

Submitted for recognition as an American National Standard

Test Methods for Electrical Connectors

NOTICE

This document has been taken directly from U.S. Military Specification MIL-STD-1344A, Notices 1-5, and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE technical standards. The initial release of this document is intended to replace MIL-STD-1344A, Notices 1-5. Any part numbers established by the original specification remain unchanged.

The original Military Specification was adopted as an SAE standard under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of government specifications and standards. TSB rules provide for (a) the publication of portions of unrevised government specifications and standards without consensus voting at the SAE Committee level, and (b) the use of the existing government specification or standard format.

Any material relating to qualified product lists has not been adopted by SAE. This material was part of the original military specification and is reprinted here for historic reference only.

1. SCOPE:

1.1 Scope:

This standard establishes uniform test methods for testing electrical connectors.

1.2 Numbering system:

The test methods are designated by numbers assigned in accordance with the following system:

1.2.1 Class of tests: The tests are divided into three classes: environmental, mechanical, and electrical. Within each class, the test methods are numbered as shown below:

1001 - 1999 - Environmental tests

2001 - 2999 - Mechanical tests

3001 - 3999 - Electrical tests

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1.2.2 Revision of test methods: Revisions are identified by a decimal point and a number added to the basic method number. For example, if the maintenance aging test is initially 2002, the first revision will be numbered 2002.1; 2002.2 will indicate the second revision issued. Subsequent revisions will be numbered consecutively.

1.3 Method of reference:

When applicable, test methods herein shall be referenced in the individual specification by specifying this standard, the method number, and the details required in the summary paragraph of the applicable method. To avoid the necessity for changing specifications that refer to this standard, the decimal number shall not be used when referencing test methods. For example, use 2002 not 2002.1.

2. REFERENCED DOCUMENTS:

2.1 Issues of documents:

The issues of the following documents in effect on the date of invitation for bids form a part of this standard to the extent specified herein.

SPECIFICATIONS

FEDERAL

P-D-680	- Dry Cleaning Solvent.
TT-I-735	- Isopropyl Alcohol.
TT-T-291	- Thinner-Paint, Volatile Spirits Petroleum Spirits.

MILITARY

MIL-T-713	- Twine, Impregnated, Lacing and Tying.
MIL-G-3056	- Gasoline, Automotive, Combat.
MIL-H-5606	- Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance.
MIL-T-5624	- Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-L-7808	- Lubricating Oil, Aircraft, Turbine Engine, Synthetic Base.
MIL-A-8243	- Anti-icing and Deicing - Defrosting Fluid.
MIL-I-17214	- Indicator, Permeability; Low-Mu (Go-No Go).
MIL-L-23699	- Lubricating Oil, Aircraft Turbine Engines, Synthetic Base.
MIL-C-25769	- Cleaning Compound, Aircraft Surface, Alkaline Waterbase.
MIL-C-45662	- Calibration System Requirements.

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2.1 (Continued):

STANDARD

MILITARY

- MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
- MIL-STD-810 - Environmental Test Methods.
- MS3190 - Contact Wire Barrel, Crimp Type.

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 Other publications:

The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM D 1141-52(1971) Substitute Ocean Water, Specification for.
- ASTM D 1149-64(1970) Accelerated Ozone Test for Cracking of Vulcanized Rubber, Test for.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19120).

IEEE STANDARDS SALES, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

- IEEE Standards No. 287 - Precision Coaxial Connections (1968)

(Application for copies should be addressed to IEEE Standards Sales, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, NY 10017).

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies).

3. DEFINITION:

- 3.1 The terms used in this standard are generally accepted by the electrical and electronics industries and commonly used in electrical connector engineering practice.

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4. GENERAL REQUIREMENTS:

4.1 Test requirements:

The requirements that must be met by the electrical connectors subjected to the test methods described herein are specified in the individual specifications, as applicable, and the tests shall be applied as specified therein. Whenever this standard conflicts with the individual specification, the latter shall govern.

4.2 Standard test conditions:

Unless otherwise specified, all measurements shall be made within the following ambient conditions:

- a. Temperature: 15° to 35°C.
- b. Atmospheric pressure: 550 to 800 millimeters of mercury (mmHg).
- c. Relative humidity (RH): 20 to 80 percent.

4.3 Temperature variation:

Where a maximum or minimum temperature is specified herein, the specified temperature must be attained and a tolerance of 5°C is allowed. For example, a temperature cycle may be described as -55° to +125°C. The temperature and tolerances would be as follows: low temperature -55°⁺⁰₋₅ °C; high temperature +125°⁺⁵₋₀ °C. The equipment used to perform these temperature tests shall be capable of maintaining the sample area within 3°C variation at the specified test temperatures. The temperature control of this equipment shall be ±2°C or better for a single point.

4.4 Reference conditions:

Reference conditions as a base for calculations shall be 20°C for temperature, 760 millimeters of mercury of air pressure, and not applicable for relative humidity.

4.5 Test equipment:

Calibration requirements shall be in accordance with MIL-C-45662.

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4.6 Equipment test methods:

Table I is a cross reference of equivalent test methods to MIL-STD-202, and MIL-STD-810.

TABLE I. Cross reference equivalent test methods.

MIL-STD-1344 Method	MIL-STD-202 Method	MIL-STD-810 Method
1001	101	
1002, type II	103 (type I) 106 (type II)	507 (1)
1003	107	Click to view the full PDF of as1344
1004	102 and 107	
1005		
1006		
1007		
1008		
1009		
1010		
1011	301	
1012	213 (I, II, III, IV) (V and VI) 201, 204, 214	
1013		
1015		
1016		
1017		
2001		
2002		
2003		
2004		
2005	212	
2006		
2007		
2008		
2009		
2010		
2011	105 and 301	
2012		
2013		
2014		
2015		
2016		
2017		
2018		
2019		
3001		
3002		
3003		
3004		
3005		
3006		
3007		
3008		

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5. NUMERICAL INDEX OF TEST METHODS:

Method Number	Title
	<u>Environmetal tests (1000 class)</u>
1001.1	Salt spray (corrosion)
1002.2	Humidity
1003.1	Temperature cycling
1004.1	Altitude immersion
1005.1	Temperature life
1006.1	Hydrostatic pressure
1007.1	Ozone exposure
1008	Air leakage
1009	Firewall
1010	
1011	Altitude-low temperature
1012	Flammability
1013	
1014	
1015	Simulated life
1016	Fluid immersion
1017	Porosity
	<u>Mechanical tests (2000 class)</u>
2001.1	Contact axial concentricity
2002.1	Maintenance aging
2003.1	Crimp tensile strength
2004.1	Shock (specified pulse)
2005.1	Vibration
2006.1	Probe damage (contacts)
2007.1	Contact retention
2008.1	Crush
2009.1	Cable pull-out
2010.1	Insert retention
2011.1	Acceleration
2012.1	Contact insertion and removal force
2013.1	Mating and unmating forces
2014	Contact engagement and separation force
2015	Impact
2016	Durability
2017	Cable seal flexing
2018	Gage location and retention
2019	Solder wicking
	<u>Electrical tests (3000 class)</u>
3001.1	Dielectric withstanding voltage
3002.1	Low signal level contact resistance
3003.1	Insulation resistance
3004.1	Contact resistance
3005	Standing Wave Ratio (SWR)
3006	Magnetic permeability
3007	Shell to shell conductivity
3008	Shielding effectiveness for multicontact connectors

CLASS 1000
ENVIRONMENTAL TESTS

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METHOD 1001.1 SALT SPRAY (CORROSION)

1. PURPOSE:

The purpose of this test is to determine the effects of a controlled salt laden atmosphere on electrical connector components, finishes, mechanisms and permit electrical readings to be taken after exposure.

2. TEST EQUIPMENT:

2.1 Chamber:

The chamber and all accessories shall be made of material which will not affect the corrosiveness of the fog, such as glass, hard rubber, or plastic. Wood or plywood should not be used because they are resiniferous. Materials should not be used if they contain formaldehyde or phenol in their composition. In addition, all parts which come in contact with test sample shall be of materials that will not cause electrolytic corrosion. The chamber and accessories shall be constructed and arranged so that there is free circulation of the spray to the same degree for all samples, no return of the liquid that has come in contact with the test samples to the salt-solution reservoir, and no direct impinging of the spray or condensation dripping on the samples. The chamber shall be properly vented to prevent pressure build-up and allow uniform distribution of salt spray. The discharge end of the vent shall be protected from strong drafts which can cause strong air currents in the chamber.

2.2 Atomizers:

The atomizer or atomizers used shall be of such design and construction as to produce a finely divided, wet, dense fog. Atomizing nozzle shall be made of material which does not react with the salt solution.

2.3 Air supply:

The compressed air entering the atomizers shall be free from all impurities such as oil and dirt. Means shall be provided to humidify and warm the compressed air as required to meet the operating conditions. The air pressure shall be suitable to produce a finely divided dense fog with the atomizer or atomizers used. To insure against clogging the atomizers by salt deposition, the air should have a relative humidity of 95 to 98 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water. The temperature of the water should be 95°F (35°C) and often higher. The permissible temperature increases with increasing volume of air and with decreasing heat insulation of the chamber, and temperature of its surroundings should not exceed a value above which an excess of moisture is introduced into the chamber (for example, 110°F (43.3°C) at an air pressure of 12 pounds per square inch), or a value which makes it impossible to meet the requirement for operating temperature.

2.4 Salt solution:

The salt-solution concentration shall be 5 percent. The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent of sodium iodide, and not more than 0.5 percent of total impurities. The 5-percent solution shall be prepared by dissolving 5 ± 1 parts by weight of salt in 95 parts by weight of distilled or other water. Distilled or other water used in the preparation of solutions shall contain not more than 50 parts per million of total solids. The solution shall be kept free from solids by filtration using a noncorrosive filter similar to that shown on figure 1, and located in the salt solution reservoir in a manner such as that illustrated on figure 2. The solution shall be adjusted to and maintained at a specific gravity in accordance with figure 3. The pH shall be maintained between 6.5 and 7.2, when measured at a temperature between 93° and 97°F (33.9° and 36.1°C). Before adjusting the pH, gently boil a sample of the solution (e.g. 10 milliliters in a pyrex breaker) for 30 to 60 seconds to remove the CO₂ absorption, then cool to the specified temperature prior to measuring the sample solution pH. Only diluted chemically pure grade hydrochloric acid or sodium hydroxide shall be used to adjust the pH. The pH measurement shall be made electrometrically using a glass electrode with a saturated potassium-chloride bridge or by a colorimetric method such as bromothymol blue, provided the results are equivalent to those obtained with the electrometric method.

3. TEST SAMPLE:

3.1 Procedure:

3.1.1 Sample:

- 3.1.1.1 Connector: A test sample shall consist of a connector assembly complete with wires, contacts, sealing plugs and accessories. The sample shall be suspended in a horizontal position. The mounting shall be compatible with the requirements for locating samples in the chamber as outlined in the test procedure. Unless otherwise specified, the connector assembly shall be normally mated.
- 3.1.1.2 Preparation: Unless otherwise specified, samples shall be given a minimum of handling, particularly on the significant surfaces, and shall be prepared for test immediately before exposure. Unless otherwise specified, samples having an organic coating shall not be cleaned with solvent. A suitable coating of wax or similar substance impervious to moisture shall be applied to protect those portions of samples which come in contact with the support and unless otherwise specified, to the cut edges and surfaces not required to be coated on coated samples.
- 3.1.1.3 Contacts: When tested separately, connector contacts shall be mated or unmated and suspended in a horizontal position. Contacts shall be subjected to low signal level contact resistance and contact resistance in accordance with methods 3002 and 3004.

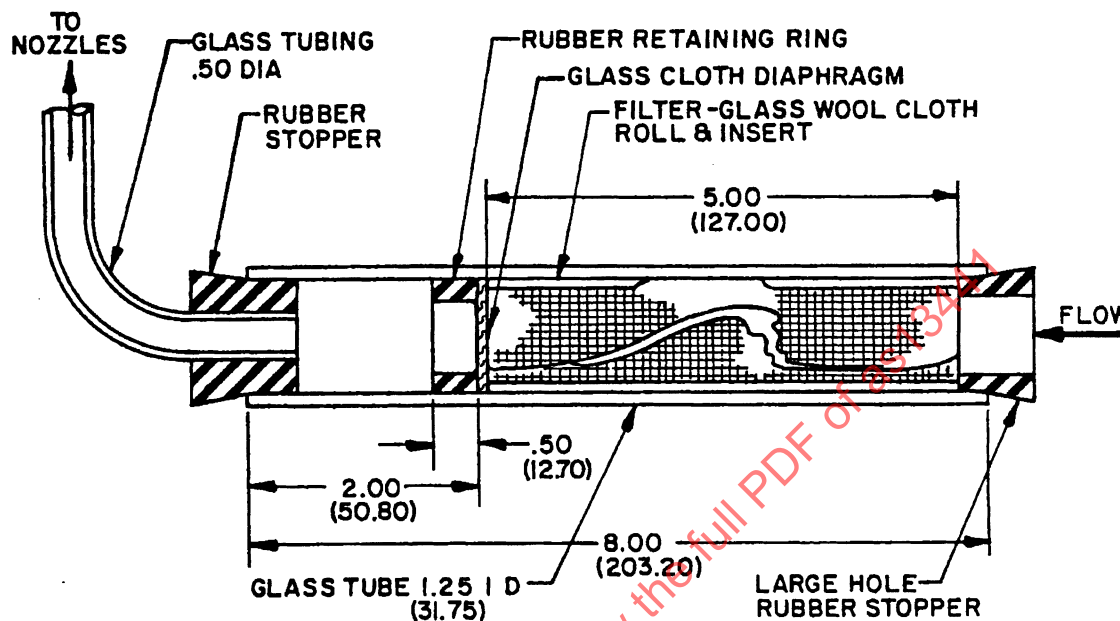


FIGURE 1. Salt solution filter.

