

INCH-POUND

MIL-DTL-3432G  
 27 October 2000  
 SUPERSEDING  
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## DETAIL SPECIFICATION

### CABLES, (POWER AND SPECIAL PURPOSE) AND WIRE, ELECTRICAL (300 AND 600 VOLTS)

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

#### 1. SCOPE

1.1 Scope. This specification covers single and multiple conductor cables with and without shields for use in 300 and 600 volts root mean square (rms) applications (see 6.1).

1.2 Classification. Cables covered in this specification are furnished in accordance with the type designation specified and are classified by the element thereof.

1.2.1 Type Designation. The type designation is formed as follows:

<u>M 3432 -</u>	<u>08</u>	<u>HG</u>	<u>E</u>	<u>(2/16S-4/12)</u>	<u>SJ</u>	<u>1090</u>
Part Number (1.2.1.1)	Total number of conductors (1.2.1.2)	Class (1.2.1.3)	Flexibility (1.2.1.4)	Conductor data (1.2.1.5)	Shielding under jacket (1.2.1.6)	Outside diameter (1.2.1.7)

1.2.1.1 Part Number. Cables covered by this specification are identified by "M 3432" followed by a hyphen.

1.2.1.2 Total number of conductors. The total number of conductors (see 6.3.1) in a cable, exclusive of ground wires (see 6.3.2 and 6.3.4), is identified by a two-digit number. For cables with less than 10 conductors, a "0" precedes the number of conductors (example - 04 = 4 conductors) in a multiple conductor power cable.

1.2.1.3 Class. The class of cables is identified by a two-letter symbol, the first letter of which designates the duty (see 6.1) in accordance with table I. The second letter indicates the application of the cables in accordance with table II.

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 (ATTN: 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.

AMSC N/A

FSC 6145

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## MIL-DTL-3432G

TABLE I. Duty of cables.

(Class) designation 1st letter	Duty	Voltage rating (max volts)
L	Light	300
M	Medium	600
H	Heavy	600

NOTE: See table VI for insulation thickness. See table IX for jacket thickness.

TABLE II. Application of cables.

Class designation 2nd letter	Application
G	General purpose, medium low temperature, -40 °C to +75 °C
O	Medium low temperature, oil resistant, -40 °C to + 75 °C
L	Low Temperature, heat resistant, -55 °C to +75 °C
D	Low temperature, oil and heat resistant, -55 °C to +75 °C
H	Low temperature, heat and weather resistant, -55 °C to +90 °C
B	Low Temperature, oil and weather resistant, -55 °C to +80 °C
C	Low temperature, oil and heat resistant, -55 °C to +80 °C
K	Low temperature, oil heat, and weather resistant, -55 °C to +80 °C
N	Low temperature, oil and heat resistant, -55 °C to +90 °C <sup>1/</sup>
E	Low temperature, ozone, oil, weather, and heat resistant, -65 °C to +90 °C

NOTE: 1/ Synthetic polyisoprene may be blended with natural rubber.

1.2.1.4 Flexibility. Flexibility of a cable is based upon the flexibility of the conductors within the cable. All conductors and ground wires within the same cable will be of the flexibility designated (see 3.2.1 and 3.2.2). The flexibility is identified as follows:

S - Semiflexible  
F - Flexible  
E - Extra-flexible

1.2.1.5 Conductor data.

1.2.1.5.1 Number and size of individual conductors. The number of individual conductors of the same wire size are designated by that number followed by a slash and a number indicating the conductor wire size. For example: "3/22" indicates 3 number 22 AWG conductors. When cables are made up of different wire sizes, each different wire size is individually represented, with a dash separating each different wire size. For example: "-6/14-1/8" indicates 6 number 14 AWG conductors and 1 number 8 AWG conductor.

1.2.1.5.2 Unshielded grouped conductors. Conductors twisted together to form a group (such as pairs, triples, quads, etc.) are designated, immediately following the wire size, by "x" followed by the number of these conductor groups contained in the cable. For example, "2/20 x 1" indicates 2 number 20 AWG conductors twisted together to form a pair; "3/22 x 4" indicates four groups, each group consisting of 3 number 22 AWG conductors twisted together to form a triple.

1.2.1.5.3 Shielding.

1.2.1.5.3.1 Grouped shielding. When one or more groups of copper conductors have a common shield over each conductor group, the designator "S x (number of groups)" follows the wire size; for example, "2/22 S x 6" indicates six pairs of number 22 AWG conductors, with a shield over each pair.

## MIL-DTL-3432G

When a single group has an overall shield, the designation "x 1" is to be omitted since conductors under a shield are twisted to form one group, for example; "2/20 S" indicates one twisted pair of number 20 AWG conductors under a common shield.

1.2.1.5.3.2 Individual shielding. When each conductor of the same size is individually shielded, the letter "I" follows the letter "S". For example: "3/14 SI" indicates 3 number 14 AWG conductors, each conductor individually shielded. A shielded single conductor is to be designated by the letter "S" instead of "SI". For example: "1/18 S" indicates 1 number 18 AWG conductor shielded.

1.2.1.5.4 Uninsulated ground drain wires. Uninsulated ground drain wires are designated in the same manner as conductors specified in 1.2.1.5 except the letter "R" is to follow the wire size. For example: "3/8 R" indicates 3 number 8 AWG ground wires. Uninsulated ground wires are not counted in the total number of conductors.

1.2.1.5.5 Cabling. All conductors and groups that are cabled together beneath the jacket, and under the jacket shield, should be enclosed in parentheses. For example: "(2/20 x 2 - 3/18)" indicates a cable made up of two twisted pairs of number 20 AWG conductors and 3 number 18 AWG conductors.

1.2.1.5.6 Cable configuration. Cables composed of two conductors laid parallel are to be designated by the letter "F", which is to follow the conductor number. For example, "2F/8" indicates 2 number 8 AWG conductors laid parallel.

1.2.1.6 Shielding under the jacket. When single shielding is over all conductors and beneath the jacket, the letters "SJ" follows the parentheses that enclose the conductor data. When double shielding beneath the jacket is specified, the letters "SSJ" will follow the parentheses that enclose the conductor data. No letters are used if an overall shield beneath the jacket is not present.

#### 1.2.1.7 Outside diameter.

1.2.1.7.1 Cables (except parallel conductors). The outside diameter of the cable is indicated by four significant figures expressing the diameter in mils (thousandths of an inch) to the nearest figure divisible by five. If a tolerance other than that specified in 3.2.8.1 is required, it is indicated by placing the tolerance immediately after this element of type designation (see 1.2.1.8b and 1.2.1.8f).

1.2.1.7.2 Parallel conductor cables. The outside diameter of the parallel conductor cable should be designated by giving the major diameter followed by a slant, followed by the minor diameter. The diameter, either major or minor, should be indicated in mils (thousandths of an inch) by four significant figures. If a tolerance other than that specified in 3.2.8.2 is required, it should be indicated by placing the tolerance immediately after the major or minor diameter.

