



Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE STANDARD

AS 1198

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Revised

AEROSPACE WIRE AND CABLES METHODS OF TESTING

1.1

SECTION 1 INFORMATION, SCOPE, CONTENTS, AND NUMBERING SYSTEM

1. INFORMATION

This standard is issued in loose leaf form to permit the insertion or removal of new or revised sections and test methods. All users of this standard should keep it up-to-date by inserting the revised or new sections and test methods as issued and by removing the superseded pages. New and revised sections will be issued with a revised title page showing the latest revision date and with a revised index (Section 3).

In Section 3, the most closely corresponding FED, TEST METHOD STD NO. 228 Method number and the most closely corresponding ASTM Test Procedure is given for reference purposes. No implication of agreement with those test methods or procedures is intended.

2. SCOPE

This standard gives the general physical, electrical, and chemical methods for testing wires and cables for conformance to the requirements of their controlling detail specifications and other related documents. This standard also includes methods (Group 5000) for comparative evaluation testing of wires and cables. It was prepared to promote standardization and to eliminate unnecessary or undesirable variation in testing procedures. This standard does not include special test methods applicable only to certain wires and cables, such as radio frequency coaxial cables, which are described in their applicable detail specifications. In case of conflict between the provisions of this standard and those of the controlling detail specification, the latter shall take precedence.

3. CONTENTS

The contents of this standard are as follows:

Section

1. Information, Scope, Contents, and Numbering System.
 2. Definition of Terms.
 3. Index of Sections and Test Methods.
 4. Testing and Test Sample Conditions.
- Test Methods

4. TEST METHOD NUMBERING

The test methods are assigned numbers, such as 1001, 1002 ----, from the applicable group.

CANCELLED

4. TEST METHOD NUMBERING (Continued)

Group

- 1000 - Conductor Tests
- 2000 - Insulation Tests
- 3000 - Wire and Cable Tests
- 4000 - Miscellaneous Tests
- 5000 - Evaluation Tests

When a test method revision incorporates a technical change, a decimal number shall be added or consecutively increased, such as 1001.1 for the first revision incorporating a technical change, 1001.2, 1001.3, ----- . As an alternative, a test method which incorporates a technical change may be assigned an entirely new test method number.

PREPARED BY
SUBCOMMITTEE A-2H, ELECTRIC CABLES, OF
SAE COMMITTEE A-2, AEROSPACE ELECTRICAL & ELECTRONIC EQUIPMENT

SECTION 2
DEFINITION OF TERMS

AWG. American Wire Gage (See Conductor Size and Strand Size)

BUNCHED LAY. In a bunched lay conductor or cable, the strands or wires are twisted together in the same direction without regard to geometrical arrangement, with the same lay length.

CABLE. Two or more wires contained in a common jacket or covering; or two or more wires twisted or molded together without a common covering; or one or more wires contained in a shield or in a shield and jacket. Unless otherwise specified, a cable or wire is one on which all manufacturing operations have been completed. (Also see "Wire" below.)

CARRIER. A carrier is the yarn or strand, or a combination of several yarns or strands laid parallel in the braid by a single bobbin of the braiding machine.

CIRCULAR MIL. A circular mil is a unit of area equal to $\pi/4$ times or 78.54% of a square mil. The cross-section area of a circle in circular mils is, therefore, equal to the square of its diameter in mils.

CIRCULAR MIL AREA. The circular mil area, abbreviated "CMA", of a strand or conductor is the cross-section area of the actual current carrying portion, expressed in circular mils. In a stranded conductor, the area of the voids or interstices between the strands are not included in the conductors circular mil area.

CONCENTRIC LAY. A concentric lay conductor or cable is composed of a central core surrounded by one or more layers of helically wound strands or wires. Unless otherwise specified, it is optional for the successive layers to be alternately reversed in direction of lay (true concentric lay) or to be in the same direction (unidirectional lay). (See further definition under UNIDIRECTIONAL LAY.)

CONDUCTOR. A conductor is a strand, or a group of strands not usually insulated from each other, suitable for carrying a single electric current. While a cable shield may actually fulfill this definition and be used as a conductor, it is termed "shield" and not "conductor".

