connectors may be attached for convenience. All of the insulated conductors except one shall be grounded. The sheath and the remaining internal shielding shall be insulated from ground. The ungrounded, insulated conductor shall be physically separated from the other insulated conductors to prevent arcing through the air. An alternating voltage of 6,000 V rms with a frequency of 60 Hz shall be applied to the ungrounded conductor for one minute. The same process shall be repeated with each conductor ungrounded. The specimen shall be observed for physical signs of breakdown.

4.7.4.4 Fungus resistance. The specimens shall be subjected to fungus as specified in ASTM G21. During qualification testing, one specimen shall be removed from incubation after 30 days and subjected to the test specified in 4.7.4.2. One specimen shall be removed from incubation after 60 days and subjected to the same test. The remaining specimens shall be removed from incubation after 90 days and subjected to the same test.

4.7.4.5 High temperature resistance. The insulated conductor(s) shall be stripped for a distance of one inch at each end of the specimen. The test specimen shall be suspended around a mandrel having a diameter of not more than five times the nominal cable diameter. A weight of not less than five pounds for each 1/4-inch of cable diameter shall be attached to each end of the sample. The specimen, on the mandrel with the weights freely suspended, shall be placed in a circulating air oven maintained at 250 ± 2 °F for a period of 120 hours. At the conclusion of the 120-hour period, the specimen shall be removed from the oven and allowed to cool to room temperature. When cool, the weights shall be removed from the specimen and the specimen shall be removed from the mandrel. The bent portion of the specimen shall then be bent again not less than 180 degrees (°) around the mandrel in the opposite direction with the opposite side of the cable in contact with the mandrel, at a uniform rate such that the complete 180° bend is accomplished in 10 seconds. After being subjected to the remaining qualification or control tests specified for the specimen, the specimen shall be inspected for evidence of breakdown of the insulation and sheath. The insulated conductor(s) shall then be stripped and inspected for evidence of pitting or corrosion.

4.7.4.6 Low temperature resistance (cold bend). The specimen shall be laid out straight in a suitable low temperature chamber and shall be subjected to an ambient temperature of -65 ± 3 °F for 96 hours. At the conclusion of the refrigeration period and while at -65 ± 3 °F, the specimen shall be bent 180° around a mandrel having a diameter of not more than 10 times the nominal outside diameter of the specimen, at the uniform rate of one 180° bend in 10 seconds. The specimen shall not show evidence of cracking, breaking, separation, or other damage.

4.7.4.7 Oil absorption. The specimen shall be suspended for 20 hours in the test liquid with not less than 1-1/2 inches, nor more than 2 inches of each specimen end protruding above the surface of the liquid. The test liquid temperature shall be maintained at not less than 158 °F nor more than 165 °F during the test. Before immersion, the diameter of the cable shall be measured at five or more approximately equally spaced locations along the length. This shall include measurements in two perpendicular directions. At the conclusion of the immersion period, the specimen shall be removed from the test liquid, allowed to cool to room temperature, and then be wiped dry with a clean, soft, absorbent, dry cloth. The test specimen shall then be remeasured at the same locations at which the pre-immersion measurements were taken and the percent increase in diameter computed.

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4.7.4.7.1 Immersion test apparatus. The immersion test apparatus shall include a bath of adequate dimensions to hold the test specimen, with means for maintaining the test liquid at the specified temperature throughout the test.

4.7.4.7.2 Test liquid. The test liquid shall be a petroleum base oil (see 6.7) with the following properties as determined by the methods indicated below and specified in FED-STD-791:

- a. Viscosity, Saybolt Universal (method 304) 155 ± 5 seconds (measured at 100 °F).
- b. Aniline point, (method 3601) 157.1 ± 1.8 °F.
- c. Flash point, (method 1103) 330 ± 5 °F.