1.2.1.8 Use and examples of type designations. Use of type designations formed as indicated in 1.2.1 is not intended to limit the number of cable types procured under this specification. Representative examples of type designations are as follows:

a. M 3432 - 10LGF(6/22-2/20-2/18x1)0640 represents a 10 conductor, light duty, general purpose, flexible cable with 6 number 22 AWG conductors, 2 number 20 AWG conductors, and one twisted pair number 18 AWG conductor. The cable has an outside diameter of .640 inch.

b. M 3432 - 18HLF(3/20x4-3/18x1-3/16)1040 ±.025 represents an 18 AWG conductor, heavy duty, heat resistant, flexible cable with four triples, each triple composed of 3 number 20 AWG conductors twisted together; one triple composed of 3 number 18 AWG conductors twisted together; and 3 number 16 AWG conductors. The cable has an outside diameter of 1.040 inches with a tolerance of .025 inch specified.

c. M 3432 - 06MDE(3/22S-2/20SI-1/16S)SJ0430 represents a six conductor, medium duty, oil resistant, extra-flexible cable with 3 number 22 AWG conductors twisted together to form a triple, in a

## MIL-DTL-3432G

common shield; 2 number 20 AWG conductors, each individually shielded; and 1 number 16 AWG conductor individually shielded. The cable has an overall shield with a jacket or sheath. The cable has an outside diameter of .0430 inch.

d. M 3432 - 15 MDF(2/22SX5-2/20S-2/18SI-1/16S)1620 represents a 15 conductor, medium duty, oil and heat resistant, flexible cable with five pairs of number 22 AWG conductors, each pair individually shielded; one shielded pair of number 20 AWG conductors; 2 number 18 AWG conductors, each individually shielded; and 1 number 16 AWG shielded conductor. The cable has an outside diameter of 1.620 inches.

e. M 3432 - 02HGF(2/4-2/8R)1080 represents a two conductor, heavy duty, general purpose, flexible cable with 2 number 4 AWG conductors, and 2 number 8 AWG uninsulated ground wires. The cable has an outside diameter of 1.080 inches.

f. M 3432 - 02HGS(2F/8)0920  $\pm$ .050/0510 represents a two conductor, heavy duty, general purpose, semi-flexible parallel cable with 2 number 8 AWG conductors having a major diameter of .920 inch with a tolerance .050 inch specified and a minor diameter of .510 inch.

## 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 (see 6.2), 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.

## SPECIFICATIONS

### FEDERAL

L-P-390	-	Plastic, Molding and Extrusion material, Polyethylene CoPolymers (Low, Medium and High Density)
A-A-59551	-	Wire, Electrical, Copper (Uninsulated)

### MILITARY

MIL-I-631	-	Insulation, Electrical, Synthetic-resin Composition, Nonrigid
MIL-I-3930	-	Insulating and Jacketing Compounds, Electrical (For Cables, Cords, and Wires)
MIL-P-24216	-	Polypropylene Cores, Strands Centers, and Substrands Wire Rope

## STANDARDS

### FEDERAL

## MIL-DTL-3432G

FED-STD-228 - Federal Test Method Standard Cable and Wire, Insulated;  
Method of Testing

## MILITARY

MIL-STD-104 - Limits for Electrical Insulation Color

MIL-STD-686 - Cable and Cord Electrical; Identification Marking and Color  
Coding of

(Unless otherwise specified, copies of the above specifications and standards are available from the Document Automation and Production Service, Building 4/D, 700 Robbins Ave, Philadelphia, PA 19111-5894.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified (see 6.2), 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 (see 6.2), the documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

## AMERICAN NATIONAL STANDARDS INSTITUTE

ANSI/NCSL Z540-1 - General Requirements for Calibration Laboratories and  
Measuring and Test Equipment (DoD-adopted)  
ISO 10012-1-1992 - Quality Assurance Requirements for Measurement  
Equipment / Metrological Confirmation System for  
Measuring Equipment  
ANSI /ASTM-D-4066 - Nylon Injection and Extrusion Materials

(Application for copies should be addressed to Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112 USA, E-Mail: [global@ihs.com](mailto:global@ihs.com) phone (800) 854-7179 or 1-(303)-397-7956 (outside the US). Fax 1-303-397-2740).

## AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM G21 - Standard Practice for Determining Resistance of  
Synthetic Polymeric Materials to Fungi (DoD-adopted)

(Applications for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.)

## UNDERWRITERS LABORATORIES INCORPORATED

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

(Copies of the UL publication may be obtained from the Underwriters Laboratories, Inc., Publication Stock, 333 Pfingsten Road, Northbrook, IL 60062.)

## NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

NEMA WC 7 / ICEA S-66-524 - Cross-Linked Thermosetting Polyethylene  
Insulated Wire and Cable for the Transmission  
and Distribution of Electrical Energy

## MIL-DTL-3432G

(Application for copies should be addressed to Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112 USA, E-Mail: global@ihs.com; phone (800) 854-7179 or 1-(303)-397-7956 (outside the US); Fax 1-303-397-2740.)

2.4 Order of precedence. In event of a conflict between the text of this document and the references cited herein (except for associated 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 Materials. Materials shall be specified herein. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the product. When a definite material is not specified, a material shall be used which will enable the wire and cable to meet the requirements of this specification. All materials shall be fungus resistant in accordance with ASTM G21.

#### 3.1.1 Wire Strands.

3.1.1.1 Copper strands. The strands comprising the conductor, uninsulated ground wires (see 6.3.4), and braided shields, shall be soft, drawn, or annealed wire conforming to the applicable requirements of A-A-59551.

3.1.2 Insulating and jacketing compounds. The insulating and jacketing compounds shall be as specified in table III, as indicated by the application of the cable (see table II).

TABLE III. Compounds in accordance with MIL-I-3930.

Class designation 2nd letter	Insulating compound designators in accordance with MIL-I-3930, applicable slash sheet in ( )	Jacketing compound designator in accordance with MIL-I-3930, applicable slash sheet in ( )
G	IS (2), IH (9), S (12), O (13), <sup>1/2</sup>	S (12), O (13), JN (18, 22) <sup>1/2</sup>
O	IS (2), IH (9), S (12), O (13), <sup>1/2</sup>	S (12), O (13), JN (18, 22) <sup>1/2</sup>
L	IS-L (3), IH (9), S (12), O (13) <sup>1/2</sup>	S (12), O (13), JS-L (16), JN-L (23) <sup>1/2</sup>
D	IS-L (3), IH (9), S (12), O (13) <sup>1/2</sup>	S (12), O (13), JN-L (19, 23) <sup>1/2</sup>
H	IH (9), S (12), O (13) <sup>1/2</sup>	S(12), O (13), JH (20) <sup>1/2</sup>
B	IH (9)	JN-L (19, 23)
C	IE (11)	JN-L (19, 23)
K	IE (11)	JU (21)
N	IR (4) IL (5) <sup>2</sup>	JR (17), JN (18, 22)
E	S (12), O (13) <sup>1/2</sup>	S (12), O (13) <sup>1/2</sup>

NOTE: <sup>1/</sup> For S and O insulating and jacketing designations, see the appendix herein for additional performance requirements.

NOTE: <sup>2/</sup> MIL-I-3930/2, /5, /12, /13, and /20 are not for CECOM use.

3.1.2.1 Polyethylene. Polyethylene shall be accordance with L-P-390.

3.1.2.2 Polyurethane. Polyurethane shall be of a polyetherurethane type.

3.1.2.3 Crosslink polyethylene. Crosslink polyethylene shall meet the requirements of NEMA WC 7/ICEA S-66-524, insulation for cables rated 0 - 2,000 volts.

3.1.2.4 Polyamide (nylon). Polyamide shall be in accordance with ASTM-D-4066.

## MIL-DTL-3432G

3.1.3 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.

3.1.4 Fillers and binders. Materials used for fillers and binders shall be compatible with the requirements of the finished cable. Twisted polyethylene film or foam polypropylene is acceptable for use with thermoplastic materials only. The yarns shall be clean, dry, and substantially free from all foreign particles, knots, lumps, or any substance that would impair the insulation of the conductor. All materials shall be fungus resistant in accordance with ASTM G21.

3.1.5 Separators. Materials used for separators shall be one of the types specified in 3.1.5.1 and 3.1.5.2.

3.1.5.1 Polyester tapes. Where used, polyester tapes shall conform to MIL-I-631 type G, form T.F. Polyester tape may be polyethylene-coated for subsequent heat sealing.

3.1.5.2 Polypropylene tape. Where used, polypropylene shall be in accordance with MIL-P-24216.

3.2 Design and construction. Cables shall be of the design, construction, and physical dimensions specified herein.

3.2.1 Conductors. Conductors shall be in accordance with A-A-59551. For a particular size and flexibility, the conductors shall be of the type, class, and service listed in table IV (see 1.2.1.4).

