AEROSPACE STANDARD

AS5419	
Issued 2003-02 Reaffirmed 2014-04	

Cable, Thermocouple Extension, Shielded and Unshielded

RATIONALE

AS5419 has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Scope:

This SAE Aerospace Standard (AS) covers the requirements for thermocouple extension cable. Manufacturers of primary thermocouple wire in accordance with this specification must be qualified to the similar wire type specified in Table 1.

1.2 Classification:

The cable shall be of the following types and shall be furnished in the basic wire size and basic wire type and shield and jacket styles, as specified.

Unjacketed - Two wires spirally laid or duplex paralleled without an overall outer jacket

Jacketed - Two wires spirally laid or duplex paralleled with an overall outer jacket

Shielded - Two wires spirally laid or duplex paralleled with one or two overall shields

Shielded and Jacketed - Two wires spirally laid or duplex paralleled with one or two shields and one or two jackets

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http://www.sae.org/technical/standards/AS5419

1.2.1 Cable Designation: Cable shall be identified by a combination of digits and letters in accordance with the following (see 3.4.1):

AS5419	A	22	JF	KXS	N	06
Aerospace standard (see 1.2.1.1)	(see 1.2.1.1.1)	Conductor size (see 1.2.1.2)	Basic wire construction (see 1.2.1.3)	EMF Designator (see 1.2.1.4)	Shield style and material (see 1.2.1.5)	Jacket material (see 1.2.1.6)

Example: AS5419A22JFKXSN06

FIGURE 1

1.2.1.1 Cable Specification Number: The finished cable shall be identified by the number of this specification.

1.2.1.1.1 Cable Configuration and Braid Shield Coverage: When a minimum shield coverage of 85% is required, specify:

"A" for spiral laid cable configuration
"B" for duplex parallel cable configuration

When a minimum shield coverage of 90% is required, specify:

"C" for spiral laid cable configuration
"D" for duplex parallel cable configuration

1.2.1.2 Conductor Size: The basic wire size shall be identified. All wires used in the cable shall be of the same size.

1.2.1.3 Basic Wire Construction: A letter symbol shall be used to designate the insulation type specification in accordance with the applicable slant sheet in Table 1.

TABLE 1 - Component Wire Construction

Symbol sequence		AS Designation
JF	Similar to MIL-DTL-25038/3	AS5419/1
TA	Similar to AS-22759/8	AS5419/2
RC	Similar to AS-22759/11	AS5419/3
ML	Similar to AS-81044/12	AS5419/4
SP	Similar to AS-22759/43	AS5419/5
WP	Similar to AS-22759/91	AS5419/6
WJ	Similar to AS-22759/86	AS5419/7

1.2.1.4 EMF Designator: A letter symbol shall be used to designate the EMF type as defined per the individual wire specification.

1.2.1.5 Shield Style and Material: The shield style and material of the overall shields shall be designated by a single letter as follows:

TABLE 2 - Shield Style and Material

Symbol single shield style	Symbol double shield style	Shield material	Maximum temperature limit for shield material (information only)
U	---	No shield	---
T	V	Tin coated copper, round	150 °C (302 °F)
S	W	Silver coated copper, round	200 °C (392 °F)
N	Y	Nickel coated copper, round	260 °C (500 °F)
F	Z	Stainless steel, round	400 °C (752 °F)
C	R	Nickel clad copper (27%), round	400 °C (752 °F)
M	K	Silver coated high strength copper alloy, round	200 °C (392 °F)
P	L	Nickel coated high strength copper alloy, round	260 °C (500 °F)
G	A	Silver coated copper, flat	200 °C (392 °F)
H	B	Silver coated high strength copper alloy, flat	200 °C (392 °F)
J	D	Tin coated copper, flat	150 °C (302 °F
E	X	Nickel coated high strength copper alloy, flat	260 °C (500 °F)
I	Q	Nickel chromium alloy, flat	400 °C (752 °F)

1.2.1.6 Jacket Material and Temperature Rating: The single jacket symbol shall be used for cables with an outer jacket only. The double jacket symbol shall be used in conjunction with a double shield symbol to describe constructions with a jacket in between two shields with another jacket over the outer shield. The single jacket symbol shall be used in conjunction with the double shield symbol to describe constructions with two overlaid shields with a single outer jacket. Unless otherwise specified (see 6.2.1f), jacket colors shall be as specified under the jacket materials as follows:

TABLE 3 - Jacket Style and Material

Single jacket symbol	Double jacket symbol	Jacket material	Temperature limit for jacket material (information only)
00	00	No jacket	---
04	54	Polyester braid impregnated with high temperature finishers over polyester tape	150 °C (302 °F)
05	55	Extruded clear fluorinated ethylene propylene (FEP)	200 °C (392 °F)
06	56	Extruded or taped and fused white polytetrafluoroethylene (PTFE)	260 °C (500 °F)
07	57	White polytetrafluoroethylene (PTFE) treated glass braid impregnated and coated with polytetrafluoroethylene finisher over presintered polytetrafluoroethylene tape	260 °C (500 °F)
08[1]	58[1]	Crosslinked white extruded polyvinylidene fluoride (PVF_2)	150 °C (302 °F)
09	59	Extruded white fluorinated ethylene propylene (FEP)	200 °C (392 °F)
11	61	Tape of natural polyimide combined with clear fluorinated ethylene propylene (FEP) wrapped and heat sealed with (FEP) outer surface	200 °C (392 °F)
12	62	Tape of natural polyimide combined with fluorinated ethylene propylene (FEP) wrapped and heat sealed with polyimide outer surface	200 °C (392 °F)
14	64	Extruded white ethylene-tetrafluoroethylene (ETFE) copolymer	150 °C (302 °F)
15	65	Extruded clear ethylene-tetrafluoroethylene (ETFE) copolymer	150 °C (302 °F)
16	66	Braid of aromatic polyamide with high temperature finisher over presintered polytetrafluoroethylene (PTFE) tape	200 °C (392 °F)
20	70	Extruded white perfluoroalkoxy (PFA)	260 °C (500 °F)
21	71	Extruded clear perfluoroalkoxy (PFA)	260 °C (500 °F)
22	72	Tape of opaque polyimide combined with clear fluorinated ethylene propylene (FEP) wrapped and heat sealed with polyimide outer surface	200 °C (392 °F)
23	73	White crosslinked extruded modified ethylene-tetrafluoroethylene copolymer (XLETFE)	200 °C (392 °F)
24	74	Tape layer of white polytetrafluoroethylene (PTFE) wrapped over a tape layer of natural polyimide combined with FEP and heat sealed	260 °C (500 °F)

