INCH-POUND
MIL-DTL-49055F
14 November 2012
SUPERSEDING
MIL-DTL-49055E
9 January 2008

DETAIL SPECIFICATION

CABLES, POWER, ELECTRICAL, (FLEXIBLE, FLAT, UNSHIELDED), (ROUND CONDUCTOR), GENERAL SPECIFICATION FOR

Reactivated after 2 August 2006 and may be used for new and existing designs and acquisitions.

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

1. SCOPE

1.1 Scope. This specification covers flexible, flat, unshielded electrical cables with either solid or stranded inner round conductors.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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 specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Comments, suggestions, or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: DSCC-VAI, P.O. Box 3990, Columbus, Ohio 43218-3990, or email to WireCable@dscc.dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

FEDERAL SPECIFICATION

TT-I-735	-	Isopropyl Alcohol

FEDERAL STANDARD

FED-STD-228	-	Cable and Wire, Insulated; Method of Testing.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-5624	-	Turbine Fuel, Aviation, Grades JP-4, JP-5 and JP5/JP-8ST
MIL-PRF-23699	-	Lubricating Oil, Aircraft Turbine Engines, Synthetic Base, NATO Code Number 0-156

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-104	-	Limits for Electrical Insulation Color.
MIL-STD-202	-	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-681	-	Identification Coding and Application of Hook Up and Lead Wire.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, 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 documents are the issues of the documents cited in the solicitation or contract (see 6.2).

ASTM INTERNATIONAL

ASTM-B3	-	Soft or Annealed Copper Wire
ASTM-B33	-	Tinned Soft or Annealed Copper Wire for Electrical Purposes
ASTM-B286	-	Copper Conductors for Use in Hookup Wire for Electronic Equipment
ASTM-B298	-	Silver-Coated Soft or Annealed Copper Wire
ASTM-B355	-	Nickel-Coated Soft or Annealed Copper Wire
ASTM-D740	-	Methyl Ethyl Ketone
ASTM-D3032	-	Hookup Wire Insulation
ASTM-G21	-	Determining Resistance of Synthetic Polymeric Materials to Fungi

(Copies of these documents are available online at http://www.astm.org or from the American Society for Testing and Materials, P.O. Box C700, 100 Barr Harbor Drive, Conshohocken, PA 19428-2959).

NCSL INTERNATIONAL

NCSL-Z540.3	-	Requirements for the Calibration of Measuring and Test Equipment

(Copies of this document are available from http://www.ncsli.org or from NCSL International, 2995 Wilderness Place, Suite 107, Boulder, CO 80301.)

UNDERWRITERS LABORATORIES (UL)

UL 1581	-	Reference Standard for Electrical Wires, Cables, and Flexible Cords

(Copies of these documents are available online at http://www.ul.com or from the Underwriters Laboratories, Inc., Publication Stock, 333 Pfingsten Road, Northbrook, IL 60002-2096.)

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

3.2 Qualification. Cables furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.6 and 6.3).

3.3 Materials. The materials for the principal components of the cable shall be as specified herein. Prior approval to use substitute material must be obtained from the qualifying activity. When a definite material is not specified, a material shall be used that will enable the finished products to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product. All materials used in the manufacture of cables furnished hereunder shall be of such quality and form that the finished product conforms to the requirements of this specification. All materials used shall conform to the requirements specified herein.

3.3.1 Insulation material. Insulation materials are listed in table I. These materials shall have temperature ratings and aging temperatures as specified herein.

3.3.2 Conductors. Conductors shall be stranded, bare or coated, as specified (see 3.1). All conductors shall conform to ASTM-B286 requirements.

3.3.2.1 Conductor strands.

a. Bare copper conductor. Bare copper conductors shall conform to soft or annealed copper conductor in accordance with ASTM-B3.

b. Tin-coated copper conductor. Tin-coated copper conductor shall conform to the continuity and adherence coating requirements for tinned, soft or annealed copper conductor in accordance with ASTM-B33.

c. Silver-coated copper conductor. Silver-coated copper conductor shall have a thickness of not less than 40 microinches of silver and meet the continuity of coating requirements of ASTM-B298.

d. Nickel-coated copper conductor. Nickel-coated copper conductor shall have a thickness of not less than 50 microinches of nickel and meet the continuity of coating requirements of ASTM-B355.

TABLE I. Insulation materials, ratings, and aging temperatures.

Material 1/	Temperature rating (max) 1/	Aging temperature
Polyvinylchloride (PVC) 2/	105°C	136°C
Polyethyleneterephthalate (PET)	105°C	136°C
Polyvinylidene fluoride (PVDF)	135°C	150°C
Polyalkene, crosslinked	150°C	225°C
Ethylene tetrafluoroethylene (ETFE)	150°C	200°C
Ethylene tetrafluoroethylene modified, crosslinked	150°C	200°C
Ethylene-chlorotrifluoroethylene (ECTFE)	150°C	200°C
Fluorinated ethylene propylene (FEP)	200°C	230°C
FEP-polyimide tape	200°C	230°C
Polytetrafluoroethylene (PTFE)	260°C	300°C
Perfluoroalkoxy (PFA)	260°C	285°C

1/ For information only.
2/ Not for aerospace application.

