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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 2695B

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Superseding AMS 2695A

ELECTRICAL CONNECTIONS
Solderless, Wire-Wrapped

1. SCOPE:

1.1 Purpose: This specification covers electrical connections made with single, solid, round copper or copper alloy wire wrapped around copper alloy terminals without the use of solder.

1.2 Application: Primarily to provide mechanically and electrically stable electrical connections for electronic application.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2422 - Gold Plating, for Electronic and Electrical Applications
AMS 4701 - Copper Wire, 99.95 (Cu+Ag), Annealed

2.2 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.2.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Materials and Equipment:

3.1.1 Wire:

3.1.1.1 The bare wire shall be a solid, round, copper or copper-alloy conductor with hardness sufficient to provide the proper degree of indenting of the wire and the terminal corner. Copper conductors shall conform to AMS 4701 or an acceptable equivalent.

3.1.1.2 The bare wire may be coated with a continuous and unbroken coating of tin, tin-lead alloy, silver, or gold, as specified. Minimum coating thickness shall be 0.00005 inch (1.27 µm) for all coatings with a maximum thickness of 0.0015 inch (38 µm) for tin-lead alloy coating.

3.1.1.3 The insulation bond strength to the conductor shall be sufficient to allow proper stripping of the wire with manual or automatic tools.

3.1.2 Terminal (Wrapost):

3.1.2.1 Terminals shall be made of beryllium copper, phosphor bronze, or other copper alloy as specified on the drawing. Hardness shall be adequate to prevent damage or deterioration during wire-wrapping and provide reasonable reuse capabilities.

3.1.2.2 Terminals shall have edges with a maximum radius of 0.003 inch (0.08 mm) with edge burrs not exceeding 0.0015 inch (38 µm) and shall be straight and parallel within 0.005 inch per inch (0.005 mm/mm). The tip shall terminate in a radius or bevel to facilitate insertion into the wrapping tool.

3.1.2.3 When specified, terminals may be gold plated in accordance with AMS 2422 to eliminate surface deterioration in very corrosive environments.

3.1.3 Tools:

3.1.3.1 The wire wrap tool shall be a hand, air, or electrically powered tool capable of wrapping the wire under tension around a single terminal or two parallel terminal pins. New tools or tools that have been repaired, readjusted, or modified shall be adequately tested to demonstrate the capablity of producing connections in accordance with this specification.

3.1.3.2 The unwrapping tool shall be a hand tool with a helical wedge top for the separation of wire from the terminal when the tool is threaded between the wire and terminal.

3.2 Procedure:

3.2.1 Description:

3.2.1.1 Solderless wire wrapped connections are made by wrapping a specified number of turns of wire, under tension, around a single-post or two-pin rectangular terminal having sharp corners. The sharp corners of the terminal (wrapost) produce high pressure points resulting in indentations of the wire or both the wire and terminal to provide electrical continuity and mechanical stability of the connection.

3.2.1.2 When specified, a modified solderless wrapped connection shall consist of not less than one-half turn of insulated wire in addition to the required number of uninsulated wire turns to provide improved vibration characteristics. To accomplish a half turn, the wire must be in contact with at least three corners of the terminal (See Figure 1).

3.2.2 Process:

3.2.2.1 Solderless wire-wrapped connections shall be made with either hand or automatic wrapping tools as in 3.1.3.1 capable of wrapping connections which conform to all requirements of this specification. The sequence of operations for making wrapped connections shall be as follows (See Figure 2):

3.2.2.1.1 Insert the stripped wire into the feed slot (hand tools only).

3.2.2.1.2 Bend the bar wire, or insulated wire when a modified connection is specified, into the notch in the tool to anchor the wire (hand tools only).

3.2.2.1.3 Place the large hole of the tool over the terminal.

3.2.2.1.4 Rotate the tool spindle around the terminal.

3.2.2.1.5 Remove the tool from the terminal.

3.2.2.2 Prior to wrapping, the wire shall be positioned radially so that subsequent routing of the unwrapped portion does not tend to unwrap the connection.

3.3 Properties: Wire-wrapped connections shall conform to the following requirements:

3.3.1 Wire Turns:

3.3.1.1 The minimum number of effective wire turns shall be as follows:

Wire Size AWG	Number of Turns minimum
30	8
28	8
26	6
24	5
22	5
20	4
18	4
16	3

3.3.1.2 The wire helix shall be closely wound on the terminal with the turns not overlapping or breaking. The first turn of insulated wire in a modified connection may overlap the last turn of uninsulated wire in a connection below it on the same terminal. The maximum allowable space between the turns of wire, excluding the first and last, shall be 0.005 inch (0.13 mm).

3.3.1.3 The clipped and dressed end of the wire shall not extend more than 0.020 inch (0.51 mm) beyond the diameter of the connection.