[1] Jacket material 08 is not to be used for cables having a diameter of 0.401 inch (10.19 mm) or greater.

2. APPLICABLE DOCUMENTS:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws unless a specific exemption has been obtained.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AS4373	Test Methods for Insulated Electric Wire
AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
AS81044	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy

2.2 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-DTL-25038	Wire Electrical, High Temperature, Fire Resistant, and Flight Critical
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-W-29606	Wire, Electric, Stranded, Uninsulated Copper, Copper Alloy or Aluminum, or Thermocouple Extension
WC 27500	Cable, Power, Electrical and Cable Special Purpose, Electrical Shielded and Unshielded
FED-STD-228	Cable and Wire, Insulated; Methods of Testing
MIL-STD-104	Limit for Electrical Insulation Color
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-686	Cable and Cord, Electrical; Identification Marking and Color Coding of

2.3 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI-MC96.1	Temperature Measurement Thermocouples
ANSI/ASQC Z1.4	Sampling Procedures and Tables for Inspection by Attributes
ANSI/ASTM B 3	Soft or Annealed Copper Wire
ANSI/ASTM B 33	Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes
ANSI/ASTM B 298	Silver Coated Soft or Annealed Copper Wire
ANSI/ASTM B 355	Nickel Coated Soft or Annealed Copper Wire

2.4 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM A 313	Wire, Steel, Corrosion-Resisting
ASTM B 170	Oxygen Free Electrolyte Copper Refinery Shapes
ASTM B 272	Copper Flat Copper Products With Finished (Rolled or Drawn) Edges (Flat Wire and Strip)
ASTM B 624	High Strength, High Conductivity Copper Alloy Wire for Electronic Application Standard Specification for
ASTM D 3032	Hookup Wire Insulation, Standard Methods of Testing
ASTM D 4591	Determining Temperatures and Heats of Transitions of Fluoropolymers by Differential Scanning Calorimetry

2.5 National Bureau of Standards Publications:

Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

H4-1	Federal Supply Code for Manufacturers, United States and Canada, Name to Code
H4-2	Federal Supply Code for Manufacturers, United States and Canada, Code to Name
NBS HDBK 100	International Annealed Copper Standard (IACS)

3. REQUIREMENTS:

3.1 Materials:

3.1.1 Copper Shield Round Strand Material: Before shielding, the copper strands used in shields shall be annealed or soft-drawn copper wire from commercially pure copper and shall conform to ASTM B 3. Nickel plated strands shall conform to ASTM B 3 or ASTM B 170. It shall be possible to solder or crimp the material to approved terminals. Wire shall be free from lumps, kinks, splints, abrasions, scraped or corroded surfaces and skin impurities.

3.1.2 Stainless Steel Shield Material: Before shielding, the stainless steel strands shall conform to ASTM A 313. It shall be possible to crimp the wire to approved terminals. The wire shall be free from kinks, abrasions, or scraped surfaces.

3.1.3 High Strength Copper Alloy Shield Round Strands: Before shielding, the high strength copper alloy strands shall conform to ASTM B 624 except that the minimum tensile strength shall be 55,000 lbf/in^2, the minimum elongation shall be 6%, and the conductivity shall be 80% (minimum) as stated in NBS Handbook 100.

3.2 Construction:

Construction shall comply with the classification given in 1.2. Combinations of shield style and material, basic wire specification and jacket materials shall be restricted to those allowed in Table 5 unless otherwise approved by the preparing activity of this standard.

3.2.1 Basic Wire: The basic wire (primary) shall meet all the requirements as defined herein. Unless otherwise specified the cable manufacturer is responsible for assuring that the basic wire requirements are as specified.

3.2.2 Cable Layup: The required number of wires for multiconductor construction determined by the cable designation shall be cabled with a left-hand lay. The lay of the individual wires shall be not less than 6 nor more than 16 times the outside major axis diameter of the unshielded, unjacketed cable as calculated in 4.5. The basic wire shall not be spliced. When cables are cut, wires will maintain proper sequence and shall not splay more than twice the diameter of the cable.

3.2.2.1 Fillers and Binder Tapes: Fillers and binder tapes, if used, shall be of a fungus resistant material with a temperature equivalent to the cable rating without fillers and tape. Fillers and binders shall also be easily removable from the finished cable without adherence to the underlying insulation.

3.2.3 Shield: When the cable designation specifies that a shield is to be incorporated in the cable construction, either a closely woven braid using round strand or a closely woven braid of flat strand shall be applied over the basic cable.

3.2.3.1 Braided Round Shields:

3.2.3.1.1 Braided Round Wire: Before application to the cable, individual tin, silver, or nickel coated copper strands shall have a minimum elongation of 6%.