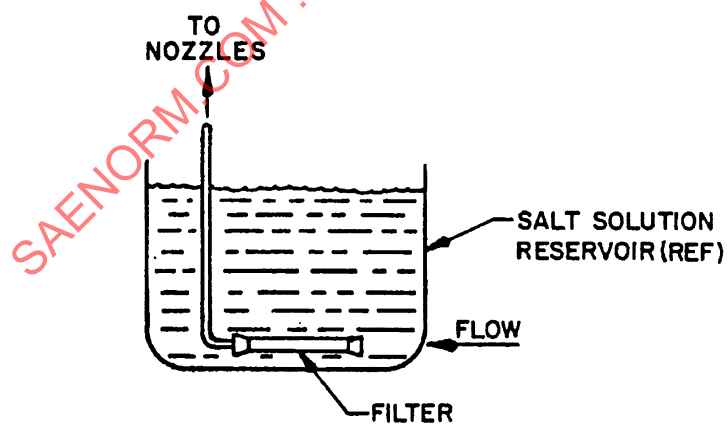


FIGURE 2. Location of salt solution filter.

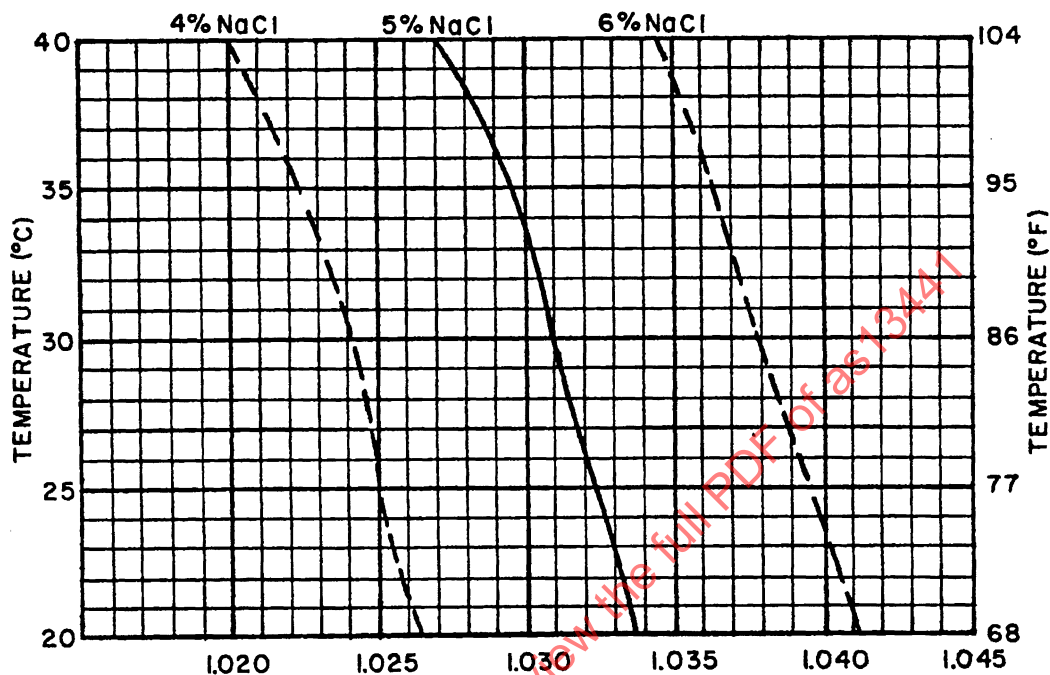


FIGURE 3. Variations of specific gravity of salt (NaCl) solution with temperature.

4. TEST PROCEDURE:

4.1 Location of samples:

Samples shall be suspended from the top using glass or plastic hooks, waxed twine, or string or nylon thread. If plastic hooks are used, they shall be fabricated of material, such as lucite, that is nonreactive to the salt solution. The use of metal hooks is not permitted.

4.2 Procedure:

The test procedures shall be as follows:

- 4.2.1 Temperature: The test shall be conducted with a temperature in the exposure zone maintained at 95^{+2}_{-3} °F ($35^{+1.1}_{-1.7}$ °C). Satisfactory methods for controlling the temperature accurately are by housing the apparatus in a properly controlled constant-temperature room, thoroughly insulating the apparatus and preheating the air to the proper temperature prior to atomization, and jacketing the apparatus and controlling the temperature of the water or of the air used. The use of immersion heaters for the purpose of maintaining the temperature within the chamber is prohibited.

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4.2.2 Atomization: The conditions maintained in all parts of the exposure zone shall be such that a suitable receptacle placed at any point in the exposure zone will collect from 0.5 to 3.0 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 centimeters diameter) based on an average run of at least 16 hours. The 5-percent solution collected shall have a sodium-chloride content of from 4 to 6 percent (specific gravity) in accordance with figure 3 when measured at a temperature between 93° and 97°F (33.9° and 36.1°C). At least two clean fog-collecting receptacles shall be used, one placed near any nozzle and one placed as far as possible from all nozzles. Receptacles shall be fastened so that they are not shielded by samples and so that no drops of solution from samples or other sources will be collected. The specific gravity and quantity of the solution collected shall be checked following each salt-spray test. Suitable atomization has been obtained in boxes having a volume of less than 12 cubic feet with the following conditions:

- a. Nozzle pressure of from 12 to 18 pounds per square inch.
- b. Orifices of from 0.02 to 0.03 inch in diameter.
- c. Atomization of approximately 3 quarts of the salt solution per 10 cubic feet of box volume per 24 hours.

When using large-size boxes having a volume considerably in excess of 12 cubic feet, the conditions in 4.2.2 a, b, and c may have to be modified in order to meet the requirements for operating conditions.

4.2.3 Length of test: The length of the salt-spray test shall be indicated in one of the following test conditions, as specified:

<u>Test condition</u>	<u>Length of test</u>
A- - - - -	96 hours
B- - - - -	48 hours
C- - - - -	500 hours
D- - - - -	1000 hours

Unless otherwise specified, the test shall be run continuously for the time indicated or until definite indication of failure is observed, with no interruption except for adjustment of the apparatus and inspection of the specimen.

4.2.4 Post cleaning: Immediately after exposure, the test samples shall be dipped in running tap water not warmer than 100°F (37.8°C) for 5 minutes, maximum and dried for 12 hours, maximum in a circulating air oven at a temperature of 38° ±3°C, after which the sample shall be examined at room temperature. If closer examination of a plated surface is required, the corrosion products may also be removed using any method that will not affect the plating.

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4.2.5 Measurements: At the completion of the exposure period, measurements shall be made as specified. To aid in examination, samples shall be prepared in the following manner, unless otherwise specified. Salt deposits shall be removed by a gentle wash or dip in running water not warmer than 100°F (37.8°C) and a light brushing, if necessary, using a soft-hair brush or plastic-bristle brush.

4.2.6 Examination: Examination of the connector shall include the following:

- a. Exposure of base metals, pitting and porosity of finishes.
- b. Cracking and delamination of components and/or finishes.
- c. Abnormal nicks, cracks or scratches on finished surfaces that indicate the removal of the normal protective coating.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date and name of operator.
- b. Sample description - including fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations:
 - (1) Visual examination (see 4.2.6).

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Mating of connector assembly, if other than normal (see 3.1.1.1).
- b. Cleaning and coating of samples if other than herein (see 3.1.1.2).
- c. Contact mounting when tested separately (see 3.1.1.3).
- d. Special mounting and details, if applicable (see 4.1.1).
- e. Test condition letter. Test run conditions if other than herein. (See 4.2.3).
- f. Measurements after exposure (see 4.2.5).

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METHOD 1002.2 HUMIDITY

1. PURPOSE:

1.1 Purpose:

The purpose of this test is to permit evaluation of the properties of materials used in connectors as they are influenced or deteriorated by the effects of high humidity and heat condition. This is an accelerated environmental test, accomplished by the continuous exposure of the specimen to high relative humidity at various temperatures. Measurements made under high humidity conditions may reflect the peculiar conditions under which the readings were made, and should be compared only to initial readings when careful analysis indicates that such a comparison is valid and applicable.

1.2 Steady state test (type I):

This test imposes a vapor on the material under test that constitutes the force behind the moisture migration and penetration. Hygroscopic materials are sensitive to moisture and deteriorate rapidly under humidity conditions. Absorption of moisture may result in swelling that would destroy functioning utility, and cause loss of physical strength and changes in other important mechanical properties. Degradation of electrical properties may also occur. This test, while not necessarily intended as a simulated tropical test, is useful in determining moisture absorption of insulating materials.

1.3 Humidity-temperature cycling tests (types II and III):

These tests obtain their added effectiveness in employment of temperature cycling that provides a breathing action, inducing corrosion processes, and the introduction of moisture into partially sealed connectors. This condition imposes a vapor pressure on the connector which constitutes the major force behind the moisture migration and penetration.

1.4 Polarizing voltage and electrical loading:

When specified, a polarizing potential of 100 volts dc shall be applied between alternate contacts connected together electrically and the remaining contacts and shell connected together electrically. The polarity of the voltage applied to the shell shall be negative.

2. TEST EQUIPMENT:

2.1 Test chamber:

The test chamber and accessories shall be constructed and arranged in such a manner as to avoid condensate dripping on the test sample. The chamber shall be trap-vented to the atmosphere to prevent the buildup of total pressure. Relative humidity shall be determined from the dry bulb-wet bulb thermometer comparison method or an equivalent method approved by the procuring activity. When readout charts are used, they shall be capable of being read with a resolution within 0.6°C (1°F). When the wet bulb control method is used, the wet bulb and tank shall be cleaned and a new wick installed at least every 30 days. The air velocity flowing across the wet bulb shall be not less than 900 feet per minute (ft/min). Circulation of conditioning air shall be at a rate (in cubic feet per minute) of five times the chamber volume; e.g. chamber volume 5 cubic feet, air flow must be 25 cubic feet per minute, minimum. However, provisions shall be made for controlling the flow of air throughout the internal test chamber area so that the velocity of air shall not exceed 150 ft/minute. Steam, or distilled, demineralized, or deionized water shall be used to obtain the specified humidity. No rust or corrosion contaminants shall be imposed on the test sample by the test facility.

3. TEST SAMPLE:

3.1 Sample:

A test sample shall consist of a plug, a receptacle, or a mated plug and receptacle as specified.

3.2 Sample preparation:

The samples shall be wired using the contacts, wire type, size, and sealing plugs (if applicable), specified.

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4. TEST PROCEDURE:

4.1 Procedure:

The test procedures shall be as follows:

a. Type I, steady state.

- (1) Conditioning. The specimens shall be conditioned in a dry oven at a temperature of $50^{\circ} \pm 5^{\circ}\text{C}$ for 24 hours. At the end of this period, measurements shall be made as specified.
- (2) Mounting. The connector shall be mounted in the test chamber so that the wires descend vertically into the connector or one connector half. There shall be no drip loops in the wires.
- (3) Exposure. The specimens shall be placed in a chamber and subjected to a relative humidity of 90 to 95 percent and a temperature of $40^{\circ} \pm 2^{\circ}\text{C}$ for the period of time indicated in one of the following test conditions, as specified:

<u>Test condition</u>	<u>Length of test</u>
A - - - - -	240 hours
B - - - - -	96 hours
C - - - - -	504 hours
D - - - - -	1,344 hours

When specified, a direct-current potential of 100 volts, or as specified, shall be applied to the specimens during the exposure period. The length of time for the application of voltage and the points of application shall be as specified.

b. Type II, temperature cycling (see figure 1).

- (1) Conditioning. The specimens shall be conditioned in a dry oven at a temperature of $50^{\circ} \pm 5^{\circ}\text{C}$ for 24 hours. At the end of this period, measurements shall be made as specified.
- (2) Mounting. Specimens shall be mounted by their normal mounting means, in their normal mounting position, but shall be positioned so that they do not contact each other, and so that each specimen receives essentially the same degree of humidity.
- (3) Initial measurements. Prior to step 1 of the first cycle, the specified initial measurements shall be made at room ambient conditions, or as specified.
- (4) Number of cycles. Specimens shall be subjected to 10 continuous cycles, each as shown on figure 2.
- (5) Subcycle. During step 7, at least 1 hour but not more than 4 hours after step 7 begins, the specimens shall be either removed from the humidity chamber, or the temperature of the chamber shall be reduced, for performance of step 7a. After step 7a, the specimens shall be returned to 25°C at 90 to 98 percent relative humidity (RH) and kept there until the next cycle begins. This subcycle shall be performed during any five of the first nine cycles.