3.3.2.2 Stranded conductors. Stranded conductors shall be concentrically-unilay or concentrically stranded in accordance with ASTM-B286. Conductors shall not be coated after stranding (no overcoating). Individual strands shall be coated before stranding and meet all the requirements of the basic wires specified in 3.3.2.1.

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

3.4 Design and construction. Design and construction of the cable shall be as specified herein and in the applicable specification sheet (see 3.1).

3.4.1 Conductors. The size and number of the conductors shall be as specified in the applicable specification sheet.

3.4.2 Wire spacing. The acceptable spacing of the wires in the cable shall be as specified in the applicable specification sheet.

3.4.3 Finished cable. Finished cable shall conform to the configuration as specified in the applicable specification sheet.

3.4.3.1 Lengths and splices. All delivered cable shall be free of conductor splices. There shall be no splices of the cable as a whole unit. Unless otherwise specified (see 4.4.1, 6.2 and table II), minimum lengths required are 10 feet with a minimum average of 25 feet per shipment.

3.4.3.2 Cable weight. The maximum cable weight per thousand feet shall be in accordance with the applicable specification sheet (see 3.1 and 4.6.1.1).

TABLE II. Finished cable lengths.

Cable width	Minimum percentage of footage in shipment with lengths greater than:			
Inches	100 ft	50 ft	25 ft	10 ft
.5	50	80	---	100
1.0	---	50	80	100
2.0	---	50	80	100

3.4.3.3 Color. The color shall be in accordance with the applicable specification sheet (see 3.1) and shall be in accordance with MIL-STD-104, class 1.

3.5 Insulation flaws. One hundred percent of the finished cable shall be subjected to the insulation flaws test specified in 4.6.3. Test voltages shall be as specified in the applicable specification sheet (see 3.1).

3.6 Dielectric withstanding voltage. Cables shall withstand the voltage specified in the applicable specification sheet (see 3.1), and there shall be no evidence of breakdown or flashover.

3.7 Insulation resistance. Cable insulation resistance shall be not less than 500 megohms–1,000 feet when subjected to the test specified in 4.6.5.

3.8 Conductor continuity. One hundred percent of the finished cable shall be subjected to the conductor continuity test specified in 4.6.8. There shall be no indication of discontinuity in any conductor.

3.9 Conductor resistance. Cable conductor direct current (dc) resistance shall not exceed the value specified in the applicable specification sheet (see 3.1).

3.10 Thermal shock. Cables shall withstand the temperature cycles specified (see 3.1), without cracking of the insulation and with no evidence of delamination or visible change. The insulation shrinkage shall not be greater than that specified in the applicable specification sheet (see 3.1).

3.11 Flammability. Cables shall not convey flame along their length and shall not convey flame to combustible materials in the vicinity when subjected to the flammability test specified in 4.6.9.

3.12 Folding. Cables shall withstand 180° transverse folding and unfolding without indicating loss of continuity. There shall be no evidence of cracking, delamination, or fracturing, and the cables shall subsequently meet the dielectric withstanding voltage requirement.

3.13 High-temperature aging. Cables shall withstand high-temperature aging. There shall be no cracking or separation of the insulation, and the cables shall subsequently meet the dielectric withstanding voltage requirement.

3.14 Flexing endurance. Cables shall exhibit no discontinuity or evidence of cracking, fracturing, delamination, or rupturing when subjected to the flexing endurance test specified in 4.6.12.

3.15 Moisture resistance. The insulation resistance of the cables shall be not less than the value specified in the specification sheet (see 3.1), and the insulation shall not exhibit any evidence of delamination, when the cables are subjected to the test specified in 4.6.13.

3.16 Low pressure (maximum rated temperature). The cable insulation shall show no evidence of shrinkage greater than .0625 inch (1.6 mm) at either end of the cable specimen, ballooning, bubbling, voids, or insulation weight loss greater than 1 percent, when subjected to the test specified in 4.6.14.