3.2.3.1.2 Round Copper or Copper Alloy Strand Size: Cables with braided shields using round copper or round copper alloy strands shall conform to Shield Group A or B. The core diameter referred to in Group A or B shall be the nominal outside core diameter of the unshielded, unjacketed cable equal to the basic wire diameter multiplied by a factor of 1.64. The following component wires Type RC, Type ML, Type SW, Type WC and Type WJ shall conform to Shield Group B. All other braided shields with round shield strands shall conform to Shield Group A.

TABLE 4 - Shield Size

Group A Cable O.D.	Group B Cable O.D.	Shield Size
0.000-0.060 in	0.000-0.250 in	38 AWG
0.061-0.310 in	0.251-0.400 in	36 AWG
0.311-0.750 in	0.401-1.000 in	34 AWG
0.751 in and larger	1.001 in and larger	32 AWG

3.2.3.1.3 Coating:

3.2.3.1.3.1 Tin Coated Copper Strands: When the cable designation specifies a tin coated shield, the individual strands shall be coated uniformly with a smooth, continuous layer of commercially pure tin. Prior to braiding, the strands shall meet the requirements of ASTM B 33. The thickness of the tin coating shall be 250 µin maximum.

3.2.3.1.3.2 Silver Coated Copper and High Strength Alloy Strands: When the cable designation specifies a silver coated copper shield, the individual strands shall be coated uniformly with a smooth continuous layer of commercially pure silver. Prior to braiding, silver coated copper strands shall meet the requirements of ASTM B 298. Silver coated high strength copper alloy strands shall meet the requirements of 3.1.3 and the adhesion and continuity of coating requirements of ASTM B 298. The thickness of the silver shall be not less than 40 µin.

3.2.3.1.3.3 Nickel Coated Copper and High Strength Alloy Strands: When the cable designation specifies a nickel coated shield, the individual strands shall be coated uniformly with a smooth, continuous layer of commercially pure nickel having a coating thickness of not less than 50 µin nor greater than 250 µin. The wire shall meet the coating requirements of ASTM B 355 prior to braiding.

3.2.3.1.3.4 Nickel Clad Copper Strands: When the cable designation specifies a nickel clad copper shield, the individual strands shall have a nickel coating having a cross-sectional area that is 27% minimum of the total cross-sectional area of the drawn strand. The wire shall meet the coating requirements of ASTM B 355 prior to braiding.

3.2.3.1.4 Stainless Steel Shield:

3.2.3.1.4.1 Stainless Steel Strand Size: On cable with outside diameter (under the shield) of less than 0.060 in (1.52 mm), the strand size shall be AWG 40. On cable with an outside diameter of 0.060 to 0.120 in (3.05 mm), the strand size shall be AWG 38. On cable with outside diameter of 0.121 in (3.07 mm) and larger, the strand size shall be AWG 36.

3.2.3.2 Braided Flattened Wire Strands: Flat wire shields shall be braided of copper, high strength copper alloy, or nickel chromium alloy. The flattened wire shall be 0.0015 in ± 0.0004 in (0.040 mm ± 0.010 mm) in thickness.

3.2.3.2.1 Copper Wire, Flattened: Copper flattened wire shall meet the requirements of ASTM B 272 except the wire shall be made by flattening round wire.

3.2.3.2.2 Flattened High Strength Copper Alloy Flat Wire: Flattened high strength copper alloy wire shall be made by flattening round wire. The flattened wire tensile strength shall be not less than 55,000 lbf/in^2 and the elongation shall be 1% minimum after flattening.

3.2.3.2.3 Coating of Flattened Wire Strands:

3.2.3.2.3.1 Tin Coated Copper Flattened Wire: Tin coated copper strands before flattening shall conform to ASTM B 33. Flattened wire strands shall meet the continuity of coating test of ASTM B 33. The thickness of coating shall be 250 µin maximum.

3.2.3.2.3.2 Silver Coated Copper or Silver Coated High Strength Copper Alloy Flattened Wire: Silver coated copper or silver coated high strength copper alloy strands shall conform to ASTM B 298 after flattening. The flattened wire strands shall have a minimum coating thickness of 40 µin and shall meet the continuity of coating requirements of ASTM B 298 after flattening.

3.2.3.2.3.3 Nickel Coated Copper or Nickel Coated High Strength Copper Alloy Flattened Wire: Nickel coated copper or nickel coated high strength copper alloy strands shall conform to ASTM B 355 after flattening. The flattened wire strands shall have a minimum coating thickness of 50 µin and shall meet the continuity of coating requirements of ASTM B 355 after flattening.

3.2.3.3 Braid Angle: The shield braid shall be a push-back type. The angle of the carriers of the braid with the axis of the cable in woven wire shields shall be not less than 18° nor more than 40°. When the major diameter of the cable beneath the braid is greater than 0.31 in (7.9 mm), the above braid angle restriction shall not apply. In this case, the shield shall be suitably applied to provide good push-back characteristic. For determination of braid angle, see 4.4.5.

3.2.3.4 Shield Coverage: The shield braid shall be applied in such a manner as to provide 85 or 90% minimum coverage for each individual shield (see 4.4.5) as specified by the part number (see 1.2.1.1.1).

3.2.4 Jacket: When a jacket is applied over a cable or shield, all jackets shall meet the following requirements. The jacket shall be easily removable from the finished cable without adherence to the underlying shield or cable. Stripping time (for jacketing styles 11, 12, and 22 only) shall be 5 s maximum when testing in accordance with 4.4.18 and shall not open more than 0.125 in (3.18 mm). The wall thickness of the jacket shall be as specified in Table 6 for applicable material. The thickness of the jacket between the shields in the double shield and double jacket shall be 75% of the values specified in Table 6. The jacket of specimens prepared for jacket thickness measurements shall not flare or raise up by more than 0.016 in (0.41 mm).