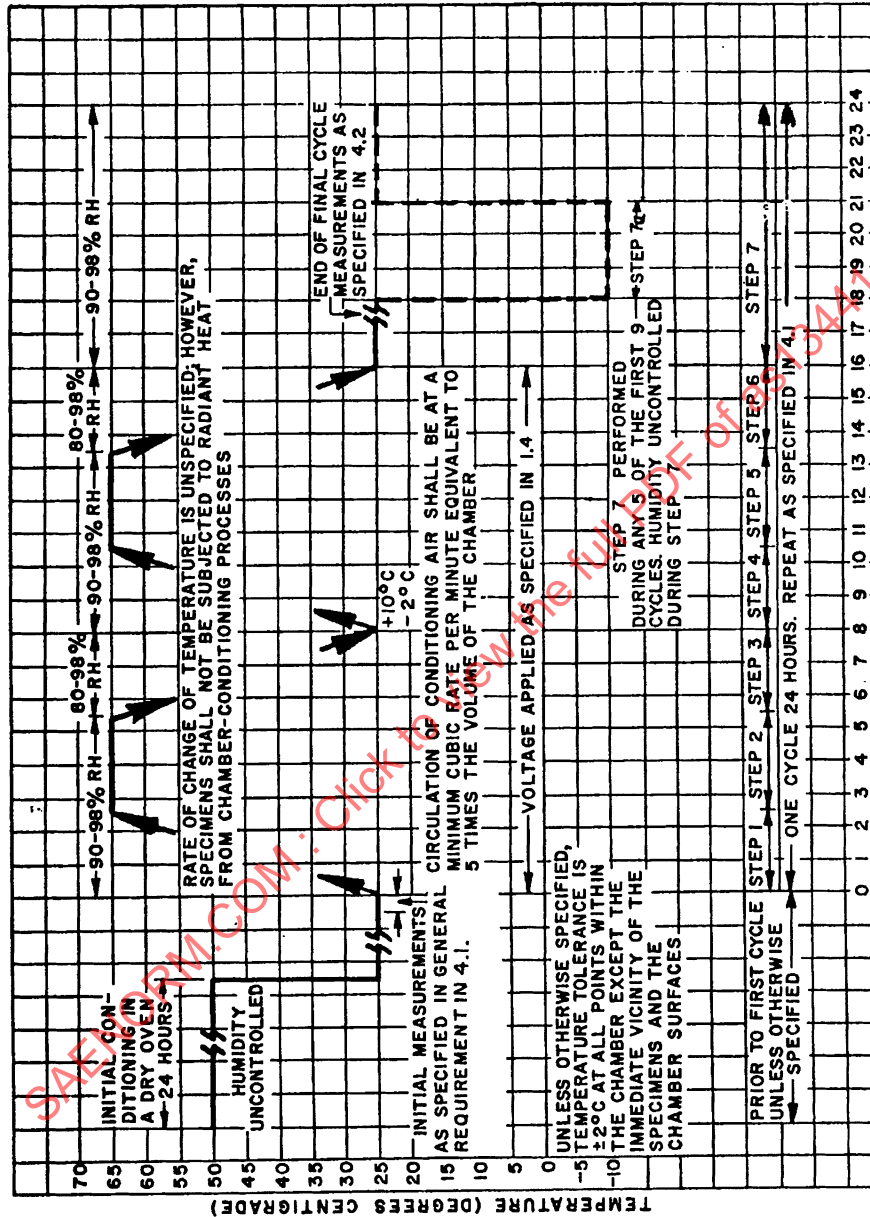


FIGURE 1. Graphical representation of moisture-resistance type II humidity test.

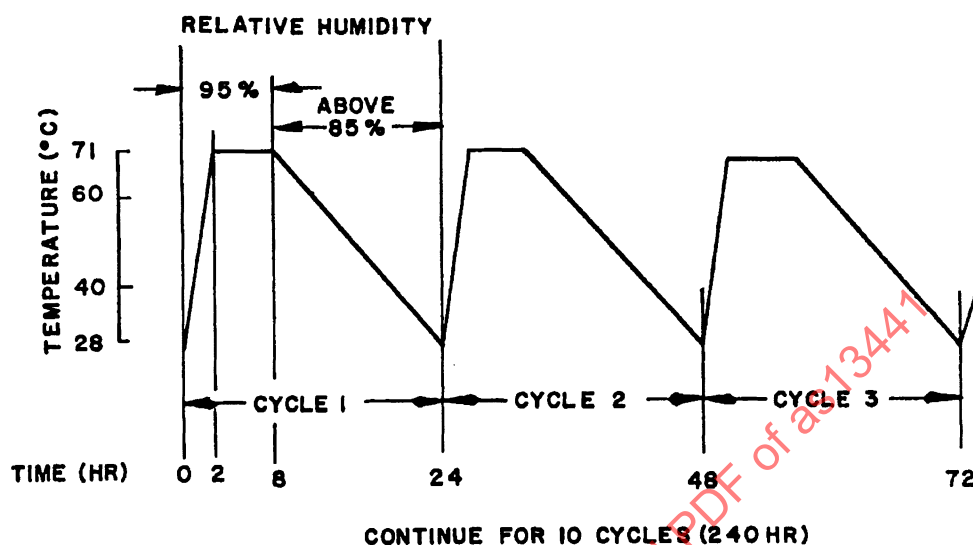


FIGURE 2. Humidity cycle, type III.

4.1 (Continued):

- (6) Step 7a. At least 1 hour but not more than 4 hours after the beginning of step 7, the specimens shall be either removed from the humidity chamber, or the temperature of the chamber shall be reduced. Specimens shall then be conditioned at $-10^{\circ} \pm 2^{\circ}\text{C}$ with humidity not controlled, for 3 hours as indicated on figure 1. When a separate cold chamber is not used, care shall be taken to assure that the specimens are held at $-10^{\circ} \pm 2^{\circ}\text{C}$ for the full 3-hour period.

c. Type III, temperature cycling (see figure 2).

- (1) Conditioning. The specimens shall be conditioned in a dry oven at a temperature of $50^{\circ} \pm 5^{\circ}\text{C}$ for 24 hours. At the end of this period, measurements shall be made as specified.
- (2) Mounting. Specimens shall be mounted by their normal mounting means, in their normal mounting position, but shall be positioned so that they do not contact each other, and so that each specimen receives essentially the same degree of humidity.
- (3) Initial measurements. Prior to step 1 of the first cycle, the specified initial measurements shall be made at room ambient conditions, or as specified.
- (4) Number of cycles. Specimens shall be subjected to 10 continuous cycles, each as shown on figure 1.
- (5) Subcycle. The subcycle shall be performed in accordance with 4.1(b)(5).
- (6) Step 7a. This step shall be performed in accordance with 4.1(b)(6).

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4.1 (Continued):

(7) Test.

- (a) Place the test item in the test chamber in accordance with 4.1(c)(1). Prior to starting the test, the internal chamber temperature shall be at standard test with uncontrolled humidity.
- (b) Gradually raise internal chamber temperature to 71°C (160°F) and the relative humidity to 95^{+5}_{-0} percent over a period of 2 hours.
- (c) Maintain condition of (7)(b) (see figure 2) for not less than 6 hours.
- (d) Maintain 85 percent, or greater, relative humidity and reduce internal chamber temperature in 16 hours to $28^{\circ} \pm 10^{\circ}\text{C}$ (82°F).
- (e) Repeat steps (7)(b), (7)(c), and (7)(d) for 10 cycles (not less than 240 hours). Figure 2 is an outline of the humidity cycle for this procedure.

4.2 Final measurements:

4.2.1 At high humidity: Particular precautions to be followed in making measurements under high humidity conditions shall be specified.

4.2.1.1 Type I: Upon completion of the exposure period and while the specimens are still in the chamber, the specified measurements shall be performed.

4.2.1.2 Type II: Upon completion of step 6 of the final cycle, the specified measurements shall be made.

4.2.1.3 Type III: Upon completion of step 7 of the final cycle, the chamber program can shall be stopped to maintain the low temperature, high humidity condition. The specified measurements shall be made.

4.2.2 After high humidity (all types): Upon removal from the humidity chamber, final measurements shall be made within 1 to 2 hours if required by the connector specification. Specimens shall not be subjected to any means of artificial drying.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations - Initial and final ambient conditions.

6. SUMMARY:

The following details shall be specified in the individual connector specifications:

- a. If polarization voltage is required (see 1.4).
- b. Type samples to be tested and whether mated (see 3.1).
- c. Wire type, size, and sealing plugs (if applicable) (see 3.2).
- d. Type I - Test condition letter (see 4.1 a(3)).
- e. Type I - Direct-current potential, if applicable. Length of application time and points of application (see 4.1 a(3)).
- f. Type II - Initial measurements and conditions if other than room ambient (see 4.1 b(1) and (3)).
- g. Type III - Initial measurements and conditions, if other than 4.1 c(1) and (3).
- h. Final measurements and precautions under high humidity conditions (see 4.2).

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METHOD 1003.1 TEMPERATURE CYCLING

1. PURPOSE:

The purpose of this test is to determine the resistance of a given electrical connector to exposure at extremes of high and low temperatures, and the shock of alternate exposure to these extremes, simulating the worst probable conditions of storage, transportation and application.

2. TEST EQUIPMENT:

2.1 Test chambers:

Separate chambers shall be used for the extreme temperature conditions of steps 1 and 3. The air temperature of the two chambers shall be held at each of the extreme temperatures by means of circulation and sufficient hot- or cold-chamber thermal capacity so that the ambient temperature shall reach the specified temperature within 2 minutes after the specimens have been transferred to the appropriate chamber.

3. TEST SAMPLE:

3.1 Sample and fixture:

A test sample shall consist of a plug, a receptacle, or a mated plug and receptacle as specified. Unless otherwise specified, the test sample shall be assembled with contact, wires, and sealing plugs, before, during, and after the test. The wire shall be of sufficient continuous length to interconnect the test connector and test equipment, as may be specified. Connectors not normally equipped with an integral coupling device shall be maintained in the simulated mated condition by a suitable fixture. The fixture shall be made as lightweight as possible in order to reduce "heat sink" effects that would reduce the severity of thermal shock. (See 4.2 for sample mass determination before wiring the sample.)

4. TEST PROCEDURE:

4.1 Initial and final measurements:

Specified measurements shall be made prior to the first cycle and upon completion of the final cycle, except that failures shall be based on measurements made after the specimen has returned to thermal stability at room ambient temperature following the final cycle.

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4.2 Sample mass determination:

Before cycling, the combined mass of the assembly (mated, if applicable) to be tested shall be determined. This mass shall include contacts, sealing rings, connector accessories attached to the connector, and any wire within the envelope boundaries of the connector. The mass of any fixture used to hold the connectors in the mated condition shall also be determined. The mass of the specimen is the total mass of the mated assembly and any fixture attached to the connector.

4.3 Number of cycles:

Specimens shall be placed in such a position with respect to the airstream that there is substantially no obstruction to the flow of air across and around the specimen. When special mounting is required, it shall be specified. The specimen shall then be subjected to the specified test condition of table I. The first five cycles shall be run continuously. After five cycles, the test may be interrupted after the completion of any full cycle, and the specimens allowed to return to room ambient temperature before testing is resumed. One cycle consists of steps 1 through 4 of the applicable test condition. Specimens shall not be subjected to forced circulating air while being transferred from one chamber to another. Direct heat conduction to the specimen should be minimized.

TABLE I. Temperature cycling.

Step	Test condition	Number of cycles
	A	5
	A-1	25
	A-2	50
	A-3	100
	Temperature	Time
	<u>°C</u>	<u>Minutes</u>
1	-55^{+0}_{-3}	(See table II)
2	25 ± 10	5 max
3	85^{+3}_{-0}	(See table II)
4	25 ± 10	5 max

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4.4 Exposure time:

The duration of test and the length of exposure at temperature extremes are standardized for a given mass of the test item (see table II). This approach will allow the connector to reach thermal stability at the temperature of the test chamber while keeping the testing time to a minimum.

TABLE II. Exposure time at temperature extremes.

Mass of specimen	Minimum time (for steps 1 and 3)
	<u>Hours</u>
1 ounce (28 grams) and below - - - - -	1/2; or 1/4 (when specified)
Above 1 ounce (28 grams) to .3 pound (136 grams) incl - - - - -	1/2
Above .3 pound (136 grams) to 3 pounds (1.36 kilograms) incl - - - - -	1
Above 3 pounds (1.36 kilograms) to 30 pounds (13.6 kilograms) incl - -	2
Above 30 pounds (13.6 kilograms) to 300 pounds (136 kilograms) incl -	4
Above 300 pounds (136 kilograms) - - - - -	8

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test condition letter.
- e. Values and observations.
 - (1) Initial and final measurements (see 4.1).
 - (2) Assembly mass (see 4.2).

6. SUMMARY:

The following details shall be specified in the individual connector specification:

- a. Mated or unmated state of the test connectors, assembly of test sample if other than 3.1, and test equipment interconnect (if applicable) (see 3.1).
- b. Initial and final measurements (see 4.1).
- c. Test condition letter (see 4.3).
- d. Special mounting, if applicable (see 4.3).

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METHOD 1004.1 ALTITUDE IMMERSION

1. PURPOSE:

The purpose of this test is to demonstrate the ability of the connector-to-wire and interface-area seals of a mated connector assembly to perform satisfactorily during and subsequent to simulated rapid descents from high altitude with attendant moisture condensation.

2. TEST EQUIPMENT:

2.1 Altitude chamber:

The altitude immersion test chamber shall consist of a suitable sealed chamber with necessary vacuum pump equipment to maintain a reduced pressure of 1 inch of mercury or lower, if required. The chamber shall have provisions for electrical connections.

2.2 Test container:

The test container for positioning the connector assembly shall have the following minimum dimensions: 2 inches wide, 9 inches long, and 3 inches deep. A salt solution shall be placed in the container to a depth that will completely cover the connector at all times during the altitude immersion test. The salt solution shall be prepared by dissolving 5 ± 1 parts by weight of noniodized commercial table salt in 95 parts by weight of distilled water. No material shall be added to, and no contaminant shall be present in the container or solution which tend to prevent wetting of the test sample by the solution.

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a fully assembled, mated electrical connector with the specified number of contacts, proper wire type size, and end preparation, sealing plugs, and other hardware as specified. Care shall be taken to ascertain that the wires are free of pin holes that would permit leakage of the solution into the connector or breathing with the chamber pressure changes. It shall be verified that wires provided for connection to shells are actually electrically connected to preceding shells.

3.2 Sample preparation:

The test samples shall be placed in the container in the chamber in such a manner that the connector assembly will be entirely immersed in the salt solution. The uppermost point of the connector shall be 1 inch maximum below the surface of the solution. Unless otherwise specified, termination of the wires of the test sample shall be unsealed and within the sealed chamber as specified. The wires shall be arranged so as to prevent any voltage breakdown or low insulation resistance which might incorrectly indicate connector failure.

4. TEST PROCEDURE:

Unless otherwise specified, the test sample and test equipment shall be established and maintained at standard test conditions.