CONDUCTOR SIZE. For a solid conductor (one strand), the size is the AWG size number; that is "Size 20", not "Size 20 AWG" or "20 AWG". For a stranded conductor, the size is that number of which the conductor's circular mil area most closely corresponds to the even numbered AWG circular mil area. For this purpose, even numbered AWG's are: 40, 38, 36, 34, 32, 30, 28, 26, 24, 22, 20, 18, 16, 14, 12, 10, 8, 6, 4, 2, 1, 0, 00, 000, and 0000. Odd numbered sizes, such as "Size 23" are not used for stranded conductors. A 760 CMA stranded conductor (of 19 Size 34 strands) is designated "Size 22", not "Size 21".

DIRECTION OF LAY. The direction of lay is the lateral direction, either right-hand or left-hand, in which a strand or wire passes over the top as it recedes from an observer looking along the axis of the conductor or cable.

ELONGATION. Elongation is the permanent extension in the gage length of a test specimen, measured after rupture. Ultimate elongation is the extension measured at the moment of rupture. Unless otherwise specified, elongation is expressed as a percentage of the original gage length. For example, if a 1-inch gage is marked on an unstretched specimen and the specimen is stretched until the gage marks are 7 inches apart, the elongation is 6 inches or 600 percent.

END. An end is an individual yarn or strand in a braid or shield.

INSULATION. Insulation is nonconducting material used to separate a conductor or shield from other conductors and shields and from ground.

INSULATION RESISTANCE. The insulation resistance of a wire or cable is the electrical resistance offered by its insulation to an impressed direct-current potential tending to produce a leakage of current through the insulation.

DEFINITION OF TERMS (Continued)

LENGTH OF LAY. The length of lay of any helically wound strand or wire of conductor or cable is the axial length of one complete turn of the helix, usually expressed in inches.

PICKS PER INCH. Picks per inch is the number of carriers in either direction contained in one inch of the braid measured parallel to the axis of the wire or cable.

PITCH DIAMETER. The pitch diameter of any layer of strands or wires of a conductor or cable is the diameter of the circle passing through their centers.

ROPE LAY. In a rope-lay conductor or cable, the stranded members are twisted together with a concentric lay. The stranded members may have either a bunched, concentric, or rope lay.

SHIELD. A metallic or electrically conductive braid, jacket, or other covering of a cable which is over the wire(s).

STRAND. A strand is a rod or filament of metal or electrically conductive material.

STRAND SIZE. The size of a strand is that number corresponding to the AWG size of the strand.

STRANDED CONDUCTOR. A stranded conductor is a conductor composed of more than one strand.

TENSILE STRENGTH. Tensile strength is the maximum force per unit of the original cross-sectional area of the sample which results in the rupture of the sample. It is calculated by dividing the maximum force in pounds by the original cross-sectional area in square inches.

UNIDIRECTIONAL LAY. Unidirectional lay is that variation of concentric lay in which all the helical layers of strands comprising the concentric conductor have the same direction of lay. The construction includes normal unidirectional lay, in which each successive layer has a greater lay length than the preceding layer, and unidirectional equal lay (unilay), generally limited to 19 strands, in which all helical layers have the same length of lay.

WIRE. An assembly consisting of a single conductor covered by one or more layers of insulating materials and without a shield. (Note: Unless otherwise specified, "wire" and "cable" are "completed" or "finished" assemblies or products. Do not use "finished wire" or "finished cable". This corresponds to the use of "strand" in lieu of "finished strand" and of "conductor" in lieu of "finished conductor".)

WIRE SIZE. The size of a wire is that number corresponding to its conductor size, such as "Size 20".
(See Conductor Size)

SECTION 3
INDEX OF SECTIONS AND TEST METHODS

SECTION		<u>*DATE</u>
1.	Information, Scope, Contents, and Numbering System	
2.	Definition of Terms	
3.	Index of Sections and Test Methods	
4.	Testing and Test Sample Conditions	