3.17 Fungus resistance. The cables shall be fungus resistant.

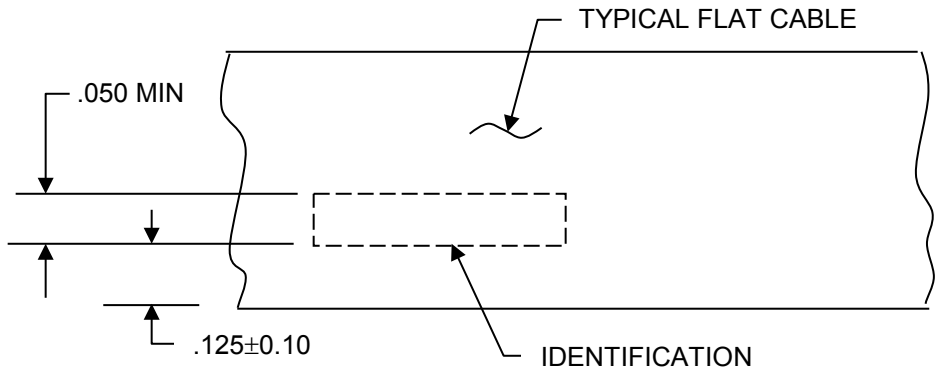
3.18 Fluid immersion. The cables shall show no change in weight greater than 5 percent and no cracking or separation of the insulation when subjected to the immersion tests specified in 4.6.16.

3.19 Marking. Unless otherwise specified (see 3.1 and 6.2), cables shall be marked in accordance with the following:

a. Part or Identifying Number (PIN) (see 3.1).

b. Manufacturer’s name or symbol, CAGE code, and the date shall be in accordance with MIL-STD-1285.

The printing shall be legible and in a contrasting color. Color used for identification coding shall be in accordance with MIL-STD-681. All number 1 conductors shall be identified. The printed marking shall be located along the reference edge of the cable at 12 inch (305 mm) maximum repeat. Marking is required on cables with 0.050 inch (1.3 mm) (or wider spacing of conductors (see figure 1)).



NOTES:
1. Dimensions are in inches.
2. Metric equivalents are for information only.

FIGURE 1. Identification marking.

3.20 Durability of identification. The identification marking shall withstand a minimum of 125 cycles (250 strokes) when tested as specified in 4.6.17.

3.21 Shrinkage. The cable shall have no separation of the insulation and the insulation shrinkage shall be not greater than that specified in the applicable specification sheet (see 3.1) when tested as specified in 4.6.18.

3.22 Workmanship. The cable shall be free of kinks, abrasions, and cracked or peeled surfaces. The cable shall be a uniform and consistent product and shall be free from defects that adversely affect the serviceability of the product.

4. VERIFICATION

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

a. Qualification inspection (see 4.4).

b. Conformance inspection (see 4.5).

4.2 Requirements cross-reference matrix. Table III provides a cross-reference matrix of section 3 requirements tested or verified in the document.

TABLE III. Requirements cross-reference matrix.

Requirement paragraph	Verification paragraph	Requirement paragraph	Verification paragraph
3.2	4.4	3.10	4.6.7
3.3	4.6.1	3.11	4.6.9
3.3.1	4.6.1	3.12	4.6.10
3.3.2	4.6.1	3.13	4.6.11
3.4	4.6.1	3.14	4.6.12
3.4.1	4.6.1	3.15	4.6.13
3.4.2	4.6.1	3.16	4.6.14
3.4.3	4.6.1	3.17	4.6.15
3.4.3.1	4.6.1	3.18	4.6.16
3.4.3.3	4.6.1	3.20	4.6.17
3.5	4.6.2, 4.6.3	3.21	4.6.18
3.6	4.6.4	3.22	4.6.1
3.7	4.6.5		
3.8	4.6.8		
3.9	4.6.6		

4.3 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following ambient conditions: 77±18°F, site pressure, and site uncontrolled relative humidity. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with NCSL-Z540.3.

4.4 Qualification inspection. Qualification inspection (see 6.2 and 6.3) shall be performed at a laboratory acceptable to the Government on sample units produced with equipment and procedures normally used in production. Cable supplied under the contract or purchase order shall be manufactured the same way as the sample tested and found satisfactory except for changes previously approved by the Government.

4.4.1 Sample size. A sample consisting of two specimens of finished cable shall be submitted to the qualification tests in table IV. Each specimen shall be a minimum of 40 linear feet of continuous unspliced cable.

TABLE IV. Qualification inspection.

Inspection	Requirement paragraph	Verification paragraph
Group I	---	---
Visual and mechanical inspection, cable dimensions, and construction	3.3 thru 3.4.3.3	4.6.1
Insulation flaws	3.5	4.6.3
Dielectric withstanding voltage	3.6	4.6.4
Insulation resistance	3.7	4.6.5
Conductor continuity	3.8	4.6.8
Conductor resistance	3.9	4.6.6
Thermal shock	3.10	4.6.7
Flammability	3.11	4.6.9
Folding	3.12	4.6.10
High-temperature aging	3.13	4.6.11
Flexing endurance	3.14	4.6.12
Moisture resistance	3.15	4.6.13
Low pressure (maximum rated temperature)	3.16	4.6.14
Fungus resistance	3.17	4.6.15
Fluid immersion	3.18	4.6.16
Durability of identification	3.20	4.6.17
Shrinkage	3.21	4.6.18

4.4.1.1 Qualification extension. Qualification shall extend to all cables of the same specification sheet with fewer conductors and the same type of construction and coating. When qualifying a different wire (AWG) size construction, the sample size shall consist of two specimens 30 linear feet (minimum) each of continuous unspliced cable. Each specimen shall be subjected to the qualification inspection in table V.