3.2.2 Uninsulated ground drain wires. Uninsulated ground drain wires shall be in accordance with A-A-59551 and table V. Each ground drain wire shall have a green cover of fibrous braid, or extruded rubber or plastic (see 3.2.6.2). When extruded rubber or plastic is used as a covering, it shall be marked "GND" (ground) in contrasting color with a maximum of 3 inches intervals in accordance with MIL-STD-686.

3.2.3 Insulated conductors. Insulated conductors shall be free stripping and extruded over the conductors. Insulated conductors shall be readily separated from each other. The minimum thickness, measured at a cross section of the insulation, for various cable duties and conductor sizes, shall be specified in table VI. The minimum insulation thickness, however, may be 80 percent of the nominal thickness at the area of contact between contiguous insulated conductors. There shall be no kinking of the insulated conductor within the sheath. Polyethylene insulated conductors of 24 through 12 AWG shall have 0.003 inch minimum thickness extruded jacket of polyamide.

3.2.4 Shielding. Shielding shall be applied over the individual conductors, over two or more conductors, or over the entire group of conductors, as specified (see 1.2.1.5.3). The shield shall consist of a braid providing a minimum coverage of 85 percent (see 4.7.1). Irregularities, breaks, and discontinuities shall be avoided in the application. There shall be no strands protruding through the insulation or the jacket. For insulated conductors in sizes 500 Kcmil to 10 AWG inclusive, the shielding shall consist of a single or double braid of strands, each strand having a nominal diameter of .0063 inch. For insulated conductors in AWG sizes number 12 through 22 inclusive, the strand shall be of .0050 inch nominal diameter. For a shield applied over two or more conductors grouped together, or over the entire group of conductors, when the diameter covered is .625 inch or less, the shielding shall consist of a single or double braid of strands, each with a nominal diameter of .0050 or .0063 inch. When the diameter covered is more than .625 inch, strands with a nominal diameter greater than .063 may be used for the braid.

3.2.4.1 Shield cover. For a single conductor, or two or more conductors grouped together under one shield, there shall be a separator applied directly on the shield. When the diameter over the shield does not exceed .020 inch, .0050 to .0080-inch thick polyamide may be extruded instead of polyester tape over the shields that have polyethylene insulated components. For overall shield, there shall be an



## MIL-DTL-3432G

overlapping, helical wrap of polyester or polypropylene tape applied over the cable core prior to shielding. (see 3.2.6.4).

3.2.5 Identification coding. The individual conductors of all cables and single wires shall be coded for their entire length in accordance with MIL-STD-686.

a. The standard means of coding shall include the following:

- (1) Solid-colored insulation with tracers, when required.
- (2) Color-coded 1/2 to 1 mil polyester tape, with or without 1/2 to 1 mil heat-sealable adhesion.
- (3) Color-coded 1 mil polyester tape with 1/2 to 1 mil heat-sealable adhesive in 8 AWG or larger, when tracers are required.
- (4) Color-coded, filled tapes in 8 AWG and larger, when tracers are not required.
- (5) Coding by marking.
- (6) Color code by green braid (ground wire only).

b. Color shall be in accordance with MIL-STD-104, class 1 for plastics and elastomers, and class 2 for thermosetting compounds. Where black, blue, brown, purple, or red (i.e., two or more of these colors) are used in the same cable, the colors (other than black) shall be light to nominal. Gray shall be dark (or slate) when in the same cable with white.

3.2.5.1 Solid-color insulation. The entire thickness of plastic or rubber insulation shall be solid colored, when practicable. When the entire thickness is not solid colored, insulation shall be applied over the inner core to form an integral part of the insulation wall. Cables having up to and including six conductors shall employ solid coloring, and each conductor shall be clearly distinguishable.

3.2.5.2 Stripe tracers. The tracer shall be in accordance with MIL-STD-686. All materials for stripping shall be nonconductive.

3.2.5.3 Coding by marking. Where prototype models or short runs of cables are specified for procurement (less than 10,000 feet) and the individual conductors of the cables have an outside diameter of .065 inch or larger, the contractor shall code the conductors by marking or coloring in accordance with MIL-STD-686.

3.2.6 Grouping and cabling. When the cables are grouped (see 1.2.1.5.2 and 1.2.1.5.5), the conductors within the group shall be twisted together. All the conductors and groups of conductors shall be cabled together in an arrangement that shall form an essentially round construction (except for parallel conductors). Where there are mixtures of different conductor sizes and element constructions (shielded singles, shielded pairs), the larger diameter conductors and shielded wires shall be toward the center.

3.2.6.1 Length of lay. The lay-up of cable layers shall be unidirectional. For cables employing semiflexible conductors and ground wires, if applicable, the length of lay shall be not greater than 20 times the outer diameter of the layer. For cables employing flexible conductors and ground wires, if applicable, the length of lay shall be not greater than 16 times the outer diameter of the layer. For cables employing extra-flexible conductors and ground wires, if applicable, the length of lay shall be not greater than 12 times the outer diameter of the layer. The outer diameter of the layers is the diameter over the separator or binder, if used (see 3.2.6.4).



## MIL-DTL-3432G

TABLE IV. Constructional and direct current resistance requirements of conductors.

Conductor Size (AWG and Kcmil)	Conductor dc resistance at 25 ° C max (ohms/1000 ft)	Semiflexible			Flexible			Extra-flexible			
		Wire type QQ-W-343		Number of Strands	Wire type QQ-W-343		Service	Number of Strands	Wire type QQ-W-343		
		Type	Class		Type	Class			Type	Class	
500	.023	E	G	259	E	H	---	427	---	---	---
450	.025	E	G	259	E	H	---	427	---	---	---
400	.028	E	G	259	E	H	---	427	---	---	---
350	.032	E	G	259	E	H	---	427	---	---	---
300	.038	E	G	259	E	H	---	427	---	---	---
250	.045	E	G	259	E	H	---	427	---	---	---
4/0	.054	E	G	133	E	H	---	259	---	---	---
3/0	.069	E	G	133	E	H	---	259	---	---	---
2/0	.086	E	G	133	E	H	---	259	---	---	---
1/0	.113	E	G	133	E	H	---	259	---	---	---
1	.142	E	G	133	E	H	---	259	R	K	1064
2	.180	E	G	49	E	H	---	259	R	K	836
3	.213	E	G	49	E	1/	---	259	R	K	665
4	.283	E	G	49	E	H	---	133	R	K	532
6	.450	E	G	49	E	H	---	133	R	K	420
8	.715	---	---	---	E	H	---	133	R	K	266
					E	G	---	49	R	K	168
10	1.14	---	---	---	B	K	Severe	104	or E	H	133
12	1.81	B	J	41	B	K	Severe	65	R	M	259
									B	M	165
14	2.82	B	J	26	B	K	Severe	41	or R	M	168
									B	M	104
16	4.49	B	K	26	B	M	Severe	65	B	O	104
18	7.15	B	K	16	B	M	Severe	41	B	O	65
20	11.35	---	---	---	B	H	Severe	26	B	O	41
22	18.09	---	---	---	B	M	Severe	19	B	O	26
24	24.50	---	---	---	B	O	Severe	19	B	P	26

NOTE: 1/ Number 2 AWG conductor shall be type RC, except it shall be composed of 259 - 16.0 mil strands.

TABLE V. Constructional and direct current resistance requirements of uninsulated ground drain wires.