TEST METHODS GROUP 1000 - CONDUCTOR TESTS

<u>METHOD</u> <u>NO.</u>	<u>TITLE</u>	<u>ASTM**</u> <u>PROCEDURE</u>	<u>FED STD</u> <u>228**</u>	<u>*DATE</u>
1001	Conductor Elongation		3211 3212	
1002	Conductor Tensile Strength		3211 3212	
1003	Strand Silver and Nickel Coating Thickness			
1004	Strand Continuity of Coating		7121	
1005	Strand Adhesion of Tin or Nickel Coating		7121	
1006	Strand Elongation		3211 3212	
1007	Strand Tensile Strength		3211 3212	

TEST METHODS GROUP 2000 - INSULATION TESTS

<u>METHOD</u> <u>NO.</u>	<u>TITLE</u>	<u>ASTM**</u> <u>PROCEDURE</u>	<u>FED STD</u> <u>228**</u>	<u>*DATE</u>
2001	Wire Insulation Tensile Strength		3021	
2002	Wire Insulation Elongation		3031	
2003	Insulation Dielectric Strength (Reserved)		6031	
2004	Insulation Specific Gravity		8321	
2005	Melting Point of Nylon (Reserved)		----	
2006	TFE Content of Coated Yarns (Reserved)		----	

TEST METHODS GROUP 3000 - WIRE AND CABLE TESTS

<u>METHOD</u> <u>NO.</u>	<u>TITLE</u>	<u>ASTM**</u> <u>PROCEDURE</u>	<u>FED STD</u> <u>228**</u>	<u>*DATE</u>
3001	Life Cycle			
3002	Bend			
3003	Dielectric - Dry Type			
3004	Cold Bend			
3005	Insulation Flaws (Spark)			
3006	Wire and Cable Weight			
3007	Conductor Resistance			
3008	Flammability (Horizontal)			
3009	Flammability (Vertical) (Reserved)			
3010	Flammability (Angle)			

* See appropriate Section Test Method for publication date.

**The Federal Standard 228 Methods and the ASTM Procedures are listed for reference purposes only.



Documents

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SECTION 3
INDEX OF SECTIONS 3 AND TEST METHODS (Continued)

TEST METHODS GROUP 3000 - WIRE AND CABLE TESTS (Continued)

<u>METHOD NO.</u>	<u>TITLE</u>	<u>ASTM** PROCEDURE</u>	<u>FED STD 228**</u>	<u>*DATE</u>
3011	Wrap			
3012	Wire and Cable Diameter			
3013	Workmanship (Reserved)			
3014	Blocking			
3015	Dielectric Tank			
3016	Impulse Dielectric			
3017	Insulation Resistance-Immersion Type			
3018	Insulation Shrinkage-Thermal Cycling Type			
3019	Abrasion Resistance			
3020	Fluid Immersion			
3021	Durability of Identification			
3022	Wicking (Reserved)			
3023	Humidity Resistance			
3024	Surface Resistance			
3025	Smoke			
3026	Acid Resistance (Reserved)			
3027	Creepage Resistance (Reserved)			
3028	Heat Resistance (Reserved)			
3029	Soldering (Reserved)			
3030	Dielectric Constant (Reserved)			
3031	Power Factor (Reserved)			
3032	Oil Absorption (Reserved)			
3033	Overload (Reserved)			
3034	Notch (Reserved)			
3035	Deformation (Reserved)			
3036	Accelerated Aging (Reserved)			
3037	Fire Resistance (Reserved)			
3038	Cut-Through (Reserved)			
3039	Examination of Product (Reserved)			
3040	Oxygen Bomb (Reserved)			
3041	Conductor & Strand Diameter & Conductor Circular Mil Area			
3042	Insulation Concentricity			
3043	Insulation Removability			
3044	Wire Insulation Shrinkage - Heat Aging Type			
3045	Insulation Resistance - Dry Type			

*See appropriate Section Test Method for publication date.

**The Federal Standard 228 Methods and the ASTM Procedures are listed for reference purposes only.



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SECTION 3
INDEX OF SECTIONS 3 AND TEST METHODS (Continued)

TEST METHODS GROUP 4000 - MISCELLANEOUS TESTS

<u>METHOD NO.</u>	<u>TITLE</u>	<u>ASTM** PROCEDURE</u>	<u>FED STD 228**</u>	<u>*DATE</u>
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TEST METHODS GROUP 5000 - EVALUATION TESTS

<u>METHOD NO.</u>	<u>TITLE</u>	<u>ASTM** PROCEDURE</u>	<u>FED STD 228**</u>	<u>*DATE</u>
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5001	Penetration Test at Rated Temperature			
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* See appropriate Section Test Method for publication date.