4.4.2 Inspection routine. Samples from the two finished cable lengths shall be subjected to the tests in table IV. Lengths of cable samples shall be as specified in the applicable test paragraph.

4.4.3 Failure. One or more failures shall be cause for refusal to grant qualification approval for the cable.

4.5 Conformance inspection. Conformance inspection shall consist of group A and B inspections.

4.5.1. Inspection lot. An inspection lot shall consist of all cables covered by a single specification sheet (see 3.1), produced under essentially the same conditions and offered for inspection at one time.

TABLE V. Qualification inspection by extension.

Inspection	Requirement paragraph	Verification paragraph
Group I	—	—
Visual and mechanical inspection, cable dimensions, and construction	3.3 thru 3.4.3.3	4.6.1
Insulation flaws	3.5	4.6.3
Dielectric withstanding voltage	3.6	4.6.4
Insulation resistance	3.7	4.6.5
Conductor continuity	3.8	4.6.8
Conductor resistance	3.9	4.6.6
Folding	3.12	4.6.10
Flexing endurance	3.14	4.6.12

4.5.1.1 Sample. Unless otherwise specified (see 6.2), the sample shall consist of that number of randomly selected units of product (see 6.4) specified in table VI.

TABLE VI. 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

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

4.5.1.1.1 Specimens. Specimens for inspection shall be taken from each unit of product that forms part of the sample. A specimen shall be a length of cable drawn from a unit of product.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspections specified in table VII, subgroups 1, 2, and 3.

4.5.1.2.1 Subgroup 1. Unless otherwise specified (see 6.2), subgroup 1 inspection shall consist of the tests specified in table VII. 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 VI. Repetitive dimensions (such as conductor spacing) shall be checked on a random 5 percent minimum but not less than 2 spaces per specimen. Subgroup 1 inspections may be performed in any order. 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.

TABLE VII. Group A inspection.

Inspection	Requirement paragraph	Verification paragraph
Subgroup 1	—	—
Visual and mechanical inspection, cable dimensions, and construction	3.3 thru 3.4.3.1 and 3.4.3.3	4.6.1
Marking	3.19	4.6.1
Workmanship	3.22	4.6.1
Subgroup 2	—	—
Insulation flaws	3.5	4.6.3
Conductor continuity	3.8	4.6.8
Subgroup 3	—	—
Conductor size	3.4.1	4.6.1
Cable color	3.4.3.3	4.6.1
Dielectric withstanding voltage	3.6	4.6.4
Insulation resistance	3.7	4.6.5
Durability of identification	3.20	4.6.17

4.5.1.2.2 Subgroup 2. For subgroup 2, the sample shall be 100 percent of the cable in the inspection lot and every length of cable shall be subjected to the inspection. Any portion of the cable exhibiting breakdown or nonconformity when subjected to the insulation flaws inspection shall be cut out and removed.

4.5.1.2.3 Subgroup 3. For subgroup 3, the sample shall be one length per lot. No defects shall be allowed under this subgroup.

4.5.1.2.4 Disposition of unit of product. Units of product which have passed all the group A inspection may be delivered on the contract or order if the lot is accepted.

4.5.2 Periodic inspection. Periodic inspection shall consist of group B inspection. The delivery of products which have passed group A inspection shall not be delayed pending results of group B inspection but shall be discontinued immediately upon determination of noncompliance of the product with any group B requirement. If there has been limited production of 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.

4.5.2.1 Group B inspection. Group B inspection shall consist of the inspections specified in table VIII. Group B inspection shall be made on sample units selected from inspection lots that have passed the group A inspection. Two test lengths shall be subjected to each test.

TABLE VIII. Group B inspection.

Inspection	Requirement paragraph	Verification paragraph
Conductor resistance	3.9	4.6.6
Thermal shock 1/	3.10	4.6.7
Flammability 1/	3.11	4.6.9
Folding	3.12	4.6.10
High temperature aging 2/	3.13	4.6.11
Flexing endurance	3.14	4.6.12
Moisture resistance 2/	3.15	4.6.13
Low pressure (maximum rated temperature) 2/	3.16	4.6.14
Fungus resistance 3/	3.17	4.6.15
Fluid immersion 2/	3.18	4.6.16
Shrinkage 1/	3.21	4.6.18

1/ Only required for initial certification or when there is a change in material used in manufacturing.
2/ Only required for initial certification, when there is a change in materials used, or when the manufacturing process changes.
3/ Only required for initial certification or when there is a change in materials used. A certificate of compliance is required, stating materials are inert to fungus growth.