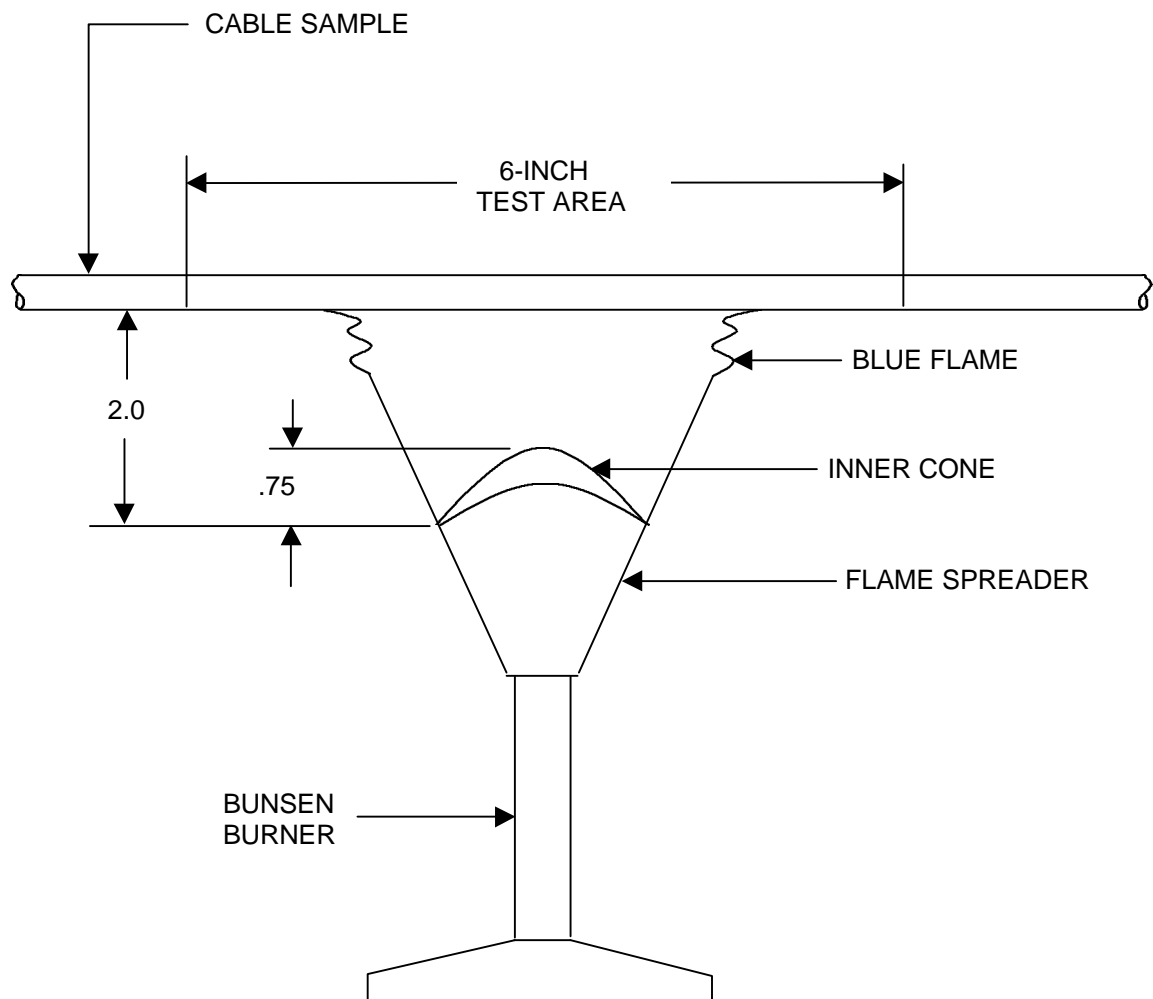
4.7.4.8 Liquid immersion. Each of three specimens shall be tested using a different one of the liquids specified in 3.5.9. The immersion test apparatus shall be used. Items such as the sheath, filling compound, tape, or wrap shall be removed from a distance of 1-1/2 inches from each end of the specimen to expose the insulated conductors. The specimen shall be immersed for 20 hours in the liquid with no less than 1-1/2 inches and no more than 2 inches of each end protruding above the surface of the liquid. At the end of the 20-hour period, the specimen shall be removed from the liquid and its surface wiped dry with a clean, soft, absorbent, dry cloth. The specimen shall be examined for evidence of damage.

4.7.4.8.1 Subsequent testing. When the specimen which has been immersed in salt water in accordance with 4.7.4.8 is subsequently subjected to the test specified in 4.7.4.2, the 5-hour immersion specified therein may be omitted.

4.7.4.9 Flammability. The specimen shall be tested using the flammability test apparatus. The specimen shall be suspended taut in a horizontal position as shown on figure 1, within a partial enclosure which allows a flow of air sufficient for complete combustion but which is free from drafts. (If the specimen is type II cable with external shielding, this shielding shall be removed.) A test area shall be marked in the center of the suspended cable as shown on figure 1. The gas flame specified on figure 1 shall be applied, as shown, to the test area so that the flame is the same distance from either edge of the test area. The flame shall be applied for 30 seconds if the cable specimen has a nominal diameter equal to or less than 1/2 inch, and 45 seconds if the cable has a larger nominal diameter. The cable shall be observed for evidence of burning particles falling from the cable. The time required for the flame to reach one of the edges of the test area shall be measured. The rate of travel in inches per minute shall be recorded. The time required for the cable to cease flaming after the gas flame has been withdrawn shall be recorded.