3.2.4.1 Jacket Material:

3.2.4.1.1 Polyester Fiber Braid with High Temperature Finishers: Braided polyester fiber jackets shall be constructed with the fibers woven in such a manner as to provide complete coverage and shall be impregnated with a high temperature finisher. The color of the finished braids shall be white or tan. After subjection to the heat aging test (see 4.4.10), the finisher shall show no indications of decomposition.

3.2.4.1.2 Extruded or Taped Polytetrafluoroethylene: Concentrically extruded or taped polytetrafluoroethylene jackets shall have wall thicknesses in accordance with Table 6 (see 4.4.12). If polytetrafluoroethylene tapes are used, they shall be unsupported and shall be a minimum of two contrahelically wrapped tapes each applied with a 25% minimum overlap. The tapes shall subsequently be sintered to form a homogeneous wall. The polytetrafluoroethylene jackets shall be white.

3.2.4.1.3 Extruded Fluorinated Ethylene Propylene: Jackets shall be constructed of a clear or white fluorinated ethylene propylene as indicated by the style and shall be concentrically extruded with wall thicknesses in accordance with Table 6. The tensile strength and elongation of the jacket shall be 3,000 lbf/in^2 minimum and 200% minimum, respectively, and shall be tested in accordance with 4.4.12.1.

3.2.4.1.4 Glass Braid with Polytetrafluoroethylene Finishers: Braided polytetrafluoroethylene coated glass fiber jackets shall be constructed with treated glass fiber containing not less than 15% by weight of polytetrafluoroethylene and woven in a manner that will provide complete coverage. The braid shall be impregnated and coated with a polytetrafluoroethylene finisher.

3.2.4.1.5 Extruded Crosslinked Polyvinylidene Fluoride: Jackets of extruded and crosslinked polyvinylidene fluoride shall be in accordance with Table 6. The tensile strength and elongation of the jacket shall be 4,000 lbf/in^2 minimum and 200% minimum, respectively, and shall be tested in accordance with 4.4.12.1.

3.2.4.1.6 Taped Polyimide/Fluorinated Ethylene Propylene: The jackets of polyimide/fluorinated ethylene propylene tapes shall consist of two or more tapes. The first tape shall be a one-side polyimide/FEP coated tape applied with not less than 20% overlap and with the polyimide side facing inward, toward the shield or component wires. Succeeding tapes shall be applied in alternating directions and with not less than 30% overlap. The tapes shall be fused together to provide a jacket with a wall thickness in accordance with Table 6.

3.2.4.1.7 Ethylene-tetrafluoroethylene Copolymer: The jackets shall be extruded ethylene-tetrafluoroethylene copolymer and shall have a wall thickness as shown in Table 6. The tensile strength and elongation of the jacket shall be 5,000 lbf/in^2 minimum and 150% minimum, respectively, and shall be tested in accordance with 4.4.12.1.

3.2.4.1.8 Extruded Perfluoroalkoxy: Jackets of extruded perfluoroalkoxy shall have a wall thickness as specified in Table 6. The tensile strength and elongation shall be 3,000 lbf/in^2 minimum and 150% minimum, respectively, and shall be tested in accordance with 4.4.12.1.

3.2.4.1.9 Extruded, Crosslinked, Modified, Ethylene-tetrafluoroethylene: Jackets of extruded and crosslinked modified ethylene-tetrafluoroethylene shall have a wall thickness as specified in Table 6. The color shall be white. The tensile strength and elongation shall be 5,000 lbf/in^2 minimum and 50% minimum, respectively, and shall be tested in accordance with 4.4.12.1.

3.2.4.1.10 Taped Polyimide/Polytetrafluoroethylene: The jackets of polyimide/polytetrafluoroethylene shall consist of two tapes. For constructions requiring an 0.006 to 0.010 in jacket thickness, the inner tape shall be a fluoropolymer/polyimide/fluoropolymer coated tape (1 mil minimum thickness) applied with a minimum 50% overlap. The outer tape shall be an unsintered polytetrafluoroethylene tape (2 mil thickness) applied in the opposite direction to the first tape and with a minimum of 50% overlap. For constructions requiring an 0.008 to 0.012 in jacket thickness, the 2 mil outer polytetrafluoroethylene tape shall have a minimum overlap of 67%. The tapes shall be heat sealed after wrapping. The polytetrafluoroethylene tape material shall be formulated in such a manner to achieve a minimum 62% contrast level when marked by a UV laser source in accordance with 3.3.14.

TABLE 5 - Recommended Shield and Jacket Materials for Each Basic Type Wire

Basic wire specification	Cable type: Shielded — Shield material	Shielded — Jacket material	Jacketed — Shield material	Jacketed — Jacket material	Shielded and Jacketed — Shield material	Shielded and Jacketed — Jacket material
TA, RC	T, S, N	00	U	04, 05, 06, 07, 09, 14-18, 20, 21	T, S, N	04, 05, 06, 07, 09, 14-18, 20, 21
SP	T, S, N	00	U	04, 05, 08, 09, 14-18, 20, 21, 23, 24	T, S, N	04, 05, 08, 09, 14-18, 20, 21, 23, 24
JF	F, C	00	U	06, 07	F, C	06, 07
ML	T, S	00	U	04, 08, 09, 14, 16, 23	T, S	04, 08, 09, 14, 16, 23
WP, WJ	T, S, N	00	U	04, 05, 06, 07 09, 11, 12, 14-18 09, 11, 12, 14-18	T, S, N	04, 05, 06, 07 09, 11, 12, 14-18 09, 11, 12, 14-18

Note: Associated double jacket types have same shield and jacket designations.