4.5.2.1.1 Sampling plan. On a 5-year basis starting from the date of qualification, the lot shall be selected from the cable with largest number of conductors that is covered by a single specification sheet and is in production.

4.5.2.1.2 Failures. If one or more specimens fail to pass group B inspection, the sample shall be considered to have failed.

4.5.2.1.3 Disposition of sample units. Units of product from which a specimen has failed shall not be delivered on the contract or order, even though the inspection lot submitted is accepted.

4.5.2.1.4 Noncompliance. If a sample fails to pass group B inspection, the manufacturer shall notify the qualifying activity and the 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, processes, etc., 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. After the corrective action has been taken, groups A and B inspections shall be repeated on additional sample units (all inspections, or the inspection on which the original sample failed, at the option of the qualifying activity). Group A (and group B, if applicable) inspection may be reinstituted; however, final acceptance and shipment shall be withheld until the group B inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6 Methods of inspection.

4.6.1 Visual and mechanical inspection. The cable shall be inspected to verify that the design, construction, physical characteristics and dimensions, color, weight, marking, and workmanship are in accordance with the applicable requirements.

4.6.1.1 Cable weight. A specimen of cable 26.44±.02 inches (672 ±.51mm) long shall be cut and weighed in grams to the nearest one percent of its weight. The weight of the specimen, after conversion from grams to weight in pounds per 1,000 feet, shall meet the applicable requirement.

4.6.2 Electrical tests. It shall be permissible to wind finished cable on testing spools and reels for electrical tests, and to rewind on shipping spools and reels after completion of the last test.

4.6.3 Insulation flaws. All cable shall be subjected to the insulation flaws test in accordance with method 6211 of FED-STD-228 with the following exceptions and conditions. The cable conductors shall be electrically tied together and grounded. A suitable fault-signaling device for detection of insulation flaws shall be provided. Any flaws detected shall be removed.

4.6.4 Dielectric withstanding voltage. The cable shall be tested in accordance with ASTM-D3032, with the following exceptions: The specimen shall be 26±.062 inches (914±1.6 mm) in length and shall be prepared for high-voltage connection by isolating adjacent conductors from each other. This may be accomplished by carefully cutting into the ends of the specimen .5 and 1.5 inches (13 and 38 mm), respectively, so that adjacent conductors can be bent to opposite sides of the specimen. Remove .25 inch (6.4mm) of insulation from the 1.5 inch (38 mm) end for electrical connections. For the first part of the test, the specified voltage (see 3.1) shall be applied between all conductors electrically connected together and the solution, and for the second part, between each conductor and its adjacent conductors. This may be accomplished by bussing together all conductors bent to one side of the specimen and connecting one high-voltage lead. The conductors bent to the other side shall be treated in a similar manner and connected to the other high-voltage lead. The center 12 inches (308 mm) of the specimen shall be immersed for one hour. Following the test, the specimen shall be examined. Tests shall be run before and after each test specifying dielectric withstanding voltage. When dielectric withstanding voltage and insulation resistance tests are performed on the same samples, the tests may be done in the following sequence:

a. Insulation resistance conductor to conductor in air.

b. Dielectric strength conductor to conductor in air.

c. Immerse samples in salt-water solution.

d. Insulation resistance conductor to solution.

e. Dielectric strength conductor to solution.

4.6.5 Insulation resistance. The specimen shall be prepared in accordance with 4.6.4. A potential of 500+50, -0 volts dc shall be applied for one minute between each conductor and its next adjacent conductor(s) in air. Following this test, the sample shall be immersed to within 6 inches (152 mm) of its ends in the water bath described in 4.6.4 at room temperature for a minimum of one hour. A voltage of 500+50, -0 volts dc shall be applied for one minute between the conductors and water. Insulation resistance, calculated from the equations shown below, shall meet the applicable requirement.

$$\text{Wire to wire megohms – 1,000 feet} = \frac{\text{Specimen resistance (megohms)} \times \text{sample length (2 feet)} \times (\text{no. of conductors} - 1)}{1{,}000}$$

$$\text{Wire to water megohms – 1,000 feet} = \frac{\text{Specimen resistance (megohms)} \times \text{immerse length (1 foot)} \times (\text{no. of conductors})}{1{,}000}$$

4.6.6 Conductor resistance. The dc resistance of the individual conductors of each specimen, 36 to 48 inches (965 to 1020 mm) long, shall be tested in accordance with method 6021 of FED-STD-228, and calculated for performance. The cable shall meet the applicable requirement.

4.6.7 Thermal shock. Cable specimens 38 to 40 inches (965 to 1020 mm) long shall be subjected to five continuous cycles at the high and low temperatures specified (see 3.1). The specimens shall be maintained at each temperature extreme for a minimum of 30 minutes. A maximum dwell time of two minutes shall be allowed for transfer between test chambers. After completion of the fifth cycle, the specimens shall be removed from the test chambers, and allowed to stabilize at room temperature. The specimen shall be examined for evidence of cracking, or shrinkage of the insulation.