4.7.4.9.1 Flammability test apparatus. The flammability test apparatus shall include a Bunsen burner equipped with a wing-top flame spreader having an opening not less than 1/16 inch wide and 2 inches long.

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NOTE: All dimensions are nominal, in inches.

FIGURE 1. Laboratory setup for the flammability test.

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4.7.4.10 Ozone resistance. The specimens shall be tested using the ozone test apparatus. The specimens shall be wrapped once around the appropriate mandrel and the two ends of the cable shall be bound together with twine or tape at the point where they intersect. After being placed on the mandrel, the specimens shall be conditioned at ambient room temperature for 45 minutes. The specimens shall then be placed in the test exposure chamber for 300 hours for the qualification test and for 168 hours for the control test. The tests shall be conducted at 100 ± 5 °F. Immediately after the completion of the test period, each sample shall be examined for evidence of cracking using 7-power magnification. The bound and taped portion of the cable and the area adjacent thereto shall not be examined. Immediately after the examination, each sample shall be subjected to the high voltage to ground test specified in 4.7.4.2.

4.7.4.10.1 Ozone test apparatus. The ozone test apparatus shall include an exposure chamber containing air mixed with ozone in the proportion of 50 ± 5 parts per 100 million parts of atmospheric air by volume, and mandrels of the size appropriate for the test specimen as specified below:

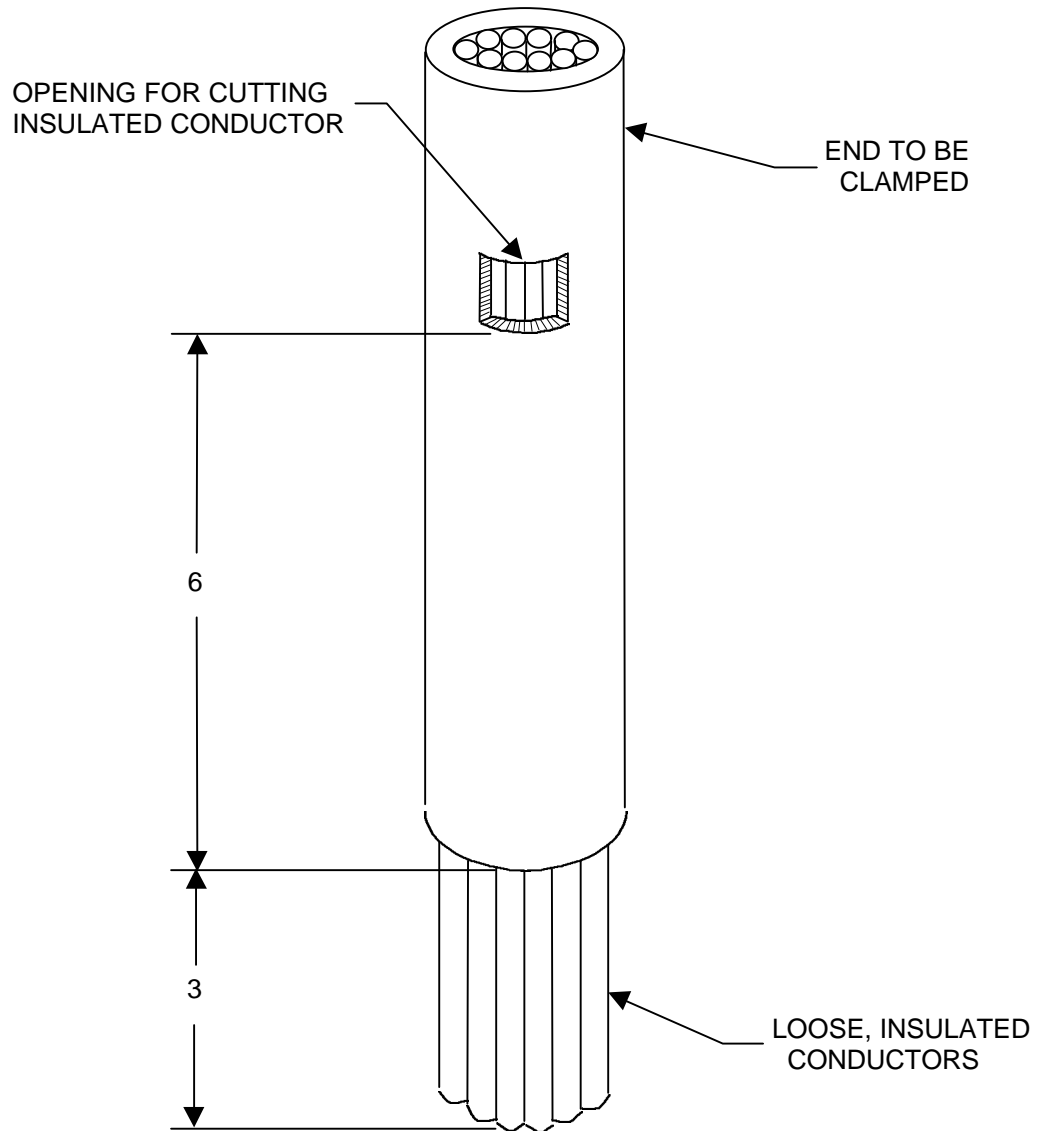
<u>Cable outside diameter (OD)</u>	<u>Mandrel diameter</u>
Less than 1/2 inch	4 times the cable OD
At least 1/2 inch but less than 3/4 inch	5 times the cable OD
At least 3/4 inch but less than 1-1/4 inch	6 times the cable OD
At least 1-1/4 inch but less than 1-3/4 inch	8 times the cable OD
At least 1-3/4 inch and above	10 times the cable OD