** The Federal Standard 228 Methods and the ASTM Procedures are listed for reference purposes only.

SECTION 4
TESTING AND TEST SAMPLE CONDITIONS

STANDARD ATMOSPHERE. Unless otherwise specified or unless for dispute testing, all tests of wire and cable shall be made at a room temperature of 23 C, +9 C, -1 C (73 F, +15.5 F, -2.5 F) except in the case of dispute or disagreement between laboratories. It is intended that the laboratory be maintained as closely as possible to 23 C and a relative humidity of 50 percent. The tolerances indicated are meant to cover variations from these specified conditions which may occur at different locations in the room.

DISPUTE TESTING. In the case of dispute or disagreement between the laboratories, unless otherwise specified, the sample shall be conditioned in an atmosphere of $50 \pm 4\%$ relative humidity and a temperature of 23 ± 1 C (73.5 ± 2 F).

SAMPLE CONDITIONING. Unless otherwise specified or for dispute testing, no conditioning of the samples is required and either no, brief, or prolonged exposure of the samples to the specified standard atmosphere is permitted. Unless otherwise specified, the specimens shall be conditioned for dispute testing for not less than 3 hours before being tested and shall be tested in the same atmosphere.

METHOD 1001, CONDUCTOR ELONGATION

1. SCOPE

This test is to be used to determine, on a sampling basis, the elongation of conductors prior to insulating and as removed from wire or cable. The conductor elongation test may be combined with the conductor tensile strength test.

2. SAMPLES

The sample shall be a length of conductor prior to insulating or the conductor obtained from a 24 inch minimum length of wire or cable as specified by the detail specification. The sample shall be of sufficient length to allow at least a 10 inch length of strand or conductor between the jaws of the elongation apparatus. Where applicable, remove the conductor from the wire or cable taking care not to physically damage the conductor or strands in any manner such as nicking, scraping, or kinking. Size 24 and smaller conductors shall be tested as a unit. Conductors larger than size 24 shall have individual strands removed for test.

3. TEST EQUIPMENT

The elongation apparatus shall be capable of presetting the starting distance between the jaws at 10 inches or greater, of applying tension at a constant rate of elongation, and of a jaw separation rate of one inch to 12 inches per minute. The jaws shall permit no slippage during the test. Drum jaws are recommended.

4. PROCEDURE

Gage marks shall be placed 10 (+1/2, -1/4) inches apart on the sample. The distance between the gage marks shall be measured and recorded as the original length of the sample. The sample shall be placed in the elongation apparatus with the gage marks as far from the respective jaws as practicable (at least one inch if possible). The sample shall be stressed to rupture at an elongation rate of 12 inches per minute maximum for copper samples and 3 inches per minute maximum for copper alloy samples. The distance between the gage marks at rupture of the sample shall be measured and recorded. For individual strands, any gap between the broken ends shall not be included in the measured distance. For stranded conductor samples, rupture shall be considered to occur when the first strand ruptures as observed visually or as indicated by a definite hesitation in the increase of, or a decrease in the applied tensile force. If rupture occurs outside the gage marks, the results shall be invalid and an additional sample shall be tested.

5. RESULTS

The percent elongation shall be calculated by dividing the permanent increase in sample length at time of rupture by the original length of the sample (both in the same units) and multiplying the results by 100.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling plan and number of samples.

METHOD 1002, CONDUCTOR TENSILE STRENGTH

1. SCOPE

This test is to be used to determine, on a sampling basis, the tensile strength of conductors prior to insulating and as removed from wire or cable. The conductor tensile strength test may be combined with the conductor elongation test.

2. SAMPLES

The sample shall be a length of conductor prior to insulating or the conductor obtained from a 24 inch minimum length of wire or cable as specified by the detail specification. The sample shall be of sufficient length to allow a least a 10 inch length of strand or conductor between the jaws of the tensile strength apparatus. Where applicable, remove the conductor from the wire or cable taking care not to physically damage the conductor or strands in any manner such as knicking, scraping, or kinking. Size 24 and smaller conductors shall be tested as a unit. Conductors larger than size 24 shall have individual strands removed for test.