4.6.8 Conductor continuity. All cables shall be tested for conductor continuity with an ohmmeter or other suitable testing device.

4.6.9 Flammability. Cables shall be tested for flammability in accordance with the VW-1 flame test of UL 1581. During calibration of the gas flame, the blue inner cone of the flame is to be approximately 1.5 inches high (38 mm) and the temperature at its tip is to be 836 °C (1537 °F) or higher which shall be verified with an accurate measuring device. The cables shall not burn for more than the specified time nor release flaming particles, and the flame shall not travel more than the distance specified in VW-1.

4.6.10 Folding. A specimen of cable 26±.062 inches (914±1.6 mm) shall be folded 180° transversely and pressed between two pieces of smooth-surfaced flat metal twice the width of the cable, with a pressure of 30±1 pounds of force per inch of cable width of the test specimen (see figure 2). After 15±1 minutes under pressure, the specimen shall be unfolded and the pressure reapplied to the unfolded creased portion of the cable for an additional 15±1 minutes. Unless otherwise specified (see 3.1), the test shall be conducted at 23±5 °C. This procedure constitutes one complete cycle. After two complete cycles of folding and unfolding on the same creased portion, the cable shall be checked for continuity and shall be examined for evidence of cracking, fracturing, or rupturing. The cable shall then be subjected to the dielectric withstanding voltage test as specified in 4.6.4.

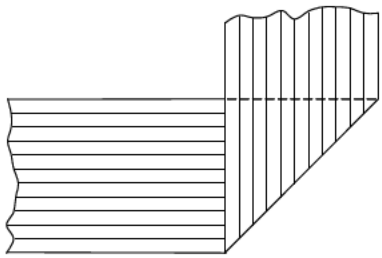


FIGURE 2. Transverse fold (180°).

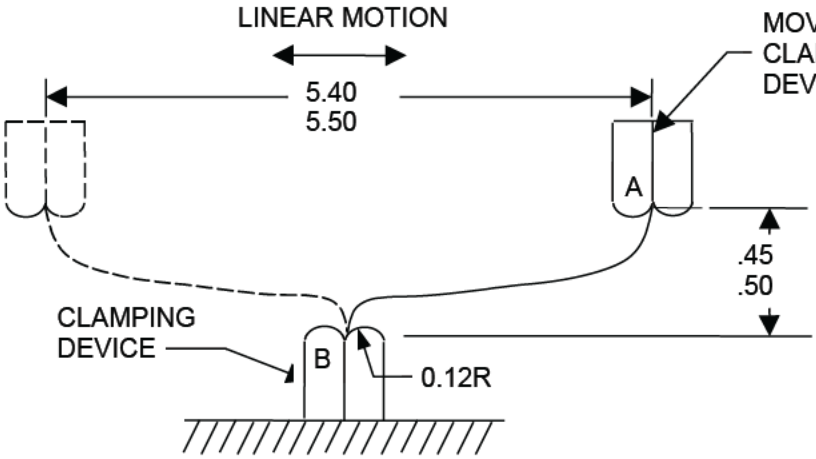
4.6.11 High temperature aging. A cable specimen, 18±.5 inches (457± 13mm) in length, shall have 0.25±.10 inch (6.35 ±.25 mm) of insulation removed from each end. The central portion of the cable shall then be bent at least halfway around a horizontally placed .25-inch (6.4mm) diameter stainless steel mandrel. The stripped conductor ends shall be evenly clamped together so that the weight is suspended from conductors only and the cable shall be loaded with the following weight so that the portion of insulation between the conductors and mandrel is under compression while the conductors are under tension.

Round wire size (AWG)	Weight (lb) per conductor (includes clamp weight)
24 through 28	0.1+0.03, -0.0

This specimen, so prepared on the mandrel, shall be conditioned in an air-circulation oven for 7 hours ± 15 minutes at the temperature specified (see table I). The velocity of air past the specimen shall be between 100 and 200 feet per minute. The velocity may be measured with the oven off and at room temperature. After conditioning, the oven shall be shut off, the door opened, and the specimen allowed to cool in the oven for at least one hour. When cool, the specimen shall be freed from tension, the strips removed, and the specimen removed from the mandrel. The central portion of the cable shall be bent at least halfway around the mandrel so that the portion, which was outside during conditioning, is now next to the mandrel. The cable shall be loaded with the applicable weight for one hour ±10 minutes at high temperature (see table I). The cable shall then be removed from the mandrel and examined for cracking and separation of the insulation. The specimen shall then be subjected to the dielectric withstanding voltage test (see 3.6 and 4.6.4).