4.7.4.11 Longitudinal shifting (class B only). The specimen shall be cut as shown on figure 2. The sheath, tape, and filling compound shall be removed from one end of the cable as indicated. The rectangular opening shall be cut no longer than necessary to sever one or two insulated conductors. The end indicated on figure 2 shall be securely clamped in a fixture with the sample suspended vertically. A mark shall then be placed on the lower end of an insulated conductor that has been severed through the rectangular opening. The mark shall be at the point where the loose insulated conductor meets the sheath. A 20-pound weight shall be attached to the conductor and suspended freely for 5 minutes. The distance of the mark from the sheath shall then be measured to determine longitudinal shifting of the insulated conductor.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department or Defense Agency automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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NOTE: All dimensions are nominal, in inches.

FIGURE 2. Preparation of sample for longitudinal shifting test.

6. NOTES

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(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This specification is being retained as a military detail specification because of environmental requirements, including operational temperatures from -65 °F to 250 °F. Cable procured by this specification is primarily intended for tank-automotive applications where it may be subjected to severe environmental conditions. Applications for types I and II and class B cables are shown below.

6.1.1 Type I. This cable is normally used in applications not requiring radio interference suppression or where such suppression is accomplished by methods other than shielding of cables.

6.1.2 Type II. This cable is normally used where shielding of cables for radio interference suppression is required.

6.1.3 Class B. This cable should be used only in connector to connector situations involving the entire cable assembly. It should not be used in situations involving removing of the sheath and exposure of the insulated conductor to ambient environment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Type and class of cable (see 1.2).
- c. Title, number, and date of applicable specification sheet (see 1.2.1, 3.2, and 3.4).
- d. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- e. Applicable PIN and length of cable (see 3.4)
- f. Any special color coding for class B cable insulation (see 3.6.1.2).
- g. Age requirements, if other than as specified (see 3.9).
- h. Inspection conditions, if other than as specified (see 4.3).
- i. Lot formation, if other than as specified (see 4.5.2.1).
- j. Sampling for conformance and control testing, if other than as specified (see 4.5.2.2 and 4.6.1).
- k. Packaging requirements (see 5.1 and 6.8).
- l. Data requirements, including qualification and qualification retention data requirements.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 13486 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Defense Supply Center Columbus (DSCC-VQP), 3990 East Broad Street, Columbus, Ohio 43213-1199.

6.3.1 Special provision for establishing qualification. Qualification of cable of a given type and part number will be recognized as establishing qualification for other cable of similar construction by the same manufacturer at the discretion of the qualifying activity in accordance with table X. The groups specified in table X have no bearing on the classification specified in 1.2.

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TABLE X. Extension of qualification.

Group	PIN	Former part number (reference)	Qualification of any item in the grouping covers all items in the grouping, see below:
1	M13486/1-3 M13486/1-4 M13486/1-5 M13486/1-6	7722204 8690176 7720853 7056679	All of group 1
2	M13486/1-7 M13486/1-9 M13486/1-10	7056678 7056677 7056676	All of group 2
3	M13486/1-11 M13486/1-12 M13486/1-14 M13486/1-15 M13486/1-17	8690175 7056675 7056674 None 7056674-1	All of group 3
4	M13486/5-1 M13486/9-1 M13486/10-1	7732849 7056683 7056684	All of group 4
5	M13486/12-1	7056686	All of groups 4 and 5
6	M13486/13-1	7724579	All of group 6
7	M13486/2-1 M13486/2-2	8345775 8345776	All of group 7
8	M13486/1-1	None	All of group 8
9	M13486/1-2	None	All of group 9
10	M13486/1-8	None	All of group 10

6.4 Definitions.

Braid (shielding). An interwoven tubular metallic construction defined in terms of ends and carriers.