3. TEST EQUIPMENT

The tensile strength apparatus shall be capable of presetting the starting distance between the jaws at 10 inches or greater, of applying tension at a constant rate of elongation, of a jaw separation rate of one inch to 12 inches per minute, and of positively indicating the amount of tensile force applied to the sample at the instant of rupture. Drum jaws are recommended.

4. TEST PROCEDURE

The diameter of each strand shall be measured with a barrel micrometer to the closest ten-thousandth of an inch and recorded. The number of strands shall be determined and recorded. For a single strand sample, at least four measurements shall be taken at random points, successively approximately 90 degrees apart, within the 10 inch length to be stressed. For a stranded conductor, at least two measurements shall be taken on each strand. The two measurements of each strand shall be taken at random points, approximately 90 degrees apart, and as close to the 10 inch length to be stressed as possible without disturbing the test length. The sample shall be placed in the tensile strength apparatus so that a 10-inch minimum length will be stressed. The sample shall be stressed to rupture at an elongation rate not to exceed 12 inches per minute for copper samples and 3 inches per minute for copper alloy samples. The tensile force required to rupture the sample shall be recorded. If the rupture occurs within one inch of either jaw, the result shall be invalid and an additional sample shall be tested. For stranded conductor samples, the tensile force on the sample at the time when the first strand ruptures, as observed visually or as noted by a definite hesitation or a decrease in the applied tensile force, shall be the value recorded.

5. RESULTS

The tensile strength in terms of force per unit (pounds per square inch) shall be calculated by dividing the recorded tensile force at time of rupture (in pounds) by the cross-sectional area (in square inches) calculated from the average strand diameter and number of strands.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling plan and number of samples.

METHOD 1003, STRAND SILVER AND NICKEL COATING THICKNESS

1. SCOPE

This test is to be used to determine the silver and nickel coating thickness on strands and on individual strands from stranded copper or copper base alloys conductors. This method is suitable for the determination of the thickness of silver and nickel coatings on strands size 8 through 40 (0.1285 through 0.0031 inch nominal diameter).

2. SAMPLES

The length of test sample strands shall initially be 8 inches minimum. Where strands from stranded conductor or from wires or cables are to be tested, the conductor shall be carefully removed taking care not to physically damage the conductor or strands in any manner such as knicking, or scraping the coating on the conductor. Individual strands shall be removed from stranded conductors by careful unwinding.

3. TEST EQUIPMENT

3.1 Kocour Company* Electronic Thickness Tester Model 955 with Accessory Unit Model Wt.

3.2 Kocour Company* Test Solution R-48 (For Silver).

3.3 Kocour Company* Test Solution R-54 (For Nickel).

*Address: 4800 South St. Louis Street, Chicago, Illinois.

4. TEST PROCEDURE

4.1 Connect the thickness tester to a 110 volt ac supply (at commercial frequency). Insert the plug of the accessory unit lead wire into the jack "WT" on the left side of the thickness tester. Turn the "Plate" selector to setting marked "Silver" or "Nickel" as applicable. Turn the power switch on and allow a 5 minute minimum warm-up period.

4.2 Fill the stainless steel beaker to within 1/2 to 1/4 inch from the top with solution R-48 for silver or R-54 for nickel. Maintain the temperature of the solution at 23 C, + 9 C, -1 C (73 F, + 15.5 F, -2.5 F).

4.3 Lay the sample on a flat surface along a ruler and, using a crayon, mark off the test length, specified in Table 1, from one end of the strand. Make this measurement as accurately as possible. Samples having 4 inch test lengths should be given an open 180 deg for bend half way between the crayon mark and the end to allow them to be submerged in the test solution without touching the beaker. Measure and record the strand diameter.

4.4 Insert the sample into the terminal on the horizontal arm of the accessory unit. Tighten the terminal so that the test length of the strand is held firmly in a vertical position. Lower the sample test length into the beaker until the liquid level is exactly at the crayon mark. Adjust the arm so that the strand is in the approximate center of the beaker.