3.3.2 Stripping Force:

3.3.2.1 The minimum stripping force necessary to first dislodge a wrapped connection when tested by using a stripping fixture as shown in Figure 3 shall be as follows:

Wire Size AWG	Stripping Force, minimum	
	Pounds Force	Newtons
30	4	17.8
28	5	22.2
26	6	26.7
24	7	31.1
22	8	35.6
20	8	35.6
18	15	66.7
16	15	66.7

3.3.2.2 The stripping force shall be applied at a uniform rate not to exceed 1 inch (25 mm) per minute linear velocity. The stripping jaw shall engage at right angles to the axis of the terminal. Clearance between the terminal and the test fixture jaws shall not exceed 0.015 inch (0.38 mm).

3.3.2.3 The stripping force shall be measured with a gage to an accuracy of not less than 1% of the reading in the test range.

3.3.3 Unwrap:

3.3.3.1 The wire shall withstand being unwrapped from the terminal and straightened without breaking or cracking.

3.3.3.2 Visual examination of the unwrapped wire shall show a uniform indentation in the wire created by the terminal edges.

3.3.4 Gas Tight:

3.3.4.1 The total gas tight area between the terminal and the wire of a wrapped connection shall be at least equal to the area of the cross-section of the wrapping wire.

3.3.4.2 To determine the gas tight area, the sample connection, if the terminal is plated, shall be suspended in a test tube containing approximately 1 to 2 mL of aqua regia. The sample connection shall remain suspended over the solution for at least five minutes until the fumes have attacked the plating.

3.3.4.3 Sample connections treated as in 3.3.4.2 or which contain unplated terminals shall be suspended in a test tube containing approximately 1 mL of ammonium sulfide solution and shall remain suspended over the solution until the terminal turns black. The sample shall then be removed, rinsed, dried, and unwrapped so as not to scratch the terminal. The gas tight areas shall remain bright, after rinsing, in sharp contrast with the exposed blackened areas of the terminal.

3.3.5 Connection Resistance:

3.3.5.1 The electrical resistance of the wire-wrapped connection, determined by voltage drop across the actual joint, shall not exceed 3 milliohms.

3.3.5.2 When environmental tests are specified, the changes in contact resistance as a result of such tests shall not exceed 2 milliohms.

3.3.5.3 The current used shall be 2.4 amperes for wrapper wire sizes of AWG 22 and smaller and 7.5 amperes for wrapper wire sizes larger than AWG 22.

3.4 Quality:

3.4.1 Connections, as received by purchaser, shall be of such quality as to Ø comply with all requirements of this specification. Care shall be taken to ensure that there is no bending, turning, or twisting of terminals during the fabrication process. The completed connection shall not be mechanically disturbed. All loose wire and clipped wire ends shall be carefully removed from the assembly.

3.4.2 Degradation of the wrapping tool shall be controlled by inspection procedure. Method for testing shall be as specified by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of wire-wrapped connections shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the connections conform to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to requirements for properties (3.3) and quality (3.4) are classified as acceptance tests and as preproduction tests and shall be performed prior to or on the initial shipment of connections to a purchaser, on each lot, when a change in material and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test connections shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

4.3 Sampling: Shall be as agreed upon by purchaser and vendor; a lot shall be Ø all the wire wrap connections produced using the same tooling and set up, equipment and wire type, processed under the same fixed conditions, and presented for vendor's inspection at one time.

4.4 Approval:

4.4.1 Sample connections and the wrapping procedure shall be approved by Ø purchaser before parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production parts shall be essentially equivalent to those on the approved sample parts.

4.4.2 Vendor shall use materials, manufacturing procedures and processes, and methods of inspection on production parts which are essentially the same as those used for the approved sample connections. If necessary to make any change in type of equipment, material, or processing, vendor shall submit for reapproval a statement of the proposed changes and, when requested by purchaser, sample connections. Production parts made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Reports: The vendor of wire-wrapped connections shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the connections have been fabricated in accordance with the requirements of this specification. This report shall include the purchase order number, lot number, AMS 2695B, part number, and quantity.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the connections may be based on the results of testing three additional specimens for each original nonconforming specimen. Failure of any retest specimen to meet the specified properties shall be cause for rejection of the connections represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Parts shall be handled and packaged in such a manner as will ensure that the required physical characteristics and properties of the wire-wrapped connections are preserved.

5.2 Packages of connections shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the connections to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1 and 5.2 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts on which electrical connections do not conform to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

8.1 Marginal Indicia: The phi (Ø) symbol is used to indicate technical changes from the previous issue of this specification.

8.2 Dimensions and properties in inch/pound units are primary; dimensions and properties in SI units are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of this specification
Part number of connections desired
Terminal material desired
Wrapping wire size
Method of testing for wrapping tool degradation (See 3.4.2)
Applicable level of packaging (See 5.3).

8.4 Similar Specifications: MIL-STD-1130 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.5 Connections meeting the requirements of this specification have been classified under Federal Supply Classification (FSC) 5935.

8.6 This specification is under the jurisdiction of AMS Committee "B".