- a. Strand - The basic single individual copper wire elements utilized in the braid.
- b. Carrier - The group of strands acting together in forming the braid.
- c. Description - The braid is normally described in terms of the diameter of the end; the number of strands per carrier, and the number of carriers utilized in forming the braid.
- d. Number of carriers - The number of groups of strands required to completely enclose the cable circumference.

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Conductor. - A collection of individual strands which is to be insulated from other conductors in the assembled cable.

Insulated conductor. - A conductor with a separator that has been covered with insulating compound.

Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste.

Sample. - A length of cable selected as specified herein, to be cut into shorter lengths to perform the inspection specified herein.

Sheath. - The outer covering or jacket of the finished cable.

Shield. - A tubular braid made of copper strands used to provide reinforcement and interference suppression both for single cables (see MIL-DTL-13486/2) and for multiple conductor assemblies (see MIL-DTL-13486/13).

Solid waste. Solid waste is (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; or (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges.

Specimen. - A length of insulated conductor, or cable, which is to be subjected to examination as specified herein or to one of the tests specified herein. A specimen may consist of a long length of insulated conductor or finished cable. A specimen may also be a short length of cable cut from a sample.

Strand. - A small diameter solid coated wire.

Tape. - A helically wound strip in one or both directions.

Unit of product. - One entire length of finished cable.

6.5 Cross-reference. A cross-reference of older (that is, prior to revision B) part numbers (referred to herein as "former part numbers") to current PINs is provided in the individual specification sheet when applicable.

6.6 Part or Identifying Number (PIN). The PINs to be used for cables acquired to this specification are created as follows:

<u>M</u>	<u>13486/X-</u>	<u>X</u>
Prefix to indicate military specification	Specification sheet number	See applicable specification sheet

6.7 Test liquid. The test liquid used in the oil absorption test specified in 4.7.4.7 is the same as ASTM No. 3 petroleum base oil (see ASTM D471).

6.8 Packaging. MIL-C-12000 has been used in the past to specify requirements for the preservation, packing, unitization, and marking of cable, cord, and wire for storage and domestic and overseas shipments.

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6.9 Subject term (key word) listing.

Flame resistant
Flexible
Fungus resistant
High temperature resistant
Low temperature resistant
Low swell
Neoprene
Oil resistant
Ozone resistant
Polychloroprene
Scuff resistant
Separator
Sheathed electrical cable
Waterproof

6.10 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

Custodians:

Army - AT
Navy - SH
Air Force - 11
DLA - CC

Preparing activity:
DLA - CC

(Project 6145-2192)

Review activities:

Army - CR, EA
Air Force - 71, 80, 82, 84, 99

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL			
INSTRUCTIONS			
<p>1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.</p> <p>2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.</p> <p>3. The preparing activity must provide a reply within 30 days from receipt of the form.</p> <p>NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.</p>			
I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-DTL-13486D	2. DOCUMENT DATE (YYYYMMDD) 2000/08/04	
3. DOCUMENT TITLE Cables, Special Purpose, Electrical: Low-Tension, Heavy-Duty, Single Conductor and Multi-Conductor, Shielded and Unshielded, General Specification for			
4. NATURE OF CHANGE <i>(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)</i>			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME <i>(Last, First, Middle Initial)</i>		b. ORGANIZATION	
c. ADDRESS <i>(Include zip code)</i>	d. TELEPHONE <i>(Include Area Code)</i> (1) Commercial (2) DSN <i>(if applicable)</i>	7. DATE SUBMITTED (YYYYMMDD)	
8. PREPARING ACTIVITY			
a. NAME Defense Logistics Agency Defense Supply Center, Columbus (DSCC-VAI)		b. TELEPHONE <i>(Include Area Code)</i> (1) Commercial 614-692-0538 (2) DSN 850-0538	
c. ADDRESS <i>(Include Zip Code)</i> P.O. Box 3990 Columbus, OH 43216-5000		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6621 Telephone (703) 767-6888 DSN 427-6888	

DD Form 1426, FEB 1999 (EG)

PREVIOUS EDITION IS OBSOLETE.

WHS/DIOR, Feb 99