TABLE 6 - Jacket Wall Thickness[1]

Diameter of cable beneath jacket (in)	06	05, 09 14, 15, 20, 21	08	11	12, 22	23	24
				inches min max			
Up to 0.150	0.010-0.015	0.007-0.016	0.005-0.010	0.0035-0.0055	0.003 -0.0055	0.005-0.010	0.006-0.010
0.161-0.200	0.010-0.015	0.010-0.020	0.006-0.012	0.0035-0.0055	0.003 -0.0055	0.006-0.011	0.006-0.010
0.201-0.250	0.010-0.015	0.010-0.020	0.007-0.014	0.0035-0.0055	0.003 -0.0055	0.007-0.012	0.006-0.010
0.251-0.300	0.010-0.015	0.010-0.020	0.007-0.014	0.0035-0.0055	0.003 -0.0055	0.007-0.013	0.006-0.010
0.301-0.400	0.015-0.025	0.013-0.020	0.007-0.014	0.006 -0.009	0.0045-0.0075	0.008-0.014	0.006-0.010
0.401-0.500	0.015-0.025	0.013-0.020		0.006 -0.009	0.0045-0.0075	0.009-0.017	0.006-0.010
0.501-0.600	0.020-0.030	0.020-0.030		0.0095-0.0136	0.007 -0.011	0.010-0.018	0.008-0.012
0.601-0.700	0.020-0.030	0.020-0.030		0.0095-0.0136	0.007 -0.011	0.012-0.022	0.008-0.012
0.701-0.750	0.020-0.030	0.020-0.030		0.0095-0.014	0.007 -0.011	0.014-0.024	0.008-0.012
0.751-0.800	0.020-0.030	0.020-0.035		0.0095-0.014	0.007 -0.011	0.014-0.024	0.008-0.012
0.801-1.000	0.020-0.030	0.020-0.035		0.0095-0.014	0.007 -0.011	0.016-0.030	0.008-0.012
Over 1.000	0.020-0.030	0.020-0.035				0.020-0.040	0.008-0.012

[1] Jacket materials not shown shall have a minimum wall thickness of 0.010 inch.

3.3 Functional Characteristics:

3.3.1 Dielectric Withstand: One hundred percent of all finished cable shall be tested in accordance with 4.4.3, 4.4.3.1, and 4.4.3.2. Following these tests, there shall be no evidence of electrical breakdown or arcing.

3.3.1.1 Impulse Dielectric (for Unshielded/Unjacketed Configuration): One hundred percent of all finished unshielded and unjacketed, multiconductor cable (except component wire Type JF), both conductors, sizes 14 to 22 AWG shall pass the impulse dielectric test in accordance with 4.4.3.3. There shall be no evidence of dielectric failure.

3.3.2 Jacket Flaws (Shielded and Jacketed Cables Only): One hundred percent of all finished cable shall be tested in accordance with 4.4.4. All flaws shall be removed or marked consistent with the requirements for packaging (see 5.1).

3.3.3 Conductor Continuity: All conductors in all lengths of finished cable shall withstand the conductor continuity test of 4.4.8 without indication of discontinuity.

3.3.4 Cold Bend (Jacketed and Shielded and Jacketed Cables Only): All finished jacketed and shielded and jacketed types of cable shall withstand the cold bend test of 4.4.6 without evidence of cracking of jackets. Shielded and jacketed cable with jacket material listed in 4.4.6 shall then pass the voltage withstand test of 4.4.7 without electrical breakdown (see 4.3).

3.3.5 Thermal Shock: All finished cable with jacket materials listed in Table 7 shall withstand the thermal shock test of 4.4.9 without cracking of the jacket (see 4.3).

3.3.5.1 Aging Stability: All finished cable with jacket materials listed in Table 7 shall withstand the aging stability test of 4.4.10 without cracking of the jacket (see 4.3).

TABLE 7 - Thermal Shock and Aging Stability

Jacket materials	Thermal shock and aging stability temperature
04	150 °C
14, 15	180 °C
05, 09, 11, 12, 16, 22, 24	230 °C
06, 07, 20, 21	285 °C

Note: Associated double jacket style uses same test temperature

3.3.6 Blocking: Adjacent layers of cable with all jacket materials shall not stick together nor to the metal mandrel when subjected to the test for blocking in 4.4.16 at rated temperature of the jacket or basic wire, whichever is lower, for 6 h.

3.3.7 Flammability: Cable specimens with all jacket materials loaded with sufficient weight to remain taut throughout test shall not burn for more than 30 s, nor more than 3.0 in (76.2 mm) when tested in accordance with 4.7.

3.3.8 Immersion: Cable specimens with jacket materials 08, 11, 12, 22, 23, and 24 shall not increase in diameter more than 5% and shall not crack when tested in accordance with 4.4.13 or 4.4.14, as applicable.

3.3.9 Lamination Sealing: Cable specimens with taped wrapped jacket materials 11, 12, 22, 24, 61, 62, 72, or 74 shall exhibit no separation of layers either along the insulation or at the ends when tested in accordance with 4.4.15.

3.3.10 Crosslinked Verification: All finished cable with jacket material 08, 23, 58 or 73 shall withstand the test of 4.4.11 without cracking of the jacket, dielectric breakdown, or pitting of metallic coatings, as applicable (see 4.3). Normal oxidation of the conductor coating shall not be cause for rejection.

3.3.11 Temperature Rating: The temperature rating of the cable shall be defined as the lowest rating of the basic specification wire, shield material, or jacket material as defined in 1.2.1.5 or 1.2.1.6.

3.3.12 Concentricity of Extruded Jackets: The concentricity of extruded jackets shall be not less than 70% when tested in accordance with 4.4.17.

3.3.13 Shield Solderability: Solderability shall be evaluated using the “Evaluation of Wrapped Lugs, Tabs, and Wire” paragraph of MIL-STD-202, Method 208 after the braided shields are tested in accordance with 4.4.19. The requirement is applicable to tin and silver coated shields only (single shield symbols T, S, M, G, H, J, and double shield symbols V, W, K, A, B, D).