Ground wire size	Ground wire resistance at 25 °C max	Semiflexible			Flexible			Extra-flexible			Length of lay max <sup>1/</sup>
		No. of strands	Dia of strands	QQ-W-343	No. of strands	Dia of strands	QQ-W-343	No. of strands	Dia of strands	QQ-W-343	
				Type	Class				Type	Class	
AWG	Ohms/1000 ft		Mils				Mils				Inches
4/0	.054	133	39.9	E	G	259	28.6	E	H	---	---
3/0	.069	133	35.5	E	G	259	25.5	E	H	---	---
2/0	.086	133	31.6	E	G	259	22.7	E	H	---	---
1/0	.113	133	28.2	E	G	259	20.2	E	H	---	---
1	.142	133	25.1	E	G	259	18.0	E	H	---	---
2	.173	49	36.8	E	G	133	22.3	E	H	---	---
3	.218	49	32.8	E	G	133	19.9	E	H	---	---
4	.283	49	29.2	E	G	133	17.7	E	H	---	---
5	.350	49	26.0	E	G	133	15.8	E	H	420	10.0
6	.450	49	23.1	E	G	133	14.0	E	H	336	10.0
7	.556	19	33.1	C	G	49	20.6	E	H	266	10.0
8	.715	19	29.5	C	G	49	18.4	E	H	210	10.0
9	.884	19	26.2	C	G	49	16.4	E	H	168	10.0
10	1.11	7	38.5	C	B <sup>2/</sup>	19	23.4	E	H	133	10.0
11	1.41	7	34.3	C	B <sup>2/</sup>	19	20.8	C	C <sup>2/</sup>	104	10.0
12	1.77	7	30.5	C	B	19	18.5	C	C	82	10.0
										65	10.0

NOTE: <sup>1/</sup> Since many of these sizes are not listed in QQ-W-343, the maximum length of lay is specified herein, instead of the service. This is the equivalent of extra severe service.

NOTE: <sup>2/</sup> Since these sizes are not listed in QQ-W-343, the applicable class is listed for information only.

## MIL-DTL-3432G

TABLE VI. Insulation thickness.

Duty (see table I)	Rubber, TPE, and crosslink polyethylene			Polyethylene		
	Conductor size inclusive (AWG and Kcmil)	Insulation thickness in inches		Conductor size inclusive (AWG and Kcmil)	Insulation thickness in inches	
		Nominal <sup>1/</sup>	Minimum		Nominal <sup>1/</sup>	Minimum
Light	24 to 18	.016	.013	25 to 18	.010	.008
	16 to 14	.018	.015	16 to 14	.012	.010
	12. to 10	.021	.018	12 to 10	.015	.012
Medium	24 to 20	.030	.025	24 to 20	.012	.010
	18 to 16	.033	.028	18 to 16	.014	.012
	14 to 12	.036	.031	14 to 12	.016	.014
	10 to 8	.038	.033	10 to 8	.020	.016
	6 to 2	.047	.042			
	1 to 2/0	.063	.056			
Heavy	24 to 20	.030	.025	24 to 16	.015	.012
	18 to 16	.033	.028	14 to 12	.020	.017
	14 to 10	.047	.042	10	.030	.025
	8 to 6	.055	.050	8 to 4	.035	.032
	4 to 2	.063	.057	2	.042	.038
	1	.070	.063	1	.046	.041
	1/0 to 4/0	.078	.070	1/0 to 2/0	.056	.052
	250 to 500 Kcmil	.094	.084	3/0 to 4/0	.064	.060
				250 to 500 Kcmil	.075	.070

NOTE: <sup>1/</sup> Nominal dimensions are included for information only.

3.2.6.2 Uninsulated ground drain wires. When specified (see 1.2.1.5.4), uninsulated ground drain wires shall be included in two, three, four, and five conductor, heavy duty unshielded cables in which all conductors are of the same size, and shall be cabled together with the conductors and fillers, if used. The number of uninsulated ground drain wires shall be the same as the number of conductors. The minimum size of the uninsulated ground drain wires shall be as specified in table VII and is dependent upon the size and number of conductors. Uninsulated ground drain wires shall not be furnished in conductor sizes less than 8 AWG.

## MIL-DTL-3432G

TABLE VII. Minimum size of uninsulated ground drain wires.

Power conductor sizes (Kcmil and AWG)	Minimum ground drain wire sizes (AWG)			
	Number of power conductors			
	Two	Three	Four	Five
500	4/0	2/0	1/0	2
400	3/0	1/0	1	3
350	2/0	1	2	4
250	1/0	2	3	5
4/0	1	3	4	6
3/0	2	4	5	7
2/0	3	5	6	8
1/0	4	6	7	9
1	5	7	8	9
2	6	8	9	10
3	7	9	9	10
4	8	10	10	12
6	10	10	12	12
8	10	12	12	12

3.2.6.3 Fillers. Fillers shall be used when required to effect a circular cross section (see 3.1.4).

3.2.6.4 Binders and separators. A binder applied over the cabled conductors to hold them in place is optional. A separator shall be applied over the cabled conductor prior to the application of the shield or jacket. The use of a separator for unshielded conductors of 8 AWG and larger shall be optional with the manufacturer. A separator shall be applied over the shield, if present, prior to the application of the jacket. For single conductor cable where no shield is present, a separator shall not be applied. Separators shall be applied as a heat barrier over the cabled conductors with polyethylene insulation, prior to extrusion of the jacket. The binders and separators shall be of the types specified in table VIII.

TABLE VIII. Binders and separators.

Binder types (optional)	Separator types		
	For unshielded cable	For shielded cable	
		Under shield	Over shield
Open wrap, open braid	Closed wrap, closed braid, compound - filled tape, polyester or polypropylene tape.	Polyester or polypropylene tape.	Closed wrap, closed braid, compound-filled tape, polyester or polypropylene tape.

3.2.7 Jacket. The jacket shall be extruded and then vulcanized (except for thermoplastics) over the cabled conductors or shielding, when used, and shall be well centered, single - or double-layer jacket. Double-layer jackets shall be used on cables whose minimum jacket thickness is .098 inch or over as specified in table IX. Double-layer jackets shall be applied in two concentric layers that are strongly bonded together; the outer layer shall be at least 50 percent of the total thickness. A reinforcement consisting of an open braid or two layers of seine twine or cabled cotton, or the equivalent, applied in reverse directions, shall be provided between the layers of the jacket. For single conductor cables where no shield is present, the jacket shall be applied directly over the insulation and adhere to the insulation. The jacket thickness shall be as specified in table IX, unless special outside diameters are specified.

## MIL-DTL-3432G

TABLE IX. Jacket thickness.

Calculated core diameter inches, inclusive	Jacket thickness					
	Duty L		Duty M		Duty H	
	Nominal	Minimum	Nominal	Minimum	Nominal	Minimum
.125 and under	.020	.018	.027	.024	.035	.032
.126 to 0.155	.022	.019	.031	.028	.040	.036
.156 to .219	.024	.022	.039	.035	.045	.041
.220 to .234	.026	.023	.039	.035	.078	.070
.235 to .290	.031	.028	.047	.042	.078	.070
.291 to .300	.031	.028	.047	.042	.094	.085
.301 to .430	.050	.045	.063	.057	.094	.085
.431 to .540			.070	.063	.094	.085
.541 to .640			.078	.070	.109	.098
.641 to .740			.094	.085	.125	.113
.741 to .850			.109	.098	.141	.127
.851 to 1.100			.125	.113	.156	.140
1.101 to 1.320			.156	.140	.172	.155
1.321 to 1.550			.172	.155	.188	.169
1.551 to 1.820					.203	.183
1.821 to 2.050					.220	.198
2.051 to 2.300					.235	.212
2.301 to 2.550					.250	.225
2.551 to 2.800					.265	.239
2.801 to 3.100					.280	.252
3.101 to 3.500					.295	.266
3.501 to 3.950					.310	.279
3.951 to 4.450					.330	.297
4.451 to 5.00					.345	.311

3.2.7.1 Polyurethane jacket. For medium and heavy duty cables, the jacket shall be reinforced with polyester or glass fiber strands treated (if necessary) to bond to polyurethane. The fibers shall be applied over the cable core and bonded to the jacket.