4.1 Altitude immersion cycling:

The chamber shall be sealed. The chamber pressure shall be reduced from room ambient to 1 inch (75,000 feet) $+0.0 -0.2$ inch of mercury within 5 minutes, and shall be maintained at this level for 30 minutes, minimum. The chamber pressure shall be increased to room ambient within 1 minute, and shall be maintained at room ambient pressure for 30 minutes, minimum. The foregoing shall constitute one cycle. Two additional cycles shall be performed (three cycles total). The connector shall remain fully immersed in the salt solution during the three cycles and for the subsequent measurements specified herein.

4.2 Insulation resistance test:

After the third cycle and while still in the salt solution, the insulation resistance test shall be performed in accordance with test method 3003.

4.3 Dielectric withstanding voltage test:

After the insulation resistance test and while the connector is still in the salt solution, a dielectric withstanding voltage test shall be performed in accordance with test method 3001.

4.4 Connector examination:

After the altitude immersion test, the test sample shall be removed from the chamber and washed in distilled or tap water. The test sample shall then be patted or wiped with suitable towels and dried by being exposed to room ambient conditions for 20 to 24 hours, or by placing in a circulating air oven at $48.9^{\circ} \pm 2.8^{\circ}\text{C}$ ($120^{\circ} \pm 5^{\circ}\text{F}$) for 2 - 3 hours. The following shall be observed and recorded:

- a. Evidence of foreign deposits on the interface or contacts.
- b. Deterioration of moisture seals.
- c. Evidence of dielectric breakdown across interface of connector.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations:
 - (1) Record chamber pressure, temperature and duration of each cycle.
 - (2) Record: Insulation resistance values. Identity of each contact pair in test sample.
Dielectric withstanding test results. Identity of each contact pair in test sample.
Connector visual examination.

6. SUMMARY:

The following details shall be specified in the individual connector specification:

- a. Wire type and size (see 3.1).
- b. Number of contacts and sealing plugs (see 3.1).
- c. Connector accessories - Support hardware to be installed on connector specimen during test (see 3.1).
- d. Connector specimen preparation (see 3.2).
- e. Insulation resistance minimum allowable limit (see 4.2).
- f. Dielectric withstanding voltage, maximum leakage current and test voltage application time if other than 5 seconds (see 4.3).

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METHOD 1005.1 TEMPERATURE LIFE

1. PURPOSE:

The purpose of this test is to determine the effects on the electrical and mechanical characteristics of electrical connectors resulting from exposure of the connector(s) to an elevated ambient temperature for a specified length of time.

2. TEST EQUIPMENT:

A suitable chamber and equipment shall be used that will maintain, monitor and record the test temperature to the tolerance and for the duration specified. The chamber temperature measurements shall be made in a manner that will indicate the connector exposure temperature rather than the chamber source temperature. The chamber size or capacity shall be such that the connectors under test shall be capable of dissipating the internally generated (I^2R) connector heat.

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a fully assembled, mated electrical connector with the specified number of contacts. Proper wire type, size, and preparation, sealing plugs, and other hardware shall be as specified.

3.2 Sample preparation:

Unless otherwise specified, the connectors, wires, and fixtures shall be normally positioned in the chamber so that there will be no restriction of the air flow. All contacts of the same wire size shall be wired in series.

4. TEST PROCEDURE:

The connector test potentials, duty cycle load and other operating conditions during exposure shall be specified.

4.1 Connector temperature:

The connector samples shall be exposed to one of the temperatures specified in table I. The connector internal temperature shall not exceed that specified in table I when test is performed under electrical load conditions. The continuous dc current to produce the specified internal temperature shall be regulated and recorded. The current shall not exceed the rated current of the contact.

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TABLE I. Connector temperatures.

Test condition	Connector exposure temperature and tolerance		Connector internal temperature (maximum)	
	°C	°F	°C	°F
1	55 ±2	131 ±3.6	65	149
2	70 ±2	158 ±3.6	84	183
3	85 ±2	185 ±3.6	102	216
4	105 ±2	221 ±3.6	125	257
5	125 ±2	257 ±3.6	150	302
6	175 ±5	347 ±9	206	402
7	200 ±5	392 ±9	238	460
8	350 tol. as specified	662 tol. as specified	400	752
9	500 tol. as specified	932 tol. as specified	575	1067

4.2 Length of test:

The connector samples shall be subjected to the specified temperature for one of the durations of table II.

TABLE II. Length of test.

Test time condition	Hours
A	96
B	250
C	500
D	1000
E	1500
F	2000
G	3000
H	5000

4.3 Examination:

At the conclusion of the test, the connector(s) shall be examined for any of the following:

- a. Dimensional changes in excess of specified limits.
- b. Hardening or softening of dielectric materials in excess of specified limits.
- c. Opening of seals.
- d. Cracking or crazing or delamination of components or finishes.
- e. Fusing or seizure of mating connectors or components.
- f. Leakage of potting materials, as specified.

The above conditions shall be judged on their effect on the continued successful operation of the connector and the ability of the connector to meet the test requirements of the individual applicable specification.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used, and date of latest calibration.
- d. Test procedure.
- e. Values and observations:
 - (1) Visual examination.
 - (2) Monitoring measurements as required by the individual specification.
 - (3) Current required to maintain specified internal temperature.

6. SUMMARY:

The following details shall be specified in the individual connector specification.

- a. Sample preparation (include internal temperature monitoring device type and location) (see 2.).
- b. Test sample description (see 3.1).
- c. Special fixtures and mounting, if other than that simulating normal operation (see 3.2).
- d. Load conditions (electrical) (see 4.).
- e. Test condition for chamber and connector temperature and length of test (see 4.1 and 4.2).
- f. Observations or measurements to be made before, during and after testing (see 4.3).

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METHOD 1006.1 HYDROSTATIC PRESSURE

1. PURPOSE:

The purpose of this test is to determine the adequacy of receptacles and plugs (mated, unmated, or provided with protective covers) and wired-mated harnesses subjected to static and dynamic hydrostatic pressures that are encountered in the undersea environment.

2. TEST EQUIPMENT:

2.1 Test container:

The test equipment shall consist of a hydrostatic pressure test vessel (following the ASME pressure vessel code as a guide). The pressure vessel shall be designed to suit the hydrostatic pressure range of the connector or receptacle to be tested. The vessel shall be equipped with a suitable pump to permit pressurization of the vessel to its required pressure condition in accordance with 4.2 and table I. The pressure gage attached to the vessel shall be accurate within plus or minus 1 percent. The vessel shall include a cover designed for mounting and sealing test flanges to the cover, see figure 1.

2.2 Test liquid:

Unless otherwise specified, the test medium shall be tap water. When a union connector is tested (see figure 2), a dielectric oil shall be located above the water in the pressure vessel to completely immerse the bulkhead connector in oil and the union connector in the water. Plain tap water may be used for production testing when authorized by the individual specification.

3. TEST SAMPLE:

3.1 Sample:

A test sample may consist of any the following:

- a. An unmated receptacle.
- b. A mated bulkhead connector, or a mated union connector, see figure 2.
- c. A protective cover.

3.2 Sample preparation:

Three types of hydrostatic pressure tests shall be conducted: An unmated receptacle, a mated connector, and a protective cover test. Samples shall be tested under the specified electrical power with all contacts in connector, or ends of cables or wires connected. Instrumentation may be connected to the test sample via the pressure vessel for electrical performance monitoring.

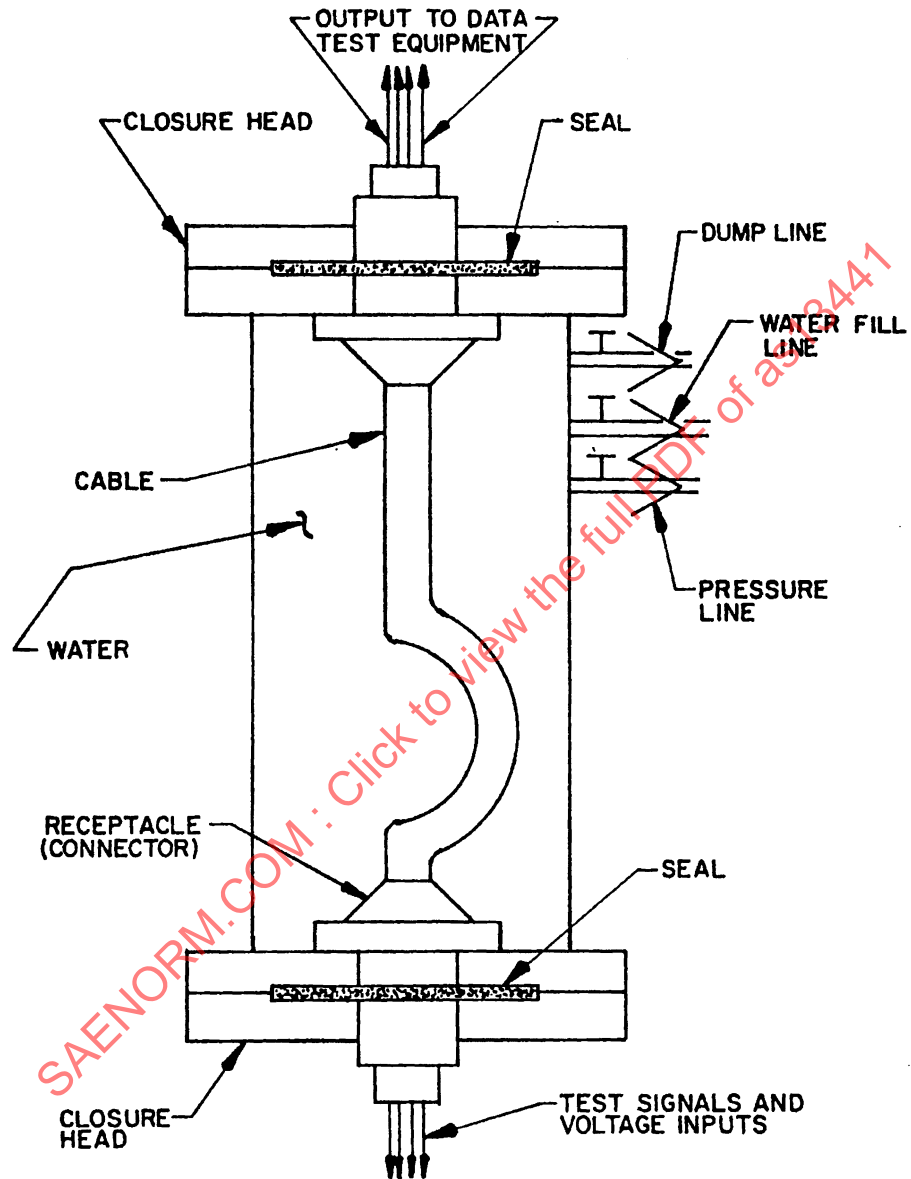


FIGURE 1. Hydrostatic test vessel.

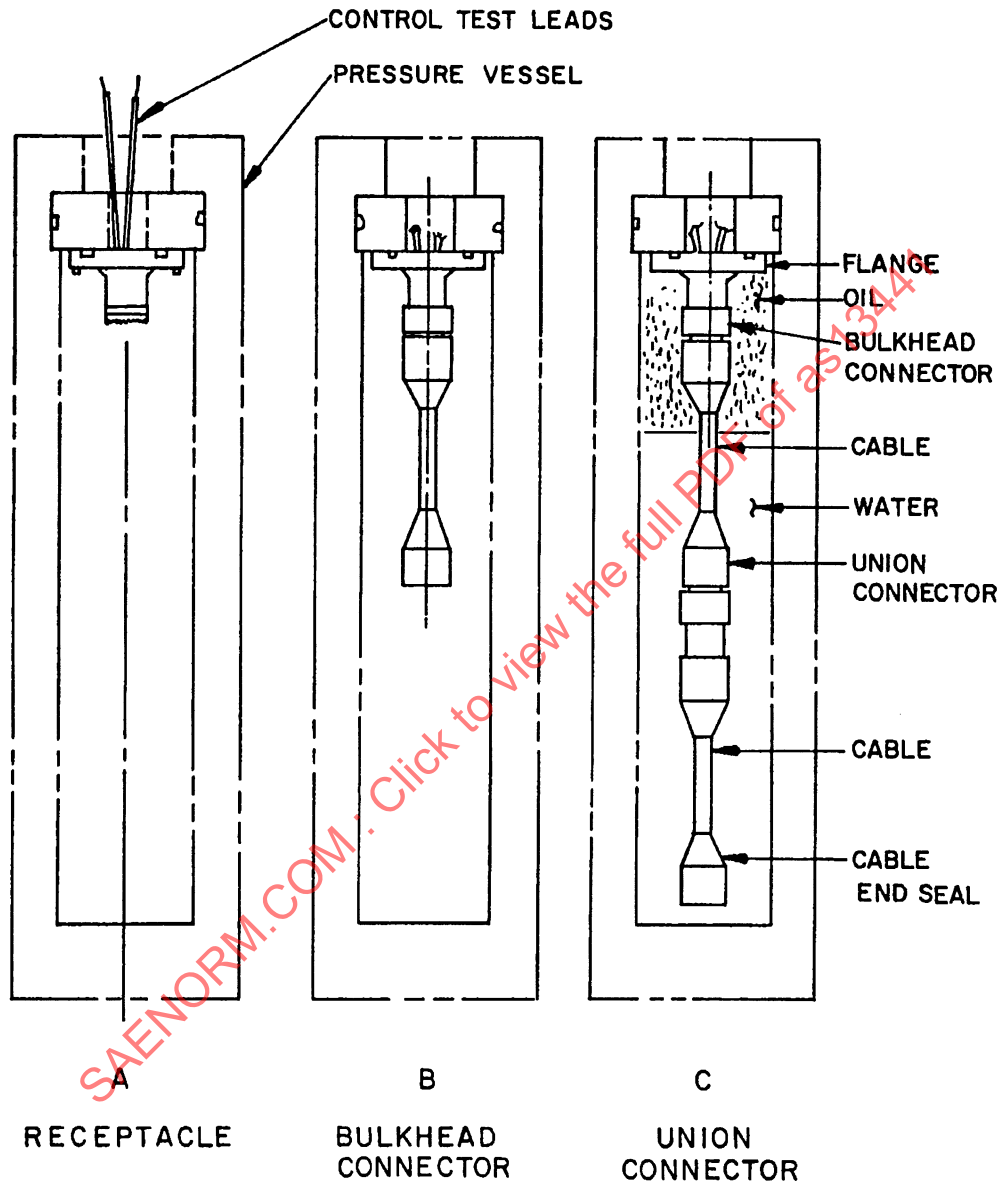


FIGURE 2. Typical connector tests.