3.3.14 Laser Markability (Optional): When required, applicable materials shall be formulated in such a manner to achieve a 62% minimum contrast level when marked by an ultraviolet (UV) laser source operating at a delivered power not to exceed 1.5 J/cm^2. The contrast level is defined as the difference between the reflectances of the background insulation and the laser mark, divided by the reflectance of the background insulation.

3.4 Identification of Product:

3.4.1 Cable Product Identification: The cable product identification shall consist of the cable designation as determined by 1.2.1 and the cable manufacturer’s code designation in accordance with publications H4-1 and H4-2.

3.4.1.1 Unshielded, Unjacketed Cable: Cable product identification shall be imprinted on the insulation of Wire No. 1 or the chromel wire of a paired cable (see 3.4.2). The cable product identification shall conform to 3.4.3. The cable product identification shall not be required when the product identification is not required by the basic wire specification for that size wire.

3.4.1.2 Shielded Cable: The cable product identification shall be imprinted on a marker tape placed beneath the shield (see 3.4.4).

3.4.1.3 Jacketed Cable: The cable product identification shall be imprinted on the outer surface of the following jacket styles (08, 23, 58, and 73). All other jacket styles shall have cable product identification imprinted on a marker tape placed beneath the jacket.

3.4.1.4 Shielded and Jacketed Cable: The cable product identification shall be imprinted on the outer surface of the following jacket styles (08, 23, 58, and 73). All other jacket styles shall have cable product identification imprinted on a marker tape placed beneath the shield or jacket.

3.4.2 Wire Product Identification: The wire product identification may be omitted on Wire No. 1 when this wire carries the cable product identification (see 3.4.1.1).

3.4.3 Printed Marking: The printed marking shall be durable, legible, and shall be black in color. The size of the printed characters shall be consistent with the magnitude of the surface upon which it is printed. The distance between the end of one mark and the beginning of the next shall be:

a. Six to eighteen inches if printed on the jacket (3.4.1.1, 3.4.1.3, and 3.4.1.4)
b. A maximum of 3 in if on a marker tape (3.4.1.2, 3.4.1.3, and 3.4.1.4)
c. A maximum of 12 in if on Wire No. 1 (3.4.1.1)

The printed marking shall be applied with the vertical axes of the printed characters lengthwise on cable (or wire) whose nominal diameter is 0.050 in (1.27 mm) or smaller. The vertical axes of the printed characters may be crosswise or lengthwise on cable (or wire) whose nominal diameter is 0.051 in (1.30 mm), or larger, or whenever tape is used (see 3.4.4).

3.4.4 Identification Tape: When tape is used for carrying the imprinted cable product identification, the tape shall be one continuous length of electrically non-adhesive type material with a temperature rating equivalent to the cable rating without the tape. The tape shall be 0.062 in (1.57 mm) nominal or larger. The color of the tape shall be white in accordance with MIL-STD-104, Class 1, except when polyimide tape is used, in which case the natural color of the polyimide is acceptable.

3.4.5 Jacket Color: Unless otherwise specified in the contract or purchase order (see 6.2), the cable jacket color shall be in accordance with the jacket material descriptions of 1.2.1.6. When a color or color tracer is specified, it shall conform to MIL-STD-104.

3.5 Workmanship:

The finished cable shall exhibit uniform quality throughout without visible irregularities when viewed with the unaided eye.

3.6 Cable Diameter:

The major diameter of the cable shall be determined as specified in 4.5 and shall not exceed the maximum diameter calculated in accordance with 4.5.

3.7 Cable Weight:

The maximum weight of the cable shall be determined as specified in 4.6. The measured weight shall not exceed the calculated weight.

3.8 Length Requirement:

The individual continuous lengths of finished cable in each inspection lot shall conform to the continuous length requirements listed below:

85% of the lengths shall be greater than 100 ft
100% of the lengths shall be greater than 50 ft

Unless otherwise specified in the contract or order, the footage of the individual continuous lengths in each spool or reel shall be marked on the spool or reel in the sequence in which the lengths will be unwound by the user.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

Unless otherwise specified in the acquisition document or purchase order, the cable manufacturer is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the acquisition document or purchase order, the cable manufacturer may use his own or any other facilities suitable for the performance of the inspection requirements specified herein.

4.1.1 Responsibility for Compliance: All items must meet all requirements of Sections 3 and 5. The inspection set forth in this specification shall become a part of the cable manufacturer's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the cable manufacturer of the responsibility of assuring that all products or supplies comply with all requirements of the acquisition document or purchase order.

4.2 Classification of Inspection:

The inspection requirements specified herein are classified as follows:

a. Quality conformance inspection (see 4.3.1)
b. Process control tests (see 4.3.2)

4.3 Inspection Conditions:

Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in AS4373.

4.3.1 Quality Conformance Inspection: Quality conformance inspection shall consist of the tests listed in Table 8.

TABLE 8 - Quality Conformance Inspection

Test	Requirement	Test method
Shield coverage	3.2.3.4	4.4.5
Braid angle	3.2.3.3	4.4.5
Shield solderability	3.3.13	4.4.19
Identification of product	3.4	4.4.1
Jacket wall thickness	3.2.4	4.4.12
Jacket concentricity	3.3.12	4.4.17
Lamination sealing	3.3.9	4.4.15
Cable jacket removability	3.2.4	4.4.18
Cable diameter	3.6	4.5
Cable weight	3.7	4.6
Cold bend	3.3.4	4.4.6
Thermal shock	3.3.5	4.4.9
Aging stability	3.3.5.1	4.4.10
Jacket, tensile strength and elongation	3.2.4.1	4.4.12.1
Blocking	3.3.6	4.4.16
Flammability	3.3.7	4.7
Impulse dielectric	3.3.1.1	4.4.3.3
Crosslink verification	3.3.10	4.4.11

4.3.1.1 Lot: A lot shall consist of all cable of a single cable designation offered for inspection at one time except that the lot shall not exceed 1,000,000 ft or one week's production, whichever is less. The lot shall be expressed in units of thousands of feet (total footage in lot divided by 1,000).