3.2.7.2 Jacket color. The jacket color shall be black in accordance with MIL-STD-104.

### 3.2.8 Diameter tolerance.

3.2.8.1 Cable diameter tolerance (except parallel conductors). The outside diameter of cables having a specified diameter of less than .500 inch shall have a tolerance of  $\pm .015$  inch. The outside diameter for cables having a specified diameter from .500 to .700 inch inclusive shall have a tolerance of  $\pm .020$  inch. The outside diameter for cables having a specified diameter of more than .700 inch shall have a tolerance of  $\pm 3$  percent. The diameter of a cable at any cross section (except for parallel conductor cable) shall be considered the average of the major and minor diameters at that cross section. If a special tolerance is required on the outside diameter, such tolerances shall be indicated at the end of the type designation (see 1.2.1.8).

3.2.8.2 Parallel conductors. The outside diameter of a parallel conductor cable shall have a tolerance of  $\pm .040$  inch for a major diameter and a tolerance of  $\pm .030$  inch for the minor diameter. If a special tolerance is required on the outside diameter, such tolerances shall be indicated at the end of the type designation (see 1.2.1.8).

3.3 Spark test. The insulated conductor shall withstand the applicable voltage specified in table XVII.

## MIL-DTL-3432G

3.4 Voltage withstand. The insulated conductor in the finished cable shall withstand the specified dielectric voltage in table XVII.

3.5 Insulation resistance. When measured, the insulation resistance shall be not less than the value obtained from the following formula:

$$R = K \log_{10} \frac{d + 2c}{d}$$

Where: R - Insulation resistance in megohms – 1,000 feet.

K - 2,000 for SBR, 50,000 for polyethylene, and 10,000 for EPDM, TPE, and crosslink polyethylene.

d - Average diameter under the insulation.

c - Specified nominal insulation thickness.

NOTE: d and c shall be expressed in the same units.

3.6 Direct current resistance. The cable resistance shall not exceed the values shown in tables IV and V.

3.7 Surface resistance. Black jacket, black insulation, and black striped jackets and insulation shall have a surface resistance of 10 megohms per inch minimum when tested in accordance with Method 6041 of FED-STD-228, or 100 megohms minimum when tested in accordance with method 1340 of UL 1581.

3.8 Hot creep (crosslink polyethylene only). The elongation and set shall not exceed the specified values in NEMA WC 7/ ICEA S-66-524.

3.9 Cold bend. The insulation, jacket, and inked markings shall not crack under bending at the applicable lower temperature listed in table II.

3.10 Polyethylene shrink-back. When tested, it shall shrink back a maximum .0625 inch and shall not split or crack.

3.11 Polyamide heat stability. There shall be no tears or cracks in the polyamide materials. Wrinkles or softening and flowing of the polyamide shall not be cause for rejection.

3.12 Marking. The cable jacket or marker tape shall be marked in accordance with MIL-STD-686. In addition, the manufacturer's name or trademark and the year of manufacture shall be included. The outer surface of the cables shall be smooth and free from raised markings. All letters and numbers in the marking shall be of the same height. There shall be no spacing between letters and numbers in the type designation, for example, M3432-06HOF(6/18)0525.

3.12.1 Marking durability (polyethylene and polyamide insulation jackets only). When the cable is tested, there shall not be a continuous line evident through any letter or numeral of the ink marking nor through any striping applied to the outer surface of polyethylene or polyamide material when subjected to 250 cycles (500 strokes) of abrasive action.

3.13 Workmanship. Cables shall be constructed and finished in a thoroughly workmanlike manner in accordance with accepted high grade production techniques. The cables shall be a uniform and consistent product and shall be free from any defects which will adversely affect the serviceability of the product, such as lumps, kinks, splits, abrasions, scrapes, corroded surface, skin impurities, and faulty extruded surface.

## MIL-DTL-3432G

## 4. VERIFICATION

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

TABLE X. Requirements cross-reference matrix.

Requirement	Verification	Requirement	Verification
3.1	4.4	3.2.6.1	4.7.1, Table XIII
3.1.1.1	4.4, Table XI	3.2.6.2	4.7.1, Table XIII
3.1.2	4.4, Table XI	3.2.6.3	4.7.1, Table XIII
3.1.2.1	4.4, Table XI	3.2.6.4	4.7.1, Table XIII
3.1.2.2	4.4	3.2.7	4.7.1, Table XIII
3.1.2.3	4.4, Table XI	3.2.7.1	4.7.1, Table XIII
3.1.2.4	4.4, Table XI	3.2.7.2	4.7.1, Table XIII
3.1.3	4.4, Table XI	3.2.8	4.7.1, Table XIII
3.1.4	4.4, Table XI	3.2.8.1	4.7.1, Table XIII
3.1.5.1	4.4, Table XI	3.2.8.2	4.7.1, Table XIII
3.1.5.2	4.4, Table XI	3.3	4.7.2, Table XIII
3.2	4.7.1	3.4	4.7.3, Table XIII
3.2.1	4.7.1, Table XIII	3.5	4.7.4, Table XIII
3.2.2	4.7.1, Table XIII	3.6	4.7.5, Table XIII
3.2.3	4.7.1, Table XIII	3.7	4.7.6, Table XIII
3.2.4	4.7.1, Table XIII	3.8	4.7.7, Table XIII
3.2.4.1	4.7.1, Table XIII	3.9	4.7.8, Table XIV
3.2.5	4.7.1, Table XIII	3.10	4.7.10, Table XVI
3.2.5.1	4.7.1, Table XIII	3.11	4.7.11, Table XVI
3.2.5.2	4.7.1, Table XIII	3.12	4.7.1, Table XIII
3.2.5.3	4.7.1, Table XIII	3.12.1	4.7.9, Table XIV
3.2.6	4.7.1, Table XIII	3.13	4.7.1, Table XIII

4.2 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with ANSI/NCSL Z 540.1 and ISO 10012-1.

4.3 Classification of inspections. The inspections specified herein are classified as follows:

- a. Materials inspection.
- b. Conformance inspection.

4.4 Materials inspection. Materials inspection shall consist of certification supported by verifying data that the materials listed in table XI used in fabricating the cables are in accordance with the applicable referenced specifications or requirements prior to such fabrication.



## MIL-DTL-3432G

TABLE XI. Material inspection.

Material	Requirement paragraph	Applicable specification
Copper	3.1.1.1	A-A-59551
Insulating and jacketing compounds	3.1.2	MIL-I-3930, appendix herein, or ASTM D4066
Polyethyelene	3.1.2.1	L-P-390
Crosslink polyethylene	3.1.2.3, 3.8	NEMA WC 7/ICEA S-66-524
Polyamide (nylon)	3.1.2.4	ASTM D4066
Fillers and binders	3.1.4	ASTM G21
Polyester tape	3.1.5.1	MIL-I-631
Polypropylene tape	3.1.5.2	MIL-P-24216

4.4.1 Reinspection. If the cable is supplied on spools, reels, or coils or in precut lengths and is more than 12 months or 4 quarters of a year old from the date of last inspection to the date of shipment, the cable shall be reinspected to meet the applicable aging test of MIL-I-3930, the appendix of this specification, or ASTM D4066 for the insulation and jacket compounds used.

4.5 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of FED-STD-228.

4.6 Conformance inspection. Conformance inspections shall consist of group A, B, and C inspections.

4.6.1 Inspection of the product for delivery. Inspection of the product for delivery shall consist of groups A and B.

4.6.1.1 Inspection lot. An inspection lot shall consist of all cables of the same type designation (see 1.2.1) produced under essentially the same conditions, and offered for inspection at the same time.

4.6.1.2 Unit of product. The unit of product shall be taken as a continuous length of cable contained on a spool, reel, or coil. The unit of product shall not exceed 5,000 feet on each spool, reel, or coil.

4.6.1.3 Inspection sample. The inspection sample shall be product selected at random from the lot without regard to quality and shall be of the size specified in table XII.