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- 3.2.1 Unmated receptacle: The unmated receptacle shall be mounted to the vessel cover flange using seal and fastening methods as specified. The face of the web section of the receptacle shall be exposed to pressure while this area is completely filled with water.
- 3.2.2 Mated connector: A bulkhead type connector or a union type connector shall be assembled using the wire or cable type, length, size and sealing methods as specified.
- 3.2.3 Protective cover: The test connector shall be installed in the vessel so that the pressure can be applied safely to the cover. The back end of the connector shall be suitably protected. Precaution should be taken to assure maximum safety when pressure is applied in various tests.

4. TEST PROCEDURE:

4.1 Hydrostatic pressure test (static):

The test sample shall be subjected to the specified test condition of table I. The test sample shall be subjected to the maximum pressure of each applicable increment for 5 minutes $\pm$ 30 seconds at standard ambient conditions, unless otherwise specified.

4.2 Hydrostatic pressure test (cycling):

When specified, the connector shall be subjected to a cyclic pressure test following the static pressure test. The specimen shall be subjected to the following cycling from 0 lb_f/in² to the maximum pressure of the test condition:

<u>Procedure</u>	<u>Number of cycles</u>	<u>Time at maximum pressure</u>
1	25	momentary
2	1,000	5 minutes $\pm$ 30 seconds
3	1	24 hours $\pm$ 30 minutes

4.3 Examination (control tests):

Control tests such as continuity and insulation resistance shall be as specified.

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TABLE I. Hydrostatic pressure test increments (static).

Test condition				Pressure increments lb _f /in ² ±1 percent
A	B	C	D	
1	1	1	1	0-20
2	2	2	2	20-250
3	3	3	3	250-500
4	4	4	4	500-1,000
	5	5	5	1,000-1,500
	6	6	6	1,500-2,000
	7	7	7	2,000-2,500
		8	8	2,500-3,000
		9	9	3,000-3,500
		10	10	3,500-4,000
		11	11	4,000-5,000
		12	12	5,000-6,000
		13	13	6,000-7,000
		14	14	7,000-8,000
			15	8,000-9,000
			16	9,000-10,000
			17	10,000-11,000
			18	11,000-12,000
			19	12,000-13,000
			20	13,000-14,000
			21	14,000-15,000
			22	15,000-16,000

4.4 Failures:

Potential modes of failure resulting from this test include:

- a. Permanent dimensional changes.
- b. Cracking and crazing of insulation materials.
- c. Permanent damage to cable sealing compounds.
- d. Water absorption by insulation materials and leakage through these materials.
- e. Leakage of receptacle-to-bulkhead seals; plug-to-receptacle seals; and cable-to-plug seals.
- f. Displacement or rupture of connector shells, inserts, contacts, wire, or sealing compounds.
- g. Changes in electrical characteristics (adverse).

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test method, condition, and procedure, as applicable.
- e. Values and observations:
 - (1) Initial and final ambient conditions.
 - (2) Circuit diagram, if used for control tests.
 - (3) Insulation resistance readings, if applicable.
 - (4) Observations of permanent or temporary dimensional changes; insulation, connector shell, contact, wire (or cable) seal, or insert damage.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Test medium, if other than tap water (see 2.2).
- b. Electrical power to be applied (see 3.2).
- c. Mated or unmated condition of test connectors (see 3.2).
- d. Connector wire or cable type, length and size, and sealing methods (see 3.2).
- e. Receptacles seal mounting and fastening method (see 3.2.1).
- f. Special precautions, if applicable (see 3.2.3).
- g. Initial measurements and conditions, if other than room ambient (see 4.1).
- h. Test condition letter (see 4.1).
- i. Test procedure number (see 4.2).

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METHOD 1007.1 OZONE EXPOSURE

1. PURPOSE:

The purpose of this test is to determine the ability of connectors to withstand the effects of controlled amounts of ozone.

2. TEST EQUIPMENT:

The test equipment shall be as follows and in accordance with ASTM D 1149-64(1970).

2.1 Test chamber:

- a. The test chamber shall be constructed of a material with minimal reaction to ozone.
- b. The volume of the chamber shall be at least 0.14 cubic meters (5 cubic feet).
- c. A means for generating and controlling an air-ozone stream shall be provided. The generating source shall be located outside the chamber. The source of the air can be either drawn directly from the laboratory or from a compressed air supply. In either case adequate filtration of foreign matter from the stream must be provided. The air-ozone stream shall be introduced into the chamber in such a manner that stratification of ozone is prevented.
- d. The air-ozone replacement rate or throughput rate must be of a magnitude such that no appreciable reduction in ozone concentration results from the introduction of test specimens. This minimum replacement rate will vary with the ozone concentration, temperature, number of test specimens introduced, and their reaction with ozone. In chambers possessing control of the replacement rate at the location of the test specimen, no minimum air-ozone rate need be defined. For many chambers operating under normal conditions (100 -150 ppm) and with the ozonated air control at the generator, an air-ozone replacement rate of a three-fourth change per minute is an acceptable minimum rate. For thorough and accurate work, especially under unusual conditions, the minimum or safe replacement rate should be determined.
- e. A means of providing adequate internal circulation shall be provided. The air-ozone velocity in the chamber shall be at least 61 centimeters (2 feet) per second. Where it is not possible to obtain such velocities, the installation of a 1,700 rpm electric motor and fan blade of approximately 15 centimeters (6 inches) diameter and 20 to 30 degrees pitch will produce such air velocities. The motor itself shall be used with an appropriate seal.
- f. A means of controlling the temperature of the chamber from ambient to $70^{\circ} \pm 5^{\circ}\text{C}$ ($158^{\circ} \pm 9^{\circ}\text{F}$) shall be provided. The temperature regulation shall be capable of maintaining the test temperatures.
- g. A glass window or glass front door shall be provided with the chamber for visual inspection.
- h. Chamber exhaust air, containing ozone, shall be vented out of the test area.

2.2 Ozone generator:

A mercury vapor lamp may be used as the source for generating ozone. The ozone concentration can be controlled by means of a variable transformer on the input to the mercury lamp.

2.3 Ozone measuring devices:

Ozone measuring devices shall be capable of measuring the concentration.

3. TEST SAMPLE:

3.1 Sample:

Each test sample shall consist of one mated and wired plug and receptacle.

3.2 Sample preparation:

All contacts shall be wired, connectors shall be mated, and suspended in the ozone chamber to allow exposure to ozone concentration.

4. TEST PROCEDURE:

Unless otherwise specified, each test sample and test equipment shall be stabilized at standard ambient conditions. Unless otherwise specified, each test sample shall then be subjected to an ozone concentration of 100 to 150 parts per million by volume for 2 hours.

WARNING: Since ozone is a toxic gas, care must be taken in using it to perform testing called out herein.

4.1 Failures:

Potential modes of failure resulting from this test are as follows:

- a. Loosening or breaking of parts.
- b. Degradation of elastomers.
- c. Insert bonding failure.
- d. Excessive swelling of resilient materials.
- e. Damage to interface seals.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used.
- d. Test procedure.
- e. Values and observations:
 - (1) Record ozone concentration.
 - (2) Visual and mechanical observation.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. The ozone concentration and time if other than herein (see 4.).
- b. Test conditions if other than standard ambient (see 4.).
- c. Wired, mated and unmated (see 3.2).

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METHOD 1008 AIR LEAKAGE

1. PURPOSE:

The purpose of this test is to determine the integrity of the seal of the shell/insert/contact interfaces in an electrical connector. It may be conducted as one of the tests in a sequential test plan and after or during the exposure of the test sample to a specified low temperature. A pressure differential is established between the front and rear faces of a mounted receptacle. The degree of leakage through the seals of the test sample is measured by means of a detection device located on the low pressure side of the test sample.

2. TEST EQUIPMENT:

2.1 Hermetic seal test equipment:

Test equipment shall be as follows:

- a. Chamber capable of providing for:
 - (1) Mounting of the test sample by means of its flange on the chamber divider which separates low from high pressure.
 - (2) A gas tight seal at the flange mounting surface of the test sample.
 - (3) Surrounding the high pressure side of the connector with a tracer gas for hermetic testing.
- b. Pressure or vacuum pumps, or a pressure bottle with pressure control valve capable of achieving and maintaining the pressure differential specified.
- c. Gages shall be provided in order to read the pressure and/or vacuum of the pressure differential between the front and rear faces of the connector during test.
- d. A mass spectrometer detector shall be used to read the tracer gas leakage rate through the connector.
- e. The tracer gas shall be either helium, argon, or a mixture of 90 percent nitrogen and 10 percent helium.

2.2 Environmental seal test equipment:

Test equipment shall be as follows:

- a. The insulated pressurized chamber shall be operable to -60°C and shall be capable of withstanding an internal pressure of 30 pounds per square inch. The internal container for mounting the connector under test shall have piping to external fittings in accordance with figure 1.
- b. Air line pressure adapter.
- c. Air line pressure regulator and gage.
- d. Graduated cylinder. 25 milliliters.
- e. Thermometer. Readable to -60°C.
- f. Valves and plumbing. In accordance with figure 1. (An alternate environmental seal test equipment arrangement in accordance with figure 2 may be used in place of the arrangement of figure 1.)

3. TEST SAMPLE:

A test sample shall consist of a wired receptacle as specified. The wires shall not be brought out of the test chamber.

4. TEST PROCEDURE:

4.1 Test conditions:

Unless otherwise specified, all measurements shall be made within the ambient conditions per general requirements of this standard.

4.2 Mounting:

The test sample shall be mounted on the chamber divider which separates low from high pressure. A suitable opening must be provided in the divider such that, with the aid of greases and/or sealing gaskets, a leak-proof junction is achieved between the test sample connector flange and divider. The test sample, after mounting in the chamber, shall be conditioned for at least 1/2 hour at the desired temperature before conducting the test.

4.3 Applying pressure:

The pressure differential between the front and rear faces of the connector shall be maintained at the value specified. Depending on the type of equipment used, this may be achieved by evacuation of one side of the chamber while maintaining atmospheric pressure at the other side, or pressurizing one side of the chamber with atmospheric pressure at the other side, or a combination of pressurizing one side of the chamber and partially evacuating the other side.

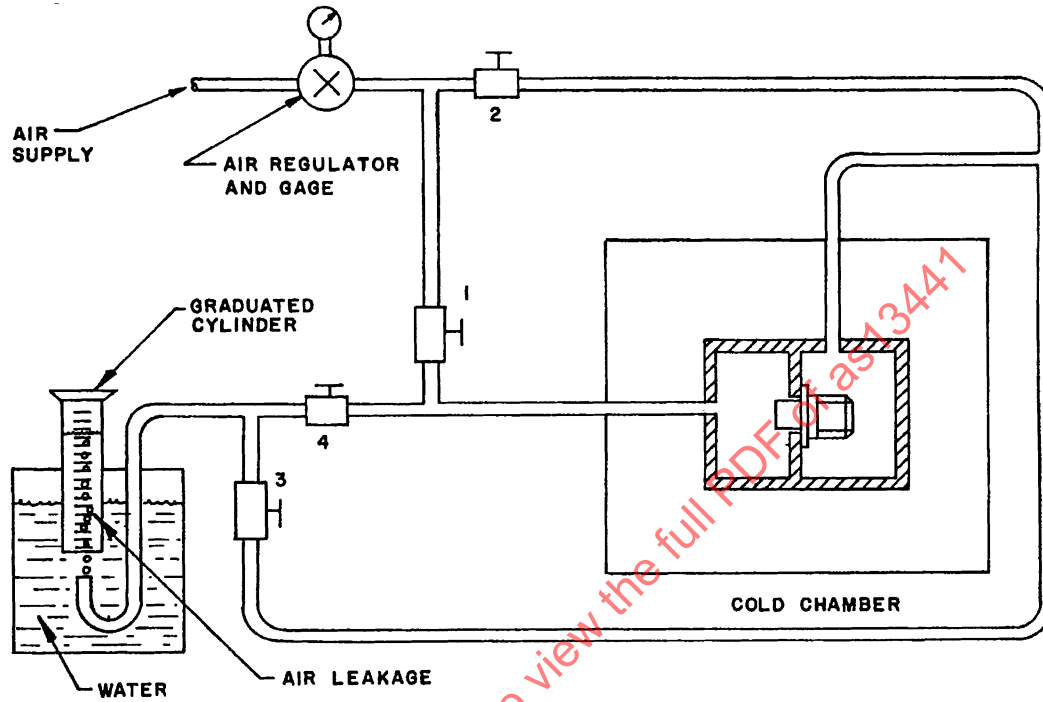


FIGURE 1. Environmental seal test equipment arrangement.