4.6.12 Flexing endurance. A specimen of cable having a length of six inches minimum shall be installed in a fixture as shown on figure 3. An equivalent test fixture, with the approval of the qualifying activity may be used. All conductors of the test specimen shall be electrically connected in series during the test and a monitor current of 20±5 milliamperes shall be applied. A continuity tester capable of indicating a current interruption of one microsecond shall be used to monitor the current. One end of the cable shall be held in the fixed clamping device. The other end shall be fastened in the movable clamping device, allowing a free length of 3 to 3.05 inches (76.2 to 77.5 mm) between clamping devices. The movable clamp shall be driven in reciprocating linear motion for 5.4 to 5.5 inches (137 to 140 mm) from one extreme position to the other extreme position. Cable and fixture shall be allowed to stabilize at the test temperature for one hour before commencing test. One cycle shall consist of travel from one extreme to the other and return. The specimen shall be subjected to a minimum of 25 cycles per minute for the number of cycles and at the temperatures specified in the applicable specification sheet (see 3.1). A different cable specimen shall be used for flexing at each temperature.

4.6.13 Moisture resistance. A specimen of cable 26 inches (660 mm) long shall be prepared as specified in 4.6.4 and tested in accordance with method 106 of MIL-STD-202 (steps 7a and 7b shall not be required). Following the tenth cycle, and while the specimen is still at environment, the wire to wire insulation resistance shall be measured as specified in 4.6.5 with a potential of not less than 500 volts dc applied for a minimum of one minute between each conductor and its next adjacent conductors. Following the test, the specimen shall be examined.



Inches	mm
.12	3.0
.45	11.4
.50	12.7
3.00	76.2
3.05	77.5
3.10	78.7
5.40	137.2
5.50	139.7

NOTES:
1. The cable length between A and B shall be 3.00 to 3.05 inches.
2. Dimensions are in inches.
3. Metric equivalents are given for information only.

FIGURE 3. Flexing endurance test fixture.

4.6.14 Low pressure (maximum rated temperature). Unless otherwise specified (see 6.2), when running this test, the specimen length shall be 26±.062 inches (914±1.6 mm) long. When a specimen length other than 26±.062 inches (914±1.6 mm) is used, the insulation resistance and dielectric withstanding voltage results shall be proportional to the specimen length. The specimen length shall be prepared by cutting both ends approximately square. The sample shall be weighed on an analytical balance. The uncoiled specimen shall be placed in a suitable oven-rack (or equivalent) in a vacuum oven that has been preheated and stabilized, for not less than 10 minutes, at the maximum conductor temperature specified (see 3.1). The oven shall then be allowed to restabilize at the specified temperature (see 3.1). After temperature stabilization, the oven pressure shall be reduced to 2.0 torr, and maintained at these conditions for not less than 30 minutes. (A torr is nearly equal to the pressure of a column of mercury one millimeter high at 0 °C and standard gravity.) On completion of the 30-minute conditioning, the heat source shall be removed and the oven shall be allowed to cool to room ambient pressure. The specimen shall then be removed from the oven. The specimen shall be weighed, checked for shrinkage, prepared per 4.6.4, then be subjected to the dielectric withstanding voltage test specified in 4.6.4, followed by the insulation resistance test as specified in 4.6.5, except the testing shall be done in air between conductors only.

4.6.15 Fungus resistance. A test specimen 26±.062 inches (914±1.6 mm) long shall be prepared for testing of external materials. Any cables that include materials that are not classified as fungus-inert (see 6.5) shall be tested in accordance with ASTM-G21.

4.6.16 Fluid immersion. The specimen shall be prepared in accordance with 4.6.4. Each specimen shall then be weighed and one specimen shall be immersed to within 6 inches of its ends in each of the fluids specified in table IX for 20±.5 hours at the temperature specified in table IX. During immersion, the radius of bend of the specimen shall have a minimum diameter of .5 inch (12.7 mm).

TABLE IX. Test fluids and test temperatures.

Test fluid	Test temperature °C
ASTM-D740 1/ TT-I-735 MIL-DTL-5624 (JP-4)	20 to 22
MIL-PRF-23699 1/	68 to 72

1/ Not for use with polyvinylchloride insulation.

Upon removal from the fluids, the specimen shall be free of surface fluids and shall remain for one hour in free air at room temperature. Each specimen shall be weighed and compared with its initial weight. The specimen then shall be folded and unfolded twice in accordance with 4.6.10 and then subjected to the dielectric withstanding voltage test (see 4.6.4).