TABLE XII. Inspection sample.

Production lot size <sup>1/</sup>	Sample size
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.

## MIL-DTL-3432G

4.6.1.4 Selection of sample units. Sample units for inspection shall be taken from each unit of product. A sample unit is defined as a length of cable drawn from a unit of product.

4.6.1.5 Test specimen. A test specimen may be the entire sample unit (length of finished cable) or any portion of the sample unit that is to be tested.

4.6.1.6 Group A inspection. Group A inspection shall consist of the inspections specified in Table XIII, in the order shown.

4.6.1.6.1 Group A acceptance. Each sample selected in accordance with 4.6.1.4 shall be examined to determine conformance with the requirements of Table XIII. If one or more defects are found in the inspection sample, the production lot shall be rejected and shall not be supplied to this specification.

TABLE XIII. Group A inspection.

Examination	Requirement paragraph	Test method paragraph
Visual and dimensional		
Conductors	3.2.1	4.7.1
Uninsulated ground wires	3.2.2	4.7.1
Insulated conductors	3.2.3	4.7.1
Shielding	3.2.4	4.7.1
Identification coding	3.2.5	4.7.1
Grouping and cabling	3.2.6	4.7.1
Jacket and jacket color	3.2.7	4.7.1
Diameter tolerance	3.2.8	4.7.1
Marking	3.12	4.7.1
Workmanship	3.13	4.7.1
Electrical (in the order shown)		
Spark test	3.3	4.7.2
Voltage withstand	3.4	4.7.3
Insulation resistance	3.5	4.7.4
Direct current resistance	3.6	4.7.5
Surface resistance	3.7	4.7.6
Hot creep (crosslink polyethylene only)	3.8	4.7.7

4.6.1.7 Group B inspection. Group B inspection shall consist of the inspections specified in Table XIV and shall be made on sample units which have been subjected to and which have passed group A inspection. Sample size selection shall be IAW table XV (small sample inspection).

TABLE XIV. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Cold bend	3.9	4.7.8
Marking durability (polyethylene and polyimide insulation jackets only)	3.12.1	4.7.9

## MIL-DTL-3432G

TABLE XV. Small sample inspection.

Lot size (passed Group A inspection)	Sample size
2 to 8	2
9 to 15	2
16 to 25	2
26 to 50	3
51 to 90	3
91 to 150	3
151 to 280	5
281 to 500	5
501 to 1200	5

4.6.1.7.1 Group B acceptance. Each sample selected in accordance with 4.6.1.7 shall be examined to determine conformance with the requirements of Table XIV. If one or more defects are found in the inspection sample, the production lot shall be rejected and shall not be supplied to this specification. Group B inspections may be performed in any order which is acceptable to the government.

4.6.1.7.2 Disposition of sample units. Samples subjected to group B tests shall not be delivered on contract or order.

4.6.2 Periodic inspection. Periodic inspection shall consist of group C. Where the results of this inspection show noncompliance with the applicable requirements, delivery of products which have passed groups A and B inspection shall be delayed.

4.6.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in Table XVI. Group C inspections shall be made on sample units selected from inspection lots which have passed groups A and B inspection.

TABLE XVI. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph
Polyethylene shrink-back	3.10	4.7.10
Polymide heat stability	3.11	4.7.11

4.6.2.1.1 Inspection sample. One sample shall be selected per each 5,000 feet of cable, or fraction thereof, not to exceed the total of five samples per order. Samples shall be selected periodically through the life of the contract to assure representative results.

4.6.2.1.2 Noncompliance. No failures shall be allowed in group C inspection. If a sample unit fails to pass group C inspection, acceptance of the product shall be discontinued until corrective action, acceptable to the government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections or the inspection that the original sample failed, at the option of the government). Groups A and B inspection may be reinstituted; however, final acceptance shall be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and the corrective action taken shall be furnished to the cognizant inspection activity and the procuring activity.

## MIL-DTL-3432G

4.7 Methods of inspection.

4.7.1 Visual and dimensional inspection. Cable shall be inspected to verify that the design, construction of conductors, ground wires, insulated conductors, shielding, identification coding, grouping and cabling, jacket, diameter tolerances, marking, and workmanship are in accordance with the applicable requirements. The inspections shall be made on a specimen not less than 2 feet in length and cut no closer than 5 feet from the end of the sample.

4.7.2 Spark test. All insulated conductors shall be subjected to the spark test in accordance with method 6211 of FED-STD-228 or method 900 of UL 1581 with the following exceptions:

- a. It shall be performed on all insulated conductors prior to cabling or shielding.
- b. For conductors larger than 6 AWG, an adaptation of method 6211, satisfactory to the Government inspector, shall be used.
- c. Speed shall be adjusted to ensure that contact is maintained for at least 0.25 seconds between the electrode and any point on the insulation or according to the formula in method 900 of UL 1581.
- d. The frequency of the voltage shall be 60 or 400 Hz, or as listed in table 900.2 of UL 1581.
- e. Use of voltmeter-equipped spark testers is optional.
- f. Spark test voltage shall be in accordance with table XVII.

TABLE XVII. Spark and dielectric withstanding test voltage.

All insulation materials			
Specified nominal thickness inclusive (inch/mm)	Spark test voltage (volts rms)	Specified nominal thickness inclusive (inch/mm)	Dielectric withstand voltage (volts)
0 to .029 (0 to .736)	3,000	0 to .020 (0 to .508)	1,000
.030 to .044 (.762 to 1.12)	6,000	.021 to .031 (.533 to .787)	1,500
.045 to .059 (1.14 to 1.50)	7,000	.032 to .047 (.813 to 1.20)	3,000
.060 and up (1.52 and up)	10,000	.048 to .063 (1.22 to 1.60)	3,500
		.064 to .077 (1.63 to 1.96)	4,000
		.078 to .094 (1.98 to 2.39)	5,000

4.7.3 Voltage withstand. Cables shall be tested as specified in method 6111 of FED-STD-228. The following exceptions shall apply:

- a. The test shall be performed only on finished cables.
- b. The source of power shall not be less than 5 kilovolt-amperes.
- c. The crest factor of the test voltage shall not differ by more than  $\pm 10$  percent from that of a sinusoidal wave when the transformer is loaded with the test specimen.

## MIL-DTL-3432G

d. The immersion period shall be at least 6 hours for unshielded cables. Cables with an overall shield shall not be immersed in water, and shall be tested dry.

e. For unshielded cables, an alternating potential, as specified in Table XVII, shall be applied between two terminals. One terminal shall be used to test each conductor in turn, and the other shall be for all remaining conductors. Any uninsulated ground drain wires, if present, shall be tied together in electrical contact with the water.

f. For shielded cables, an alternating potential, as specified in Table XVII, shall be applied between two terminals. One shall be used to test each conductor in turn, and the other shall be for all the remaining conductors. Any ground wires, if present, and the shield shall be tied together. The test voltage shall be maintained for 60 seconds +5, - 0 from the time it is reached.

4.7.3.1 Alternate voltage withstand. The following alternate procedure may be used when tested as specified in 4.7.3. Specimens are to be tested dry.

a. Arrange the conductors in a rectangle containing rows and columns; for example, a 20-conductor cable would have five columns and four rows. A 33-conductor cable would have five columns and seven rows, with two unused spaces.

b. Connect all the conductors in columns together. Do this for each column.

b. Apply the specified test voltage, for the specified time, between each column of the rectangle in turn, and the remaining columns connected together.

d. Disconnect all the conductors in a column. Do this for each column.

e. Connect all conductors in a row together. Do this for each row.

f. Apply the specified test voltage for 60 seconds +5, - 0, between each row the rectangle in turn, and the remaining rows connected together.

g. Connect all the conductors together.

g. If shields are present, apply the specified voltage from Table XVII between all the conductors connected together and the shields connected together.