4.3.1.2 Sample: A sample shall consist of individual lengths of cable chosen at random from any one lot for the purpose of inspection or test. The sample size or number of lengths to be chosen from each lot shall be determined by the sampling plan.

4.3.1.3 Sample Unit (Tests of Table 8): The sample unit shall consist of a single piece of finished wire chosen at random from the inspection lot and of sufficient length to permit all applicable examinations and tests. Unless otherwise specified, the length of the sample unit shall be 25 ft. Not more than one sample unit shall be taken from a single unit of product.

4.3.1.4 Specimen: A specimen shall consist of a piece of one sample unit upon which a particular inspection or test is to be made.

4.3.1.5 Sampling: A random sample of the size specified shall first be selected from the lot. A specimen of sufficient length shall then be selected from each sample unit for the specified tests. Sampling inspection shall be in accordance with ANSI/ASQC Z1.4.

4.3.2 Process Control Tests: The process control tests are either of such nature that they cannot be performed on finished cable submitted for inspection and, therefore, must be conducted at the most appropriate stage of manufacturing operations, or tests can be conducted on 100% of the finished cable. The process control tests shall consist of the tests listed in Table 9.

TABLE 9 - Process Control Tests

Test	Requirement	Test
Copper shield round strand material	3.1.1	4.4.2
Stainless steel shield material	3.1.2	4.4.2
High strength copper alloy shield round strand	3.1.3	4.4.2
Thickness of coating	3.2.3.1.3	4.4.2.2.1
Continuity of coating	3.2.3.1.3	4.4.2.2.2
Strand elongation	3.2.3.1.1	4.4.2.1
Adhesion of nickel coating	3.2.3.1.3.3	4.4.2.2.3
Jacket flaws	3.3.2	4.4.4
Dielectric withstand	3.3.1	4.4.3 or 4.4.3.1 (if applicable)
Conductor continuity	3.3.3	4.4.8
Basic wire acceptance	3.2.1	Basic wire specification

4.3.2.1 Sampling for Process Control Tests:

4.3.2.1.1 Shield Strand Material: From each week's production of individual shield strands or from every 100 lb of individual shield strand, whichever is less, three 10-ft lengths of each style of shield strand representative of the material to be used in the finished cable shall be selected.

4.3.2.1.2 Coating: A sample shall consist of at least 3.5 ft of strand, before braiding, that is representative of the strand to be used in each lot of finished cable (see 4.3.1.1).

4.3.2.1.3 Coated Copper Strand Elongation: A sample shall consist of at least 3.5 ft of strand, before braiding, that is representative of the strand to be used in each lot of finished cable (see 4.3.1.1).

4.3.2.1.4 Basic Wire: Sampling of the basic wire shall be in accordance with the sampling plan of the similar wire type defined in Table 1. Additional impulse dielectric testing in accordance with the basic wire specification shall be performed when potentially degrading operations, either thermal, mechanical, or chemical have been performed subsequent to the original test.

4.3.3 Rejection and Retest: When the sample selected from a production run fails to meet the specified tests, no items still on hand or later produced shall be accepted until the extent and cause of failure have been determined. After investigation, the cable manufacturer shall advise the acquiring activity of the action taken and after corrections have been made, all process control tests shall be repeated.

4.3.3.1 Tests May Continue: For production reasons, testing may be continued pending the investigation of the process control sample failure, but final acceptance of the material shall not be made until it is determined that the lot meets all the requirements of the specification.

4.4 Methods of Inspection:

4.4.1 Inspection of Product: All samples of cable shall be carefully inspected for packaging and all other requirements of this specification not covered by tests to ascertain conformance to this specification.

4.4.2 Shield Strands:

4.4.2.1 Elongation: Elongation tests on the coated copper strand shall be conducted in accordance with FED-STD-228, Method 3211, using a 12-in specimen, 10-in bench marks, and a 10-in initial jaw separation. Soft annealed copper shall be pulled at a rate between 5 and 10 in per minute.

4.4.2.2 Coating:

4.4.2.2.1 Thickness: The thickness of the coating shall be determined by the electronic determination method of AS4373.

4.4.2.2.2 Continuity of Silver and Nickel Coating: Continuity of silver and nickel coating tests shall be conducted in accordance with ASTM B 298 or ASTM B 355, as applicable. There shall be no evidence of exposed copper.

4.4.2.2.3 Adhesion of Nickel Coating: Two 6-in specimens shall be cut from the sample of nickel coated strand. One specimen shall be wrapped over its own diameter for eight close turns. The second specimen shall remain in its straight form. Both specimens shall then be subjected to ten continuous cycles of temperature change. Each cycle shall consist of 4 h at 250 °C ± 5 °C followed by 4 h at room temperature. Upon completion of the thermal cycling, the straight specimen shall be wrapped over its own diameter for eight close turns in a manner identical to that of the first specimen. Both wrapped specimens shall then be subjected to the test specified in 4.4.2.2.2. There shall be no indication of exposed copper.

4.4.2.2.4 Continuity of Tin Coating: The continuity of coating test shall be conducted in accordance with the test procedure in ASTM B 33. There shall be no evidence of exposed copper.

4.4.3 Dielectric Withstand:

4.4.3.1 Dielectric Withstand-Component Wires: The finished cable shall be tested in accordance with Method 6111 of FED-STD-228, except that immersion is not required. Each conductor, in turn, shall be tested against all others tied together with the (inner) shield (if any). The test voltage shall be 1,500 Vrms for 600-V rated basic wire and 2,500 Vrms for 1,000-V rated basic wire. The time of electrification shall be not less than 15 nor more than 30 s.