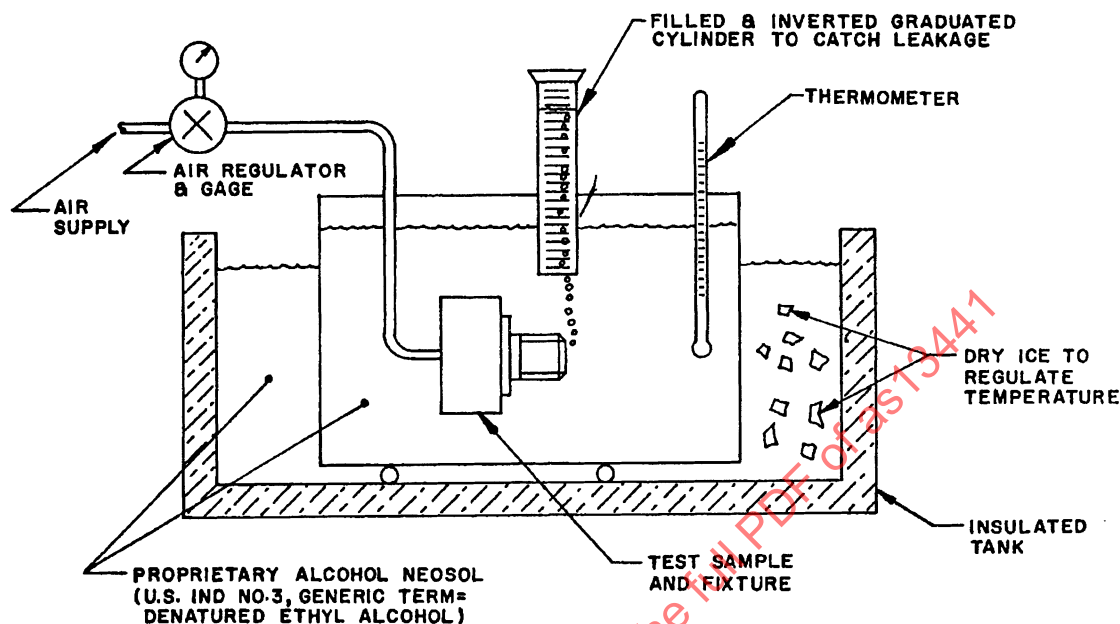


FIGURE 2. Alternate environmental seal test equipment arrangement.

4.4 Leak detection:

- 4.4.1 Leak detection for hermetic seal connectors: The leak detector shall be connected to the low pressure or vacuum side of the chamber. The tracer gas shall be introduced at the high pressure side of the chamber in such a manner that it surrounds the face of the connector test sample. The leakage rate (if leakage exists) shall be measured and compared to the maximum allowable leakage specified.
- 4.4.2 Leak detection for environmental seal connectors: The graduated cylinder shall be filled with liquid and then inverted over the air exit tube from the test sample. The leakage rate shall be measured and recorded.

4.5 Test sample orientation:

Unless otherwise specified, the test sample shall be tested with the flange and mating face in the high pressure side of the chamber, the rear face to extend into the low pressure side of the chamber. When specified, the connector shall be reversed and leakage checked in the opposite (or both) directions.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure used.
- d. Values and observations:
 - (1) Initial and final ambient conditions.
 - (2) Leakage rate observed, comparison to connector specification requirements, whether samples passed or failed.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Initial measurements and conditions, if other than room ambient (see 4.1).
- b. Full description of test sample (see 3.).
- c. Manner in which sample is to be prepared (see 3.).
- d. Pressure differential required (see 2.1 b).
- e. Test sample orientation and whether reverse testing is also required (see 4.5).
- f. Maximum allowable leakage rate, expressed as atmospheric cubic centimeters per second ($\text{atm cm}^3/\text{s}$) (see 4.4.1).

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METHOD 1009 FIREWALL

1. PURPOSE:

The purpose of this test is to determine the ability of mated wired connector (plug and receptacle) to resist flame, passing through the connector for 20 minutes or other causes such as ignition of gases on the end of the connector protected by the firewall, or break in continuity for a limited period of time.

2. TEST EQUIPMENT:

Test equipment shall be as follows:

- a. Glass tape.
- b. Flame producing apparatus capable of producing a natural gas flame at a flow rate equivalent to an input of 33,000 to 37,000 Btu/h, and maintaining a flame at a temperature of 1,093°C +30° -00°.
- c. Power supply capable of producing a potential of 100-125 Vac at 60 Hz, capable of delivering 2 amperes.
- d. Ammeter certified to an accuracy of 1 percent having capabilities of measuring dc test currents specified in table I.
- e. Vibration apparatus capable of vibrating the mated connector continuously at 33 Hz with a total excursion of 1/4 inch.
- f. Power supply capable of producing dc test current as specified.

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a mated, torqued, high temperature wired connector.

3.2 Sample preparation:

The sample shall be prepared as follows:

- a. Thoroughly clean of oil, grease, dirt and foreign material using a non-combustible solvent.
- b. Wrap the plug wire bundle with glass tape or protect by suitable means to ensure that the wire bundle is capable of meeting the electrical requirements of this test.
- c. Physical and electrical degradation after 20 minutes exposure and 6 minutes electrical assessment.

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4. TEST PROCEDURE:

4.1 Mounting:

Unless otherwise specified, the mated, torqued and wired connector shall be mounted on a fixture in accordance with figures 1, 2, and 3.

4.2 Gas flow:

The flame shall be natural gas at a flow rate equivalent to an input of 33,000 to 37,000 Btu/h during the entire test.

4.3 Exposure:

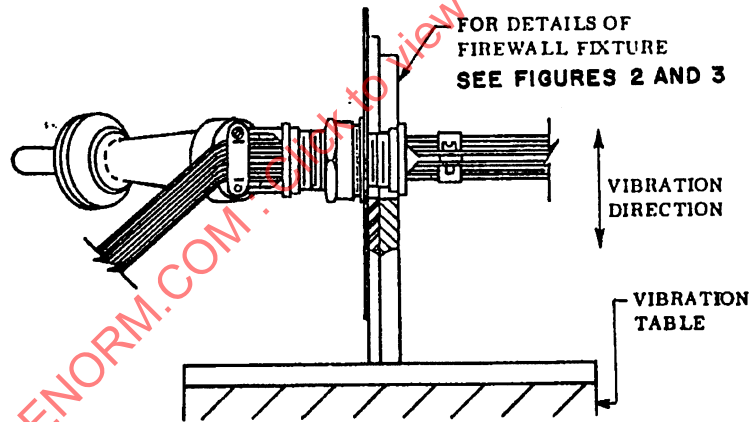
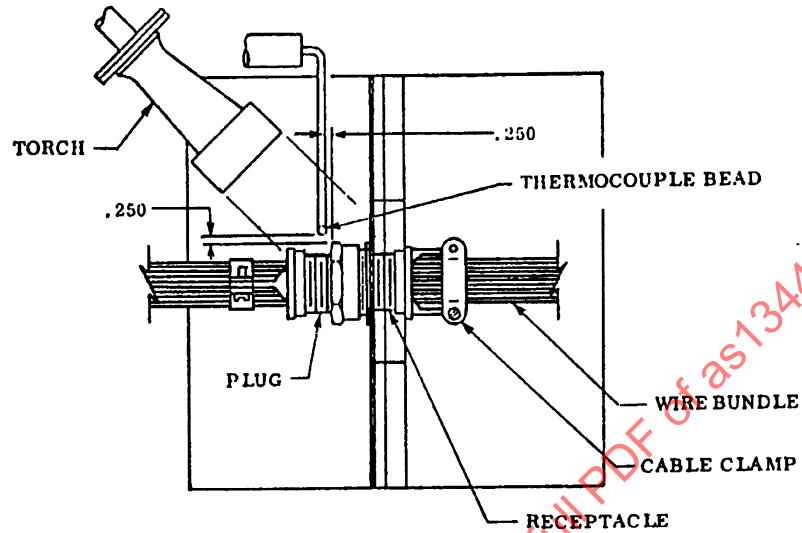
The connector assembly shall be exposed to a 1,093°C minimum flame (measured 0.250 inch from the assembly) for a period of 20 minutes. Simultaneously the assembly shall be vibrated continuously at 33 Hz with total excursion of 1/4 inch.

4.4 Test potential:

During the first 5 minutes of the test, unless otherwise specified, all contacts shall carry the dc current specified in table I without break in continuity. Electrical integrity shall be maintained through the first 6 minutes of test. During the sixth minute of the test, the potential specified in 2.c. shall be applied between adjacent contacts, and between contact and shell, and draw no more than 2 amperes.

TABLE I. Firewall test currents.

Contact size		DC test currents (amperes)
Mating end	Wire barrel end	
22	22	5.0
20	20	7.5
16	16	13
12	12	23
8	8	46
4	4	80
0	0	150



DIMENSIONS IN INCHES

FIGURE 1. Firewall test setup.

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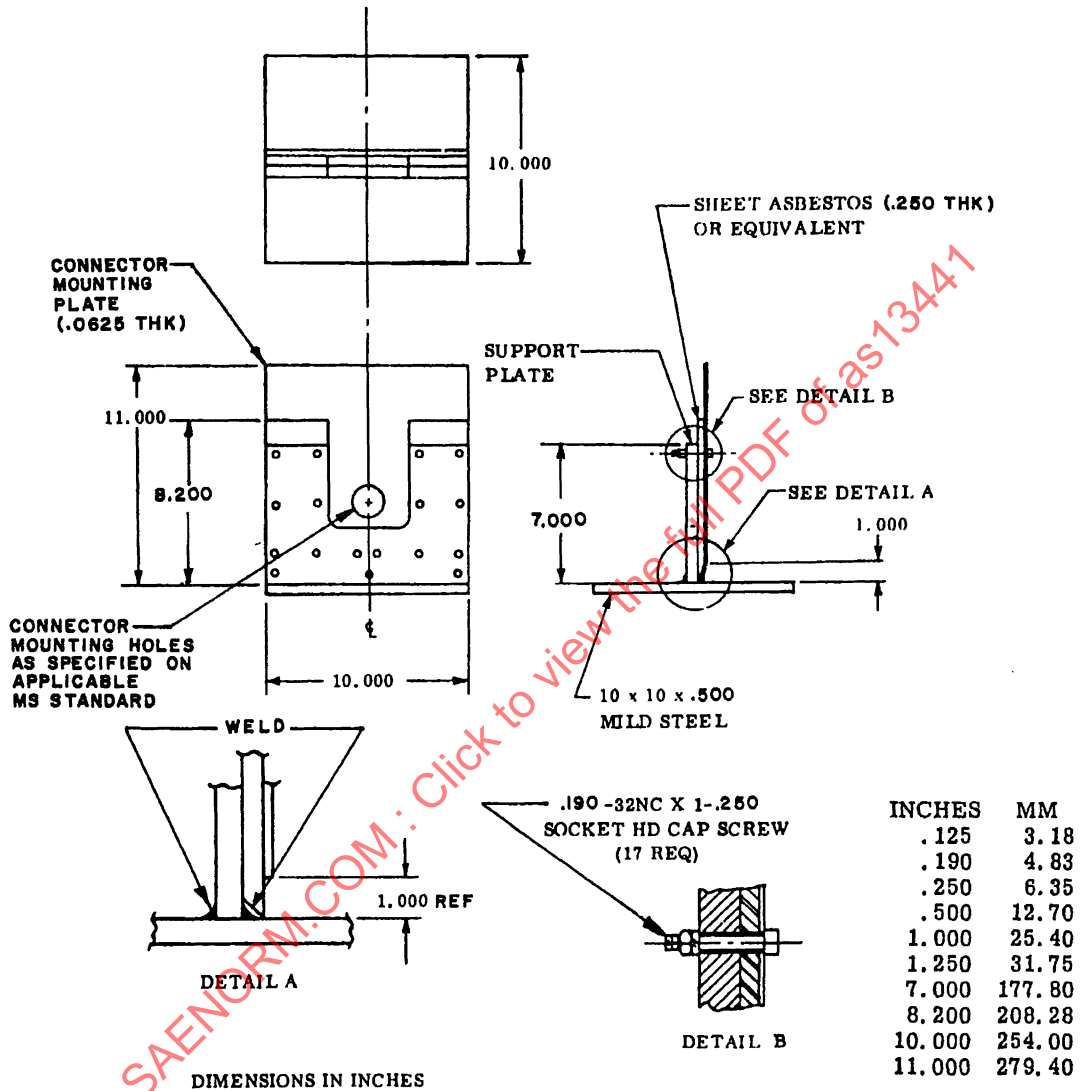
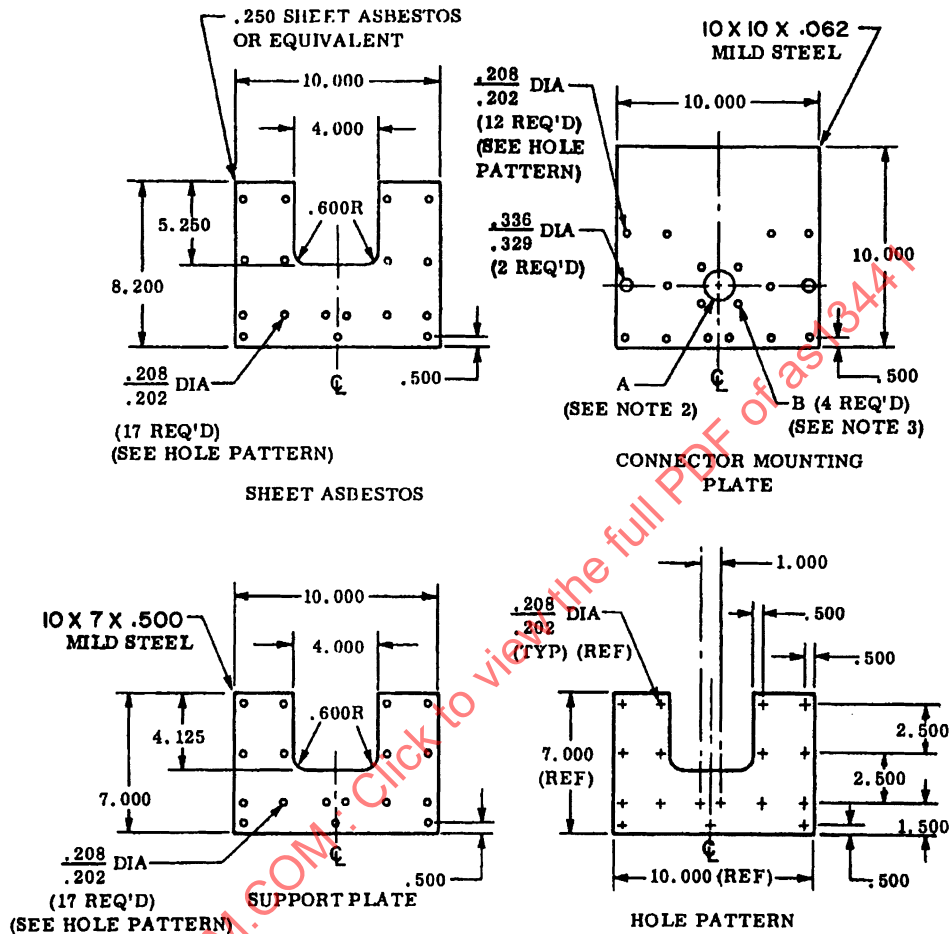


FIGURE 2. Firewall fixture assembly (typical).