4.5 Press the "Test Button" to start the test. When the test is complete the instrument will turn off. Record the counter reading.

4.6 Precautions:

(a) Make no adjustments of the sample while the tester is in operation. If an adjustment is necessary, stop the test by pressing the "Stop" button, make the adjustment, and repeat the test with a new sample.

(b) Avoid spilling the test solutions into the accessory unit.

METHOD 1003, STRAND SILVER AND NICKEL COATING THICKNESS (Continued)

4. TEST PROCEDURE (Continued)

4.6 Precautions:

- (c) The sample must be clean. If the sample is insulated, remove the insulation with a solvent or other suitable means before testing.
- (d) Do not store the test solution in a stainless steel beaker. Do not return used solutions to the original stock solution.
- (e) The extent to which the solutions become exhausted depends on the number and size of the samples tested, as well as on the thickness of the coatings which are stripped. In general, solutions may be re-used approximately 8 to 10 times, or until erratic results are obtained.
- (f) The minimum thickness of coating which can be tested on a particular strand size is determined by multiplying the thickness factor (from Table 1) for the strand size by 5.

5. RESULTS

The coating thickness, in microinches, shall be calculated by multiplying the recorded counter reading by the applicable thickness factor from Table 1.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling plan and number of samples.

METHOD 1003, STRAND SILVER AND NICKEL COATING THICKNESS (Continued)

<u>STRAND SIZE</u>	<u>STRAND DIAMETER INCHES, NOMINAL</u>	<u>TEST LENGTH, INCHES</u>	<u>THICKNESS FACTOR</u>
8	0.1285	0.50	0.70
9	0.1144	0.50	0.80
10	0.1019	0.50	0.90
11	0.0907	0.50	1.00
12	0.0808	0.50	1.10
13	0.0720	0.50	1.28
14	0.0641	0.50	1.44
15	0.0571	0.50	1.62
16	0.0508	0.50	1.80
17	0.0453	0.50	2.04
18	0.0403	0.50	2.32
19	0.0359	0.50	2.56
20	0.0320	0.50	2.86
21	0.0285	0.50	3.28
22	0.0253	0.50	3.70
23	0.0226	1.00	2.05
24	0.0201	1.00	2.30
25	0.0179	1.00	2.55
26	0.0159	1.00	2.90
27	0.0142	1.00	3.25
28	0.0126	1.00	3.70
29	0.0113	2.00	2.05
30	0.0100	2.00	2.30
31	0.0089	2.00	2.60
32	0.0080	2.00	2.90
33	0.0071	2.00	3.25
34	0.0063	2.00	3.65
35	0.0056	4.00	2.06
36	0.0050	4.00	2.32
37	0.0045	4.00	2.60
38	0.0040	4.00	2.90
39	0.0035	4.00	3.28
40	0.0031	4.00	3.68

METHOD 1004, STRAND CONTINUITY OF COATING

1. SCOPE

This test is to be used to determine the continuity of tin, silver, and nickel coatings on strands prior to conductor stranding and wire manufacture.

2. SAMPLES

The sample length shall be 6 inches minimum. The samples shall be cleaned by immersion in a suitable organic solvent for at least 3 minutes; then removed and wiped dry with a clean, soft cloth. The cleaned samples shall be kept wrapped in a clean, dry cloth until tested. That part of the sample to be immersed in the sodium polysulfide or HCl solutions shall not be handled. Care shall be taken to avoid abrasion of the coating by the cut ends of the strands.