4.7.4 Insulation resistance. Insulation resistance of the cables shall be determined as specified in method 6031 of FED-STD-228 except that:

a. The test shall be performed only on finished cables.

b. The insulation resistance shall be measured immediately after the voltage withstand test, and optionally after the cable has been immersed at least six hours. The cable may be tested dry.

c. The test voltage shall be not less than 200 volts nor more than 500 volts dc.

d. The polarity of the conductor shall be maintained negative with respect to the water.

e. For unshielded cables, the potential shall be applied between two terminals. One will test each conductor in turn, and the other will test all the remaining conductors and uninsulated ground drain wires, if present, tied together in electrical contact with the water.

## MIL-DTL-3432G

f. For shielded cables, the potential shall be applied between two terminals. One will test each conductor in turn, and the other will test all the remaining conductors, the uninsulated ground drain wires, if present, and the shields tied together, in electrical contact with the water. Cables with an overall shield shall not be immersed in water and shall be tested dry.

g. If the measurement is made at a temperature other than 15.6 °C, the manufacturer shall correct the measured value of insulation resistance to the resistance at 15.6 °C. If the insulation resistance is equal to or greater than that required by 3.5, when the measurement is made at temperature greater than 15.6 °C, no correction factor need be used. The manufacturer shall demonstrate that the correction factor is accurate for his compound.

h. Insulation resistance may be determined in less than 1 minute, if the galvanometer has ceased fluctuating and the reading indicates that a steady insulation resistance value has been obtained.

4.7.5 Direct current resistance. The direct current resistance of each conductor and uninsulated ground drain wire, if present, shall be measured on the finished cables as specified in FED-STD-228, method 6021.

4.7.6 Surface resistance. The uninsulated conductors and jacketed cables shall be tested in accordance with method 6041 of FED-STD-228 or method 1340 of UL 1581. All specimens, after having been provided with the required electrodes but prior to testing, shall be cleaned by the procedure described in the test method. In positioning the specimens in the test chamber, the specimens shall be placed so that their ends are a minimum of 1 inch from any wall of the chamber unless otherwise specified in the test procedure.

4.7.7 Hot creep (crosslink polyethylene). The crosslink polyethylene insulation shall be tested in accordance with NEMA WC 7 / ICEA-S-66-524.

#### 4.7.8 Cold bend.

4.7.8.1 Specimens. One length of cable from each sample unit shall be prepared for test. The length shall be divided into two parts. Provide one specimen for checking inked markings and jacketed cable as a whole, and a duplicate specimen for checking insulated conductors apart from the finished cable. The set shall be tested aged. If failure occurs to any one specimen, two additional specimens shall be prepared from the same sample unit and tested. If either of the additional specimens fail, the sample unit represented thereby shall be considered defective.

4.7.8.2 Procedure. The jacketed cable specimens and the insulated conductor specimen shall be aged in an air oven for 48 hours, 30 minutes at  $71 \pm 2$  °C, removed from the oven, and allowed to cool to room temperature. Aged specimens selected for checking inked markings and cables as a whole, shall be attached to the proper size mandrel as determined in 4.7.8.2.1. The specimens selected for checking insulation apart from the cable shall have the jacket removed and one of each differently colored insulated conductor shall be attached to the proper size mandrel as determined in 4.7.8.2.1. The specimens shall be suspended vertically with lower ends weighted sufficiently to keep specimens taut and to permit bending them without handling. The mandrel and specimens shall be placed in the cold chamber at the lower temperature  $\pm 2$  °C specified in table II, for a minimum of 4 hours. While at this temperature, the jacketed cable specimens shall be bent for 6 close turns, one turn for polyethylene insulation, around the mandrels at the rate of 15 - 18 turns per minute. The insulated conductor specimens (shielding or non-adhering color coding removed) shall be bent at the rate of one turn per second. If six turns cannot be obtained from a specimen because its length is restricted by space limitations in the cold chamber, the number of turns obtainable from a 5-foot specimen shall be permitted. After the test has been completed, the jacket on the specimens of cable shall be examined using a magnifying glass of at least 3X magnification and then removed. The conductor insulation on all specimens shall be examined for cracks using the same power magnifying glass.

## MIL-DTL-3432G

4.7.8.2.1 Mandrels. The mandrel shall be of a standard size in one of the diameters (in inches) specified in table XVIII. The standard size selected shall be the largest size that does not exceed the value computed in accordance with table XIX, except that the .062-inch mandrel shall be used when a smaller size is indicated by the computation.

TABLE XVIII. Mandrel diameters.

Inches	Inches	Inches	Inches
.062	.500	1.90	5.56
.094	.680	2.38	6.63
.125	.840	2.88	8.63
.188	1.050	3.50	10.75
.250	1.310	4.00	
.375	1.660	4.50	

TABLE XIX. Computed mandrel size.

Nominal outside diameter of insulated conductor or cable, inclusive <sup>1/</sup>	Mandrel size, maximum		
	Unshielded cable	Shielded cable	Individual insulated conductors
<u>Inches</u>	<u>Inches</u>	<u>Inches</u>	<u>Inches</u>
Up to .150	1.0 x OD	3.0 x OD	1.0 x OD
.151 to .250	1.0 x OD	3.0 x OD	1.5 x OD
.251 to .300	1.0 x OD	3.0 x OD	2.0 x OD
.301 to .350	2.0 x OD	3.0 x OD	3.0 x OD
.351 to .450	2.5 x OD	3.0 x OD	2.5 x OD
.451 to .550	3.0 x OD	3.0 x OD	3.0 x OD
.551 to .750	4.0 x OD	4.0 x OD	
.751 to .950	5.0 x OD	5.0 x OD	
.951 to 1.500	6.0 x OD	6.0 x OD	
1.501 to 2.00	8.0 x OD	8.0 x OD	
2.001 and over	10.0 x OD	10.0 x OD	

**NOTE:** <sup>1/</sup> For the nominal outside diameter cable (see 1.2.1.7). The nominal outside diameter of the insulated conductor shall be determined from the nominal outside diameter of the conductor and the nominal insulation thickness (see table VI). For parallel cables, the nominal outside diameter shall be the major axis.

4.7.9 Marking Durability. A short specimen of finished wire or sheath shall be firmly clamped in a horizontal position with its upper longitudinal surface area freely exposed. A small steel mandrel (.025 diameter  $\pm$ .001) shall be repeatedly rubbed over the insulation surface at the stripe so that the longitudinal axis of the mandrel and specimen will be at right angles to each other. A weight shall be affixed to the jig holding the rubbing mandrel so that the combined jig and weight exerts a 500-gram thrust normal to the insulation surface. A motor-driven reciprocating cam mechanism and counter shall be used to permit an accurately measured number of abrasion strokes. The length of stroke in one direction shall be .375 inch and the frequency of strokes shall be 120 strokes per minute (each stroke consisting of a 180° rotation of the eccentric drive mechanism). The direction of motion shall be along the axis of the wire or cable jacket and perpendicular to the axis of the mandrel. This procedure shall be repeated on one additional specimen selected at least 50 feet away from the previous specimen.

4.7.10 Polyethylene shrink-back. A 7-inch long specimen shall be cut from the insulated conductor. Shield and color coding braid, tape, or jacket shall be removed. The specimen shall then be cut to 6



## MIL-DTL-3432G

inches with the conductor flush with the insulation. The specimen shall then be air oven aged at  $85 \pm 1$  °C for 24 hours  $\pm 5$  hour. The specimen shall then be removed and allowed to cool to room temperature. The amount the conductor extends beyond the insulation shall be measured at each end and the insulation shall be examined for splitting or cracking.

#### 4.7.11 Polyamide heat stability.

4.7.11.1 Polyamide coating over the primary insulation. A 1-foot specimen shall be bent around a metal mandrel six times the outside diameter of the specimen for two turns and taped down on its ends. The specimen and the mandrel shall be placed in a gravity convection type oven at a temperature of  $93.3 \pm 2.9$  °C for 24 hours. Remove the specimen and mandrel from the oven and cool them in a silica gel desiccator or equivalent until they return to room temperature (1 hour minimum). Remove them from the desiccator, straighten the specimen and inspect for tears or cracks in the material.

4.7.11.2 Polyamide coating under or over component shield. A sufficient length of specimen shall be used to ensure at least six close turns when bent on a metal mandrel, six times the outside diameter of the specimen. Each turn shall be in contact with the next. The ends of the specimen shall be taped together so that the turns are held in place on the mandrel. The mandrel and specimen shall be suspended in a gravity convection oven at the temperature of  $148.9 \pm 2.8$  °C for 15 minutes. The specimen and mandrel shall be removed from the oven and cooled in a silica gel desiccator or equivalent until the specimen is at room temperature (1 hour minimum). Remove them from the desiccator, unwrap the coils, and inspect for tears or cracks in the material.

### 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 material 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 Points 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's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

### 6. NOTES

6.1 Intended use. The cables covered by this specification are intended for use by the Armed Services in extensive electrical and electronic applications. The cables may be used to transmit power, synch pulses, data transmission voltages, broadband, audio, or control power. The shielded cables are suitable for radio-frequency use in limited applications. A tough and flexible jacket is essential because the cables will be subjected to extreme mechanical abuse and extreme humidity and temperature conditions. Cables designated for light, medium, and heavy-duty are for use as indicated in 6.1.1 through 6.1.3.

6.1.1 Light-duty (L) cables. Light-duty cables are intended for use in test equipment in short lengths, or for interconnection of major components. They are intended to withstand severe flexing and frequent manipulation. Light-duty cables should not be used where they will be stepped on, run over by vehicles, beaten, or subjected to severe impacts. Light-duty cables are suitable for lightweight portable tools or small motor and generator leads where flexibility rather than long life is essential.

6.1.2 Medium-duty (M) cables. Medium-duty cables are intended to withstand the same usage as heavy duty cables except they should not be used where they will be run over by vehicles or subjected to severe impacts. They are intended to be a substitute for all uses of heavy-duty cables when the reduction in weight would be advantageous to the equipment they are used in. Medium-duty cables are suitable for small portable tools, sound equipment, radio receivers, and motor leads, which do not require the heavier, sturdier, heavy-duty cables.

## MIL-DTL-3432G

6.1.3 Heavy-duty (H) cables. Heavy-duty cables are intended for use where they will be subjected to extreme service impacts or will be run over by heavy vehicles, such as trucks, tanks, or the like. They are designed to withstand severe flexing and mechanical abuse over long periods of time without deterioration. Heavy-duty cables are suitable for portable tools, extension lamps, charging cables, and control cables.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of the specification.
- b. 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).
- c. Complete type designation (see 1.2.1).
- d. Lengths required.
- e. Packaging requirements (see 5.1).

6.3 Definitions.

6.3.1 Insulated conductor. A conductor consists of a stranded wire, with insulating covering, suitable for carrying an electric current.

6.3.2 Equipment ground wire. An insulated conductor (green) intended for grounding non-current-carrying metal parts of equipment.

6.3.3 Wire. A single metallic conductor of stranded construction designed to carry current in an electrical circuit.

6.3.4 Uninsulated ground drain wires. Uninsulated ground drain wires are wires which may be bare or covered with a non-insulating green covering used to identify them as ground wires, and should not be confused with the green insulated conductor used in portable power cables as the equipment ground conductor (see 6.3.2). These uninsulated ground drain wires are used in heavy duty outdoor and mine cables.

6.4 Disposal. Caution should be taken during handling and disposal of all insulating and jacketing materials in accordance with ASTM C930 and FED-STD-313.

6.5 Subject term (key word) listing.

Extra flexible  
 Fillers and binders  
 Ground drain wires  
 Heavy duty  
 Hot creep  
 Light duty  
 Medium duty  
 Semiflexible  
 Separators

## MIL-DTL-3432G

## APPENDIX

PROCEDURE FOR TESTING INSULATING AND JACKETING COMPOUNDS  
TYPE TPE-O AND TPE-S (LOW TEMPERATURE)

## 10. SCOPE

10.1 Scope. This appendix details the procedure for testing samples of insulating and jacketing compounds for both low temperature, heat and ozone resistant, olefinic thermoplastic elastomer (TPE-O) and low temperature, heat and ozone resistant, styrenic thermoplastic elastomer (TPE-S). This appendix is a mandatory part of the specification. The information contained herein is intended for compliance to the latest issue of MIL-I-3930.

## 20. APPLICABLE DOCUMENTS

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

## UNDERWRITERS LABORATORIES INCORPORATED

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

(Copies of the UL publication may be obtained from the Underwriters Laboratories, Inc., Publication Stock, 333 Pfingsten Road, Northbrook, IL 60062.)

## AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

(Application for copies should be addressed to Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112 USA, E-Mail: global@ihs.com phone (800) 854-7179 or 1-(303)-397-7956 (outside the US). Fax 1-303-397-2740.)

30. PHYSICAL PROPERTY REQUIREMENTS

	TPE-O	TPE-S
Unaged:		
Tensile strength, minimum psi	1,000	1,000
Elongation, minimum percent	250	250
Tear strength, minimum lb/in, using ASTM D624, die C	150	150
Tensile strength at 100 percent modulus, minimum psi	200	200
* Air oven aging, 168 hours $\pm$ 1 hour at 136 $\pm$ 1 °C:		
Tensile strength retention, minimum percent	80	80
Elongation, minimum percent of original	65	65
* Oil immersion (ASTM # 2 oil), 18 hours $\pm$ 0.5 hour at 121 $\pm$ 1 °C (jacket only):		
Tensile strength retention, minimum percent	75	75
Elongation, minimum percent of original	75	75

## MIL-DTL-3432G

Ozone resistance (after air-oven conditioning).

168 ± 1 hour in ozone (jacket only) at 50°C

No cracking

No cracking

Brittleness temperature:

Unaged, maximum °C

-55

-55

Aged, maximum °C

-55

-55

Maximum torsional stiffness ratio:

10

10

Cold tension recovery (minimum percent at -55°C):

TBD

TBD

\* In lieu of doing performance tests, supplier may also provide certificate of compliance in accordance with UL 1581 if it conforms to the values specified in this appendix.

MIL-DTL-3432G

CONCLUDING MATERIAL

Custodians:

Army – CR  
Air Force – 11  
Navy - AS

Preparing Activity:

DLA – CC

(Project 6145-2232)

Review activities:

Air Force – 99  
Army – AR, MI  
Navy – MC, SH

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

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.
2. The submitter of this form must complete blocks 4, 5, 6, and 7, and send to preparing activity.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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.

### I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER  
MIL-DTL-3432G

2. DOCUMENT DATE (YYYYMMDD)  
20001027

3. DOCUMENT TITLE CABLES, (POWER AND SPECIAL PURPOSE) AND WIRE, ELECTRICAL (300 AND 600 VOLTS)

### 5. REASON FOR RECOMMENDATION

### 6. SUBMITTER

a. NAME (Last, First, Middle Initial)

b. ORGANIZATION

c. ADDRESS (Include Zip Code)

d. TELEPHONE (Include Area Code)  
(1) Commercial  
(2) AUTOVON  
(if applicable)

7. DATE SUBMITTED  
(YYYYMMDD)

### 8. PREPARING ACTIVITY

a. NAME DEFENSE LOGISTICS AGENCY  
DEFENSE SUPPLY CENTER, COLUMBUS

b. TELEPHONE (Include Area Code)  
(1) Commercial (614) 692-0538  
(2) AUTOVON 850-0538

c. ADDRESS (Include Zip Code)  
DSCC-VAI  
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, Ft. Belvoir, VA 22060-2533  
Telephone (703) 767-6888 AUTOVON 427-6888