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NOTES:

1. Dimensions are in inches. Unless otherwise specified, dimensions symmetrical about centerline.
2. A hole shall provide suitable clearance for the applicable connector.
3. B connector mounting holes shall be as specified on the applicable MS standard.

FIGURE 3. Firewall fixture details (typical).

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Special mounting, if applicable (see 4.1).
- b. Vibration frequency, if other than 33 Hz (see 4.3).
- c. Voltage and test currents, if other than herein (see table I and 4.4).
- d. Physical and electrical degradation acceptable after 20 minutes exposure and 6 minutes electrical assessment (see 4.4).

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METHOD 1011 ALTITUDE-LOW TEMPERATURE

1. PURPOSE:

The purpose of this test is to simulate actual service usage by inducing low temperatures, and applying the test voltage at simulated altitudes.

2. TEST EQUIPMENT:

2.1 Altitude chamber:

The altitude test chamber shall consist of a suitably sealed chamber with necessary vacuum pump equipment to maintain a reduced pressure of mercury as required to simulate at least 110,000 feet of altitude (5.74 torr). The chamber shall have provisions for electrical connections.

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a fully assembled, mated electrical connector with the specified number of contacts. Proper wire type, size, end preparation, sealing plugs, and other hardware shall be as specified. Connectors to be tested shall be free from foreign matter that could affect their operation. It shall be verified that wires provided for connection to connector being tested are electrically connected.

3.2 Preparation:

When cleaning is specified, the assembled connector shall be cleaned with a suitable solvent, dipped in distilled water while still moist with solvent, and conditioned in an air circulating oven at $35^{\circ} \pm 5^{\circ}\text{C}$ for 2 hours. When removed from the oven, parts shall be cooled in ambient conditions for 1/2 hour before the test. When specified, special preparations or conditions such as special test fixtures, reconnections, grounding, and isolation shall be required.

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4. TEST PROCEDURE:

4.1 Altitude-low temperature:

Wired, mated assembled connectors shall be conditioned in a dry oven at a temperature of $50^{\circ} \pm 5^{\circ}\text{C}$ for a minimum of 8 hours. The connectors shall be wired in a continuous series circuit and placed in a chamber that will simulate actual service usage with strain relief clamps installed.

- a. Reduce the chamber internal temperature to $-54^{\circ} \begin{smallmatrix} +0 \\ -4 \end{smallmatrix}^{\circ}\text{C}$ and maintain until the connector stabilizes.
- b. Reduce the chamber internal pressure to a maximum of 20 torr.
- c. Maintain the above temperature and pressure for 1 hour minimum.
- d. Unless otherwise specified, apply 625 V rms, 60 Hz between the connector shell and all contacts for 1 minute, minimum. A disruptive discharge occurring with the voltage applies 60 seconds or less shall be identified as a failure.
- e. With the test voltage removed, increase the chamber internal pressure and temperature to standard ambient conditions and allow the connector to stabilize.
- f. With the connector mated and the series circuit opened, subject the connectors to the dielectric withstanding voltage test method 3001, and the insulation resistance test method 3003 of this standard. The test voltage shall be applied for 5 seconds, minimum.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.
 - (1) Record chamber pressure, temperature and duration of each cycle.
 - (2) Record: Insulation resistance values and identity of each contact pair in test sample.
Dielectric withstanding test results and identify of each contact pair in test sample.
Connector visual examination.

6. SUMMARY:

The following details shall be specified in the individual connector specification:

- a. Wire type and size (see 3.1).
- b. Number of contacts and sealing plugs (see 3.1).
- c. Wire end preparation (location in chamber) (see 3.1).
- d. Connector accessories - Support hardware to be installed on connector specimen during test (see 3.1).
- e. Connector specimen preparation (see 3.2).
- f. Test voltages for altitude, dielectric withstanding voltage, maximum leakage current, and test voltage application time, if other than 5 seconds (see 4.1).

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METHOD 1012 FLAMMABILITY

1. PURPOSE:

The purpose of this test is to determine the connector's resistance to burning when exposed to a flame. Burning resistance is defined as the ability to not support or propagate combustion after an ignition source is removed. This test evaluates the time it takes for the flame of a burning connector to extinguish after removal of the applied flame, and the possibility of the spread of burning, as caused by burning droplets and after-glow. This test does not simulate any actual service application. It is intended to test a connector by itself in a condition that can readily be duplicated in any test laboratory.

2. TEST EQUIPMENT:

Test equipment shall be as follows:

- a. A test chamber shall be used that is protected from drafts but provided with means for venting fumes at the top and admitting an adequate supply of fresh air at the bottom. A chemistry hood with the exhaust fan turned off, or a metal box about 2 feet wide by 3 feet high by 2 feet deep, with an open front or a viewing window and holes for air intake and venting of fumes may be used.
- b. A Bunsen or Tirrill, or equivalent burner with a 1/4 inch inlet, a nominal bore of 3/8 inch, and a height of approximately 4 inches from the primary inlets to the top. The tube shall not be equipped with end attachments such as a stabilizer.
- c. A 20 mesh (20 openings per 25.4 mm), 0.017 inch (0.043 mm) diameter iron wire gauze, 5 inches (127 mm) square and/or a piece of flammable material, a layer of untreated surgical cotton, shall be positioned centrally and horizontally 12 inches below the bottom of the samples so that any burning particles or dripping material from the sample will fall on the flammable material.
- d. A supply of technical grade methane gas with suitable regulator and meter for uniform gas flow (natural gas having a heat content of approximately, $1000 \text{ BTU/Ft}^3 = 37 \times 10^6 \text{ J/m}^3$ has been found to provide similar results).
- e. A ring stand with clamps, or the equivalent, for horizontal and vertical positioning of the sample and the wire gauze. Mounting clamps shall be located so as not to act as heat sinks.
- f. Stop watch or other suitable timing device.
- g. Conditioning room or chamber capable of being maintained at $23^\circ \pm 2^\circ\text{C}$ ($73^\circ \pm 3.6^\circ\text{F}$) and a relative humidity of 50 ± 5 percent.

3. TEST SAMPLE:

3.1 Sample:

A test sample shall consist of an unmated connector with unwired contacts assembled. The test procedure requires a minimum of three test samples.

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3.2 Sample preparation:

Samples shall be thoroughly cleaned of oil, grease, dirt, and foreign material using a noncombustible solvent. The samples are to be conditioned for at least 48 hours at $23^{\circ} \pm 2^{\circ}\text{C}$ ($73^{\circ} \pm 3.6^{\circ}\text{F}$) and a relative humidity of 50 ± 5 percent to establish moisture equilibrium prior to testing.

4. TEST PROCEDURE:

Unless otherwise specified, the following applicable test procedure shall be complied with.

4.1 Test procedure:

The test procedure shall be as follows:

- a. Unless otherwise specified, testing shall be performed at standard ambient conditions.
- b. The test sample shall be held by a mounting clamp within the chamber with the wiring face vertical, the longest dimension of the wiring face in the vertical plane and parallel to, and a minimum of 6 inches from any side of the chamber.
- c. A piece of flammable material shall be positioned as specified in 2.c.
- d. The burner of 2.b. shall be adjusted to produce a blue flame. The temperature of the hottest portion of the flame, as measured with a thermocouple pyrometer, shall be not less than 843°C ($1,550^{\circ}\text{F}$).
- e. The burner flame shall be applied in accordance with the test conditions of table I, centrally at the lower edge of the test sample to the wiring face (back) for one set of test specimens and to the mating face (front) for another set of test specimens. It shall be positioned perpendicular to the sample, and at an angle of 30 degrees to the vertical plane of the sample. The flame shall not impinge on the clamps or other devices that hold the test sample, unless these devices are normally used in service to support the sample. The burner shall be positioned from the lower edge of the sample so that the end of the burner tube is $1/2$ the height of the flame (see figure 1).

TABLE I. Test conditions.

Condition	Flame height (inches)	Flame application time (seconds)	Number of applications of flame
A	1-1/2	60	1
B	1-1/2	30	1
C	3/4	10	1

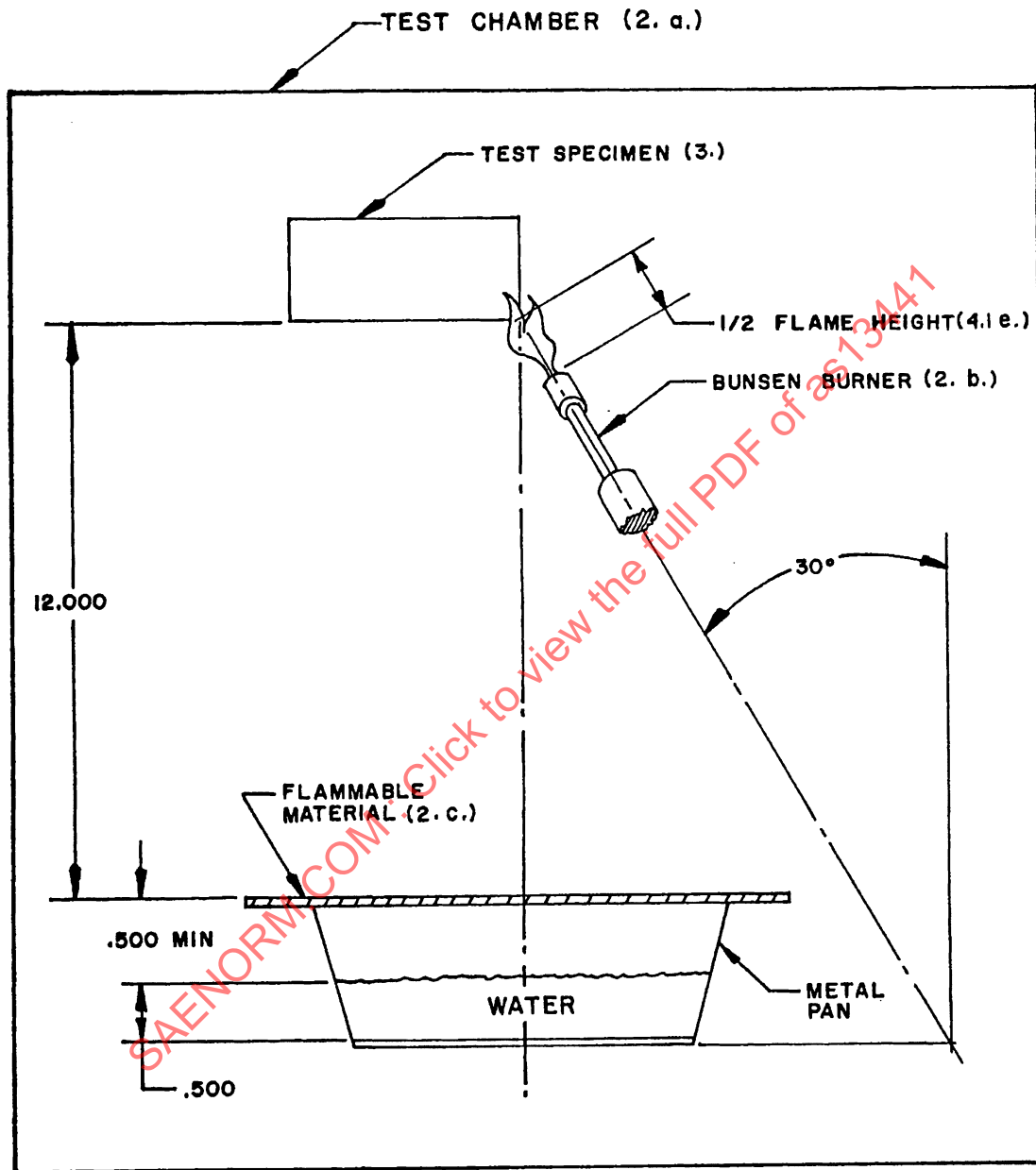


FIGURE 1. Flammability test setup.

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4.1 (Continued):

f. Unless otherwise specified, the following shall be the criteria for failure:

- (1) Burning after removal of applied flame shall extinguish within the time specified in table II.
- (2) After-glow shall extinguish within time specified in table II after burning ceases.
- (3) There shall be no dripping which shall cause the flammable material to ignite.
- (4) There shall be no violent burning or explosive type fire.

TABLE II. Flame and after-glow extinguishing time.

Conditions	Flame extinguishing time (seconds)	After-glow extinguishing time (seconds)
A	3	3
B	15	15
C	30*	*

*Flame plus glow time

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Record test condition and results of test procedure (see table I).
- c. Record values for:
 - (1) Time in seconds of burning of visible flame on the sample after removal of applied flame.
 - (2) Time in seconds of after-glow after extinction of flame.
- d. Record any dripping or falling of particles (burning or not burning) onto the flammable material or ignition of the flammable material.
- e. Record any violent explosion, sputtering, or other unusual type burning.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Test condition from table I, (see 4.1).
- b. Flame and after-glow extinguishing time, if other than the time specified in table II (see 4.1 f(1)).

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METHOD 1015 SIMULATED LIFE

1. PURPOSE:

The purpose of this test is to determine the adequacy of a connector to perform its operational function on land (general and heavy duty), aircraft, marine or underwater for the representative time period of application. This method shall not be used prior to low level measurement (method 3002).