4.6.17 Durability of identification. The durability of product identification shall be evaluated at room temperature as follows:

a. Test apparatus. A repeated scrape-abrasion tester shall be used. The instrument shall be capable of rubbing a small cylindrical steel mandrel .025 to .028 inch (.64 to .71 mm) in diameter repeatedly over the upper surface of the cable in such position that the longitudinal axis of the steel mandrel and specimen are at right angles to each other with surfaces in contact. A weight affixed to a fixture above the rubbing mandrel shall control the force exerted normal to the surface of the insulation. A motor-driven, reciprocating-cam mechanism shall be used to deliver an accurate number of abrading strokes in a direction parallel to the longitudinal axis of the specimen. The number of strokes shall be measured by a counter. The length of the stroke shall be .375 inch (9.52 mm) minimum and the frequency of the stroke shall be 60 cycles (120 strokes) per minute.

b. Test procedure. A test specimen shall be prepared by removing from the cable at least a 4-inch (102 mm) length of two adjacent conductors containing identification. The specimen shall be mounted in the specimen holder and 150 grams shall be applied through the steel mandrel to the marked surface of the specimen. The counter shall be set at zero and the drive motor started. The specimen shall be subjected to the specified number of cycles as stated in 3.20 and shall be examined. Erasure or obliteration of a continuous line of identification marking shall constitute test failure.

4.6.18 Shrinkage. A 12±.5-inch (305±13 mm) specimen of cable shall be cut so that the insulation and conductor are flush at both ends. The specimen shall then be conditioned in an air-circulating oven for six hours at the aging temperature listed in table I for the cable material specified in the applicable specification sheet. The velocity of air past the specimen shall be between 100 and 200 feet per minute. The velocity may be measured with the oven off and at room temperature. After conditioning, the specimen shall be removed from the oven and allowed to cool to room temperature. The shrinkage of the insulation shall then be measured as the greatest distance that the insulation has receded from either end of the conductors. The measurement obtained at the end showing the greater shrinkage shall be considered the shrinkage of the specimen. This shrinkage shall meet the applicable requirement.

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, or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point packaging activities within the Military Service or Defense Agency, or within the military service's system command. Packaging data retrieval is available from the managing Military Service or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(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 –55 °C to 200 °C. Electrical cables covered by this specification are suitable for use in aerospace, ground, and shipboard applications to provide minimum size, weight, and space.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.

b. Title, number, and date of the applicable specification sheet (see 3.1).

c. If required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).

d. Applicable PIN (see 3.1 and 3.22).

e. Total number of feet and acceptable minimum continuous length (see 3.4.3.1).

f. Inspection conditions, if other than as specified (see 4.3).

g. Qualification and qualification retention data requirements (see 4.4).

h. Sampling plan and tests, if other than as specified (see 4.5.1.1.1 and 4.5.1.2.1).

i. Test specimen length, if other than as specified (see 4.6.16).

j. Packaging requirements (see 5.1 and 6.5).

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. 49055 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime-VQP, P.O. Box 3990, Columbus, Ohio 43218-3990 or via email vqp.jbc@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Definitions.

Conductor. A conductor is a single conductive path in a conductive pattern.

Conductor diameter. The conductor diameter is the diameter of the total circular cross section of the conductor, including all metallic conductor coatings.

Current-carrying capacity. The current-carrying capacity is the maximum current that can be continuously carried through a conductor under specified conditions.

Delamination. Delamination is a separation between any of the layers of the base laminate or between the laminate and the mated conductors, or both.

Dielectric strength. The dielectric strength is the maximum voltage that a dielectric material can withstand, under specified conditions, without rupturing; usually expressed as volts/unit thickness.

Flat cable. Flat cable is any cable with two or more parallel conductors in the same plane enclosed by an insulating material.

Insulation resistance. Insulation resistance is the electrical resistance of the insulating material, determined under specified conditions, between any pair of conductors.

Laminate. A laminate is a product made by bonding together two or more layers of material with pressure, heat, or adhesive.

Margin. The margin is the distance between the edge of a flat cable and the centerline of the nearest conductor.

Solderability. Solderability is the property of a metal to be wetted by solder.

Unit of product. The unit of product is each reel, spool, or coil of cable.

Wetting. Wetting is the free flow and spreading of solder on conductive paths and terminals to form an adherent bond.

6.5 Fungus resistance. Guideline 4 of MIL-HDBK-454 includes a listing of fungus-inert materials (group I) and fungus nutrient materials (group II) and provides guidelines on the use of preferred and acceptable materials.

6.6 Subject term (key word) listing.

Bare
Coated
Flammability
High-temperature aging
Shrinkage
Stranded

6.7 Environmentally preferable material. Environmentally preferable materials should be used to the maximum extent possible to meet the requirements of this specification. As of the dating of this document, the U.S. Environmental Protection Agency (EPA) is focusing efforts on reducing 31 priority chemicals. The list of chemicals and additional information is available on their website at http://www.epa.gov/osw/hazard/wastemin/priority.htm. Included in the list of 31 priority chemicals are cadmium, lead, and mercury. Use of these materials should be minimized or eliminated unless needed to meet the requirements specified herein (see section 3).

6.8 Changes from previous issue. The margins of this specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - AS
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 6145-2012-009)

Review activities:
Army - AR, AT, AV, CR4, MI
Navy - EC, OS, SH
Air Force - 99

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.