3. TEST EQUIPMENT

- 3.1 Suitable containers, such as 250 ml Erlenmeyer Flasks or 6 inch test tubes, which will hold at least 180 ml of solution and allow immersion of approximately 4-1/2 inches of the sample.
- 3.2 Sodium Polysulfide Solution: A concentrated solution shall be made by dissolving sodium sulfide crystals (cp) in distilled water until the solution is saturated at about 23 C (73 F), and adding sufficient flowers of sulfur (in excess of 250 g per liter of solution) to provide complete saturation; as shown by the presence in the solution of an excess of sulfur after the solution has been allowed to stand for at least 24 hours. The sodium polysulfide solution shall be made by diluting a portion of the concentrated solution with distilled water to a specific gravity of 1.142 at about 23 C (73 F). The sodium polysulfide solution shall have sufficient strength to thoroughly blacken a clean, uncoated copper sample in 5 seconds. A portion of the sodium polysulfide solution used for testing samples shall not be considered to be exhausted until it fails to blacken a clean, uncoated copper sample in 5 seconds.
- 3.3 Hydrochloric Acid (HCl Solution): Commercial hydrochloric acid (sp. gr. 1.12) shall be diluted with distilled water to a specific gravity of 1.088 measured at about 23 C (73 F). A portion of the HCl solution having a volume of 180 ml shall be considered exhausted if it fails to remove the discoloration of the silver, from the sodium polysulfide solution immersion, within 15 seconds.
- 3.4 A suitable organic solvent such as benzine, ether, or trichloroethylene.
- 3.5 Commercial distilled water.
- 3.6 Clean, soft cloths.

4. TEST PROCEDURE

The sodium polysulfide and HCl solutions shall be maintained at a temperature between 22 and 32 C (70.5 and 88.5 F) during the test.

- 4.1 Tin-Coated Copper or Copper Alloy: A length of at least 4-1/2 inches of each of the clean tin-coated samples shall be immersed in the solutions in accordance to the following cycle. The samples shall be immersed for one minute in the HCl solution; then removed, washed in clean distilled water, and wiped dry with a clean, soft cloth. The samples shall then be immersed for 30 seconds in the sodium polysulfide solution; then removed, washed, and dried as above. The samples shall then be immersed for one minute in the HCl solution; then removed, washed, and dried as above. The samples shall then be immersed for 30 seconds in the sodium polysulfide solution; then removed, washed, and dried as above.
- 4.2 Silver-Coated Copper or Copper Alloy: A length of at least 4-1/2 inches of each of the clean silver coated samples shall be immersed for 30 seconds in the sodium polysulfide solution; then removed, washed, and dried as above. The sample shall then immediately be immersed for 15 seconds in the HCl solution, then removed and washed, and dried as above.

METHOD 1004, STRAND CONTINUITY OF COATING (Continued)

- 4.3 Nickel-Coated Copper or Copper Alloy: A length of at least 4-1/2 inches of each of the nickel-coated samples shall be immersed for 30 seconds in the sodium polysulfide solution; washed, and dried as above.
- 4.4 Sample Examination: After the samples have been treated as described in paragraph 4.1, 4.2, or 4.3, they shall be examined to ascertain if the copper or copper alloy is exposed through the coating as indicated by blackening due to the action of the sodium polysulfide. Blackening within 1/2 inch of the cut end of the sample shall be disregarded. The samples shall be examined with the unaided eye (with normal spectacles, if worn) against a white background. The specimens shall be considered to have failed if blackening is revealed other than within 1/2 inch of the cut end of the sample.

5. RESULTS

Samples which do not blacken, and thus have not displayed exposed copper or copper alloy, shall be considered to pass this test.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling plan and number of samples.

METHOD 1005, STRAND ADHESION OF TIN OR NICKEL COATING

1. SCOPE

This test is to be used to determine whether the tin or nickel coatings on strands are adherent to the copper or copper alloy base metal.

2. SAMPLES

The sample length shall be approximately 12 inches. The samples shall be cleaned by immersion in a suitable organic solvent for at least 3 minutes; then removed and wiped dry with a clean, soft cloth. The cleaned samples shall be kept wrapped in a clean, dry cloth until tested. That part of the sample to be immersed in the test solution shall not be handled. Care shall be taken to avoid abrasion of the coating by the cut ends of the samples.

3. TEST EQUIPMENT

- 3.1 Suitable containers, such as 250 ml Erlenmeyer Flasks or 6 inch test tubes, which will allow immersion of at least 4-1/2 inches of the sample.
- 3.2 A suitable organic solvent such as benzene, ether, or trichloroethylene.
- 3.3 Sodium Polysulfide Solution: A concentrated solution shall be made by dissolving sodium sulfide crystals (cp) in distilled water until the solution is saturated at about 23 C (73 F), and adding sufficient flowers of sulfur (in excess of 250 g per liter of solution) to provide complete saturation; as shown by the presence in the solution of an excess of sulfur after the solution has been allowed to stand for at least 24 hours. The sodium polysulfide solution shall be made by diluting a portion of the concentrated solution with distilled water to a specific gravity of 1.142 at about 23 C (73 F). The sodium polysulfide solution shall have sufficient strength to thoroughly blacken a clean, uncoated copper sample in 5 seconds. A portion of the sodium polysulfide solution used for testing samples shall not be considered to be exhausted until it fails to blacken a clean, uncoated copper sample in 5 seconds.
- 3.4 Commercial distilled water.