2. TEST EQUIPMENT:

- a. Separate chambers may be used to conduct the tests noted for extreme temperature conditions. Chambers shall recover within 2 minutes after sample transfer. Room temperature shall be $21^{\circ} \pm 3^{\circ}\text{C}$ ($70^{\circ} \pm 5^{\circ}\text{F}$).
- b. Pressure vessels used to conduct the hydrostatic pressure tests shall be designed in accordance with the ASME Pressure Vessel Code.
- c. Vibration test equipment shall be specified.

3. TEST SAMPLE:

3.1 Sample:

A test sample shall consist of a mateable assembly.

- a. The test samples shall be visually examined for chips, cracks, tears, loose or missing parts, proper lubrication, proper assembly and mateability. Any sample which shows degradation, wear or any other physical defect shall be replaced before testing.
- b. The test samples shall be wired and assembled according to the manufacturer's or military recommendations. Maintenance aging preconditioning shall be conducted in accordance with prescribed procedures on all connectors having removable contacts and shall consist of one removal and insertion of all of the contacts in each plug and receptacle.
- c. Unless otherwise specified, the test samples shall be wired with conductor sizes matching the contact size in the connector. The wire type and configuration shall be that specified, or that recommended by the connector manufacturer when no military specification exists.
- d. Alternate contacts of the connector shall be wired in a series circuit (see figure 1) between a source and a load such that adjacent contacts are at opposite potential wherever possible. In the event that the connectors have more than one size contact, each contact size shall be wired as separate connectors.

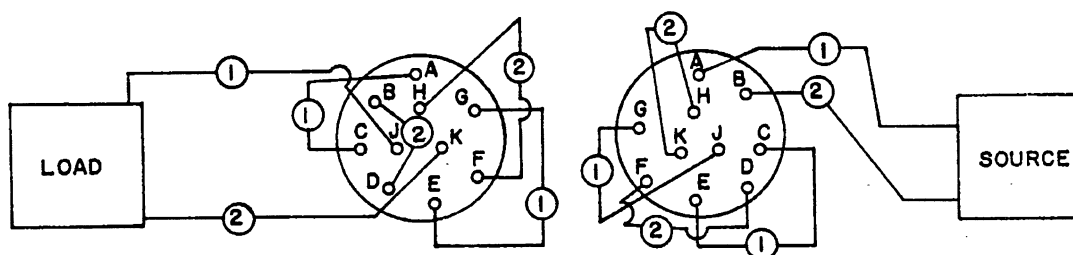


FIGURE 1. Wiring diagram typical.

3.1 (Continued):

- e. The mated, wired connectors shall be connected between a source and a load such that each circuit will be continuously carrying the maximum operating voltage. The operating voltage and rated current shall be that specified or that recommended by the manufacturer when no military specification exists.
- f. The test cycles described herein represent a particular area of connector application and are complete within themselves. Testing of one connector sample must be limited to one application category although this cycle may be run as many times as is required to provide the necessary number of unit hours.
- g. The criteria for failure of the test sample shall be determined by the following: The test samples shall operate the load specified in 3.1 e throughout the entire cycle. The total life of the connector shall then be the total number of unit hours the load is operated.

4. TEST PROCEDURE:

4.1 Test condition A (general duty land):

The test samples initially at room temperature shall be divided into two equal groups, placed in suitable chambers, and subjected to the following cycles:

- a. Group I.
 - (1) Initial chamber conditions to be $21^{\circ} \pm 3^{\circ}\text{C}$ ($70^{\circ} \pm 5^{\circ}\text{F}$), $50 \pm 5\%$ RH; maintain for 11 hours.
 - (2) Raise chamber conditions to $39^{\circ} \pm 3^{\circ}\text{C}$ ($100^{\circ} \pm 5^{\circ}\text{F}$), $80 \pm 5\%$ RH; rise to be accomplished over 1 hour period; maintain conditions for 11 hours.
 - (3) Return to initial sample condition (room temperature), with drop accomplished over a 1-hour period.

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4.1 (Continued):

b. Group II (see table I):

- (1) Initial chamber conditions to the specified limit of $T_1 \pm 3^\circ\text{C}$ ($\pm 5^\circ\text{F}$) with uncontrolled humidity; maintain for 10 hours.
- (2) Drop chamber conditions to the same applicable limit of $T_2 \pm 3^\circ\text{C}$ ($\pm 5^\circ\text{F}$) with uncontrolled humidity; drop to be accomplished over a 2-hour period; maintain condition for 10 hours.
- (3) Return to initial sample condition (room temperature with rise accomplished over a 2-hour period).

- c. After each group has completed one cycle as described above, the samples are unmated, remated, and switched so that group II goes through the group I cycle and group I goes through group II cycle. This provides a 48 hour cycle for each group. The transfer of samples shall be accomplished within the first hour of the first phase of each cycle. Provisions shall be made to remove power from the connectors while they are unmated and remated.

TABLE I. Temperature limits for use in test cycles.

Limit	Temperature T_1	Temperature T_2
I	74°C (165°F)	-55°C (-67°F)
II	105°C (221°F)	-55°C (-67°F)
III	150°C (302°F)	-55°C (-67°F)
IV	200°C (392°F)	-55°C (-67°F)

4.2 Test condition B (heavy duty):

The test samples initially at room temperature shall be divided into three groups, placed in suitable chambers and fixtures and subjected to the following cycles:

a. Group I.

- (1) Initial chamber conditions $21^\circ \pm 3^\circ\text{C}$ ($70^\circ \pm 5^\circ\text{F}$), 50 ± 5 percent RH; maintain for 11 hours.
- (2) Within 1 hour change chamber conditions to $38^\circ \pm 3^\circ\text{C}$ ($100^\circ \pm 5^\circ\text{F}$), 80 ± 5 percent RH; maintain for 11 hours.
- (3) Within 1 hour return chamber to initial conditions.

b. Group II.

- (1) Initial chamber conditions $74^\circ \pm 3^\circ\text{C}$ ($165^\circ \pm 5^\circ\text{F}$), humidity uncontrolled; maintain for 10 hours.
- (2) Within 2 hours change to $-55^\circ \pm 3^\circ\text{C}$ ($-67^\circ \pm 5^\circ\text{F}$), humidity uncontrolled; maintain for 10 hours.

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4.2 (Continued):

- c. Group III.
 - (1) Mount samples, for vibration, in plane specified.
 - (2) Vibrate as specified in continuous cycles for a duration of 24 hours.
- d. After each group of samples has completed the 24 hour phase, they shall be rotated and tested to the next higher phase (group I goes to group II, group II goes to group III, group III goes to group I). This is continued until each group of samples has been through each group of tests for a total of a 72 hour cycle. Each connector shall be unmated and remated during the transfer from group to group. Provisions shall be made to remove power from the connectors while they are unmated and remated.

4.3 Test condition C (aircraft):

The test samples shall be placed in a sealed chamber of such size that can readily be attached to a vibrator table. The wiring of the connectors (see 3.1 c.) between the load and the connector, and between the source and the connector shall be such as to maintain the sealed condition of the chamber. The chamber conditions shall provide the following cycle:

- a. Reduce chamber pressure to 1.3 ± 0.2 inHg. Maintain for 8 hours.
- b. Inject air, at atmospheric pressure, into the top of the chamber. The injected air shall be $88^\circ \pm 3^\circ\text{C}$ ($190^\circ \pm 5^\circ\text{F}$) and shall bubble through water at $88^\circ \pm 3^\circ\text{C}$ ($190^\circ \pm 5^\circ\text{F}$). Maintain for 4 hours at atmospheric pressure.
- c. During the last hour of phase 4.3 b. vibrate chamber and connector package through one complete cycle as specified. This provides a 12-hour cycle.

4.4 Test condition D (marine):

The test samples, initially at room temperature, shall be placed in suitable chambers and subjected to the following cycle:

- a. Initial chamber conditions $21^\circ \pm 3^\circ\text{C}$ ($70^\circ \pm 5^\circ\text{F}$), 50 ± 5 percent RH; maintain for 10 hours.
- b. Within 1 hour change chamber conditions to $49^\circ \pm 3^\circ\text{C}$ ($120^\circ \pm 5^\circ\text{F}$), 80 ± 5 percent RH; maintain for the remainder of a 10-hour period.
- c. Immediately upon completion of step 4.4 b. remove samples and submerge immediately in synthetic ocean water, (see ASTM D 1141-52) at room temperature. (Samples shall be removed as soon as entire connector has passed beneath the surface.)

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4.4 (Continued):

- d. Within 1/2 hour from completion of step 4.4 b, place samples in a chamber at $-55^{\circ} \pm 3^{\circ}\text{C}$ ($-67^{\circ} \pm 5^{\circ}\text{F}$); maintain for 2 hours.
- e. The test samples shall carry the load specified in 2. a. through the a., b., and d. steps of this cycle. At the end of the cycle, connectors shall be allowed to warm to room temperature and shall be unmated and remated. This provides a 23 hour cycle. Provisions shall be made to remove power from connectors while they are unmated and remated.

4.5 Test condition E (underwater):

The test samples initially at room temperature shall be divided into two groups and subjected to the following cycles:

- a. Group I.
 - (1) Initial chamber conditions $21^{\circ} \pm 3^{\circ}\text{C}$ ($70^{\circ} \pm 5^{\circ}\text{F}$), 50 ± 5 percent RH; maintain for 10 hours.
 - (2) Within 1 hour change chamber conditions to $49^{\circ} \pm 3^{\circ}\text{C}$ ($120^{\circ} \pm 5^{\circ}\text{F}$), 80 ± 5 percent RH; maintain for the remainder of a 10-hour period.
 - (3) Within 1/2 hour place samples in a chamber at $-55^{\circ} \pm 3^{\circ}\text{C}$ ($-67^{\circ} \pm 5^{\circ}\text{F}$); maintain for the remainder of a 4-hour period.
- b. Group II.
 - (1) Submerge samples in synthetic ocean water (see ASTM D 1141-52) at room temperature to the specified pressure limit of $P \pm 5$ percent (see table II); maintain for 23 hours.
 - (2) Remove samples from pressure vessel and allow 1 hour for air drying.
- c. After each group has completed one cycle as described above, the group II samples are unmated, remated and switched so group I samples go through group II test and group II samples go through group I tests to provide a 48 hour cycle. The transfer of samples shall be accomplished within the first hour of the first phase of each group. Provisions shall be provided to remove power from connectors while they are unmated and remated.

TABLE II. Pressure level.

Level	Pressure $P \pm 5\%$
	lb_f/in^2
I	1,000
II	3,500
III	10,000
IV	16,000

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification.

- a. Conductor size, if not matched to the contact size (see 3.1 c.).
- b. Wire type and configuration (see 3.1 c.).
- c. Operating voltage and rated current (see 3.1 e.).
- d. Number of unit cycles required (see 3.1 f.).
- e. Related test condition to be tested to (see 4.1, 4.2, 4.3, 4.4, and 4.5).
- f. Temperature limits (where applicable) (see table I and 4.1 b.).
- g. Pressure limits (where applicable) (see table II and 4.5 b(1)).
- h. Mounting for vibration (see 4.2 c.).

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METHOD 1016 FLUID IMMERSION

1. PURPOSE:

The purpose of this test is to determine the ability of an electrical connector to resist degradation when exposed to specific fluids with which the connector may come into contact during its service life. Typical degradation from this test might be:

- a. Swelling of any materials.
- b. Softening of any materials.
- c. Loss of seal or adhesive bonding between two bonded surfaces.
- d. Reduction of electrical properties.
- e. Discoloration of materials, finishes and marking, but this may not be considered detrimental.

2. TEST EQUIPMENT:

- a. Pyrex breakers (one for each test fluid) or similar stainless vessels to contain the various fluids in a sufficient quantity to completely immerse mated connectors, including wire, if appropriate.
- b. An air circulating oven capable of maintaining temperature within $\pm 3^{\circ}\text{C}$ of required setting. The maximum test temperature is 175°C (347°F).
- c. Immersion thermometer covering the range of 0° to $+150^{\circ}\text{C}$ (32° to 302°F).
- d. Table stoves or hot plates.
- e. Unless otherwise specified, test fluids shall be in accordance with table I. The fluids listed represent those in wide general use. When other special fluids are required for a particular connector, such as ethylene glycol, et al, they shall be specified. The test temperature shall be at least 10°C below the fluids' flash point.

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TABLE I. Test fluids and cycles.

Fluid	Test cycles				Number of cycles
	Unmated			Mated	
	Condition	Immerse $\pm 3^{\circ}\text{C}$	Drain	Over cure 6 hours $\pm 3^{\circ}\text{C}$	
(a) MIL-H-5606 (hydraulic fluid) (b) Hydraulic fluid <u>1</u> / (c) MIL-T-5624 (grade JP-5) (d) MIL-L-7808 (lubricating oil) (e) MIL-L-23699 (lubricating oil) (f) MIL-A-8243 <u>2</u> / (defrosting fluid) (g) MIL-C-87936 type I <u>2</u> / (diluted for cleaning)		5 minutes 85°C 85°C 25°C 120°C 120°C 65°C 65°C	1 hour minimum in air at room temperature	100°C 100°C 55°C 125°C 125°C 100°C 100°C	7
(h) MIL-G-3056, type I (gasoline) (i) Isopropyl alcohol per TT-I-735, grade A or B, mixed one part by volume with three parts by volume of mineral spirits per TT-T-291, type I or P-D-680, type I		5 minutes 25°C	24 hours in free air		5
(j) Coolant-dielectric fluid synthetic silicate ester base <u>3</u> /	30 minutes in oven at 175°C	1 $\pm$ 0.1 minute in fluid at room temperature	1 hour minimum in air at room temperature		1

1/ M2-V Chevron oil ST0145LB0001 or approved equivalent.

2/ Mated connectors.

3/ MIL-C-47220 or Coolanol 25 or approved equivalent.

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3. TEST SAMPLES:