4.4.3.2 Dielectric Withstand-Inner Jacket: The inner jacket of a double shielded cable shall be subjected to a dry dielectric test. A potential of 500 Vrms shall be applied to the inner shield with the outer shield grounded. The time of electrification shall be not less than 15 s nor more than 30 s.

4.4.3.3 Impulse Dielectric Test (for Unshielded/Unjacketed Cable Configuration): The electrode head through which the cable is passed in the impulse dielectric test shall be of a suitable bead chain construction such that the electrode will give intimate metallic contact with practically all of the cable insulation surface. The characteristics of the impulse test and of the equipment auxiliary to the electrode head shall be as specified in the basic wire specification with test voltage at 6 kV (peak).

4.4.4 Jacket Flaws: One-hundred percent of all finished shielded and jacketed cable shall pass through a suitable spark test device that will give intimate metallic contact with practically all of the jacket surface and impress a potential of 1,500 V AC at commercial frequency between the electrode of the spark test device and the cable shield. Electrode length and speed of cable through the electrode shall be such that the jacket will be subjected to the test potential for a minimum of 0.2 s.

4.4.5 Braid Angle and Shield Coverage: The braid angle and the percent coverage of the braid shall be determined by the following formula:

$$\text{Tan } \alpha = 2\P (D+2d_1) P/C \quad \text{(Eq. 1)}$$

$$\text{If "F" is less than 1, coverage is determined by } K = 100 (2F-F^2) \quad \text{(Eq. 2)}$$

$$\text{If "F" is greater than 1, then } K = 100\% \quad \text{(Eq. 3)}$$

where:

¶ = pi (3.14)
K = percent coverage
F = $EPd_2/\sin a$
P = picks per inch of cable length
α = angle of braid with axis of cable
E = number of strands per carrier
d_1 = diameter of one of the round shield strands or thickness of flattened strand
d_2 = diameter of one of the round shield strands or width of flattened strand
D = diameter of cable under shield
C = number of carriers
n = number of basic wires (2)
b = basic wire diameter

Slide the test specimen of braid over a mandrel which has a diameter equal to the nominal diameter (D) of the braid (if no mandrel exists then take care to ensure the braid diameter is formed as close to the nominal diameter as possible.) Determine the quantity P by counting the number of picks over a given length of braid. Determine n/C by counting the number of ends on a single carrier. Determine C by counting the number of carriers on the braid. Find the value of d_1 and d_2 by measuring the strands with a micrometer. These will be equivalent for round strands. Calculate the braid angle α using Equation 1. Using the braid angle, calculate the value of F. Depending on the value of F, calculate the value of the shield coverage using either Equation 2 or 3.

4.4.6 Cold Bend: The ends of previously untested samples of finished cable shall be secured to a mandrel in a cold chamber. The other end of each specimen shall be secured to separate load weights sufficient to keep the cable vertical and tangent to the mandrel during the bending operation. The mandrel size shall be as specified in Table 10. The temperature of the chamber shall be lowered to -55 °C ± 5 °C at a rate not to exceed 50 °C per minute. The specimens and the mandrel shall be conditioned at this temperature for 4 h. At the end of this period, and while both mandrel and specimen are still at this low temperature, the cable shall be wrapped around the mandrel for 180° without opening the chamber. The time required for bending around 180° of the mandrel shall be 1/2 min at a uniform rate of speed. A revolving mandrel operated externally from the chamber shall be used. The specimens shall then be removed from the mandrel and visually inspected, without magnification, for cracks. Specimens of shielded and jacketed types of cable with jacket materials 05, 06, and 08 through 12, 14 through 16, 20, 22, and 23 (and associated double jacket types) shall be subjected to the voltage withstand test specified in 4.4.7. After being subjected to the cold bend test or voltage withstand test of the jacket, all specimens shall be dissected. The individual wires shall then be immersed within 3 in of their ends for 1 h in a 5% salt solution. At the end of this period, a potential of 1,000 Vrms at commercial frequency shall be applied for 1 min from each conductor in the salt solution.

4.4.7 Voltage Withstand, Jacket: Specimens shall be formed into the shape of a U. All conductors shall be electrically connected together with the shields (if any) on both ends of the specimen. The specimens shall be tested in accordance with AS4373, Method 510, except the time of immersion shall be 1 h minimum. The test voltage shall be 1,000 Vrms, and the time of electrification shall be 1 min. The test voltage shall be applied between the conductors (plus shield) and the immersion liquid.

4.4.8 Conductor Continuity: Each basic wire in 100% of all finished cable in shipment reels or coils shall be tested for conductor continuity with an ohmmeter or other suitable testing device. There shall be no indication of discontinuity.

4.4.9 Thermal Shock: Specimens of finished cable with jacket materials listed in Table 7 shall be wrapped around a mandrel for at least six close turns with the ends of the specimens tied to the mandrel. The mandrel diameter shall be as specified in Table 10. The specimens on the mandrel shall be subjected to a temperature within ±5 °C of the values specified in Table 7 for 4 h. At the end of this period, the specimen shall be inspected visually for cracks.

4.4.10 Aging Stability: Specimens of finished cable with jacket styles listed in Table 7 shall be aged for 96 h at temperatures within ±5 °C of the values specified in Table 7 in a forced draft air oven. These specimens shall then be removed from the oven, allowed to cool at room temperature for 30 min and wrapped at a uniform rate of 15 rpm ± 3 rpm at room temperature around a mandrel as specified in Table 10. At the end of this period, the specimens shall be removed from the mandrel as a helical coil and be inspected visually for cracks, without the aid of magnification (see 3.3.5.1).