4. TEST PROCEDURE

- 4.1 Tin-Coated Copper or Copper Alloy: The tin-coated copper or copper alloy sample shall be bent back and wrapped over its own diameter for 8 close turns.
- 4.2 Nickel-Coated Copper or Copper Alloy:
 - 4.2.1 Method A: The nickel-coated copper or copper alloy sample shall be bent back and wrapped over its own diameter for 8 close turns.
 - 4.2.2 Method B: One nickel-coated copper or copper alloy sample shall be bent back and wrapped over its own diameter for 8 close turns. A second sample shall remain in its straight form. Both of these samples shall then be subjected to 10 consecutive cycles of temperature exposure. Each cycle of temperature exposure shall consist of 4 hours at 250 ± 3 C (482 ± 5 F) followed by 4 hours at room temperature. Upon completion of the temperature exposure cycles, the straight sample shall be bent back and wrapped over its own diameter for 8 close turns.

METHOD 1005, STRAND ADHESION OF TIN OR NICKEL COATING (Continued)

4. TEST PROCEDURE (Continued)

- 4.3 Immersion and Examination: The wrapped portion of the samples shall be immersed in the sodium polysulfide solution maintained at a temperature between 22 and 32 C (70.5 and 88.5 F), for 30 seconds; then removed and immediately rinsed in clean water and the excess removed by shaking. The outer peripheral surface of the wrapped portion of the samples shall be visually examined. For 0.021 inch diameter and smaller strands, a magnification not greater than three times may be used. For strands larger than 0.021 inch diameter, the samples shall be examined with the unaided eye (with normal spectacles, if worn). Any cracking or parting of the coating on this surface, shown by blackening of the copper or copper alloy, shall constitute failure of this test. Blackening within 1/2 inch of the cut end of the sample shall be disregarded.

5. RESULTS

Samples which do not blacken, and thus have not displayed exposed copper or copper alloy, are considered to have passed this test.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling Plan.

Number of Samples (at least two samples are required for Method B for nickel-coated copper or copper alloy strands).

Method A or B for Nickel-Coated Strand.

METHOD 1006, STRAND ELONGATION

1. SCOPE

This test is to be used to determine, on a sampling basis, the elongation of strands (or solid conductors) which have not been stranded or insulated. The strand elongation test may be combined with the strand tensile strength test.

2. SAMPLES

The sample shall be a sufficient length of strand to allow at least a 10 inch length between the jaws of the elongation apparatus.

3. TEST EQUIPMENT

The elongation apparatus shall be capable of presetting the starting distance between the jaws at 10 inches or greater, of applying tension at a constant rate of elongation, and of a jaw separation rate of one inch to 12 inches per minute. The jaws shall permit no slippage during the test. Drum jaws are recommended.

4. PROCEDURE

Gage marks shall be placed 10 (+1/2, -1/4) inches apart on the sample. The distance between the gage marks shall be measured and recorded as the original length of the sample. The sample shall be placed in the elongation apparatus with the gage marks as far from the respective jaws as practicable (at least one inch if possible). The sample shall be stressed to rupture at an elongation rate of 12 inches per minute maximum for copper samples and 3 inches per minute maximum for copper alloy samples. The distance between the gage marks at rupture, not including any gap between the broken ends, shall be measured and recorded. If rupture occurs outside the gage marks, the result shall be invalid and an additional sample shall be tested.

5. RESULTS

The percent elongation shall be calculated by dividing the permanent increase in sample length at time of rupture by the original length of the sample (both in the same units) and multiplying the result by 100.

6. INFORMATION REQUIRED IN DETAIL SPECIFICATION

Sampling plan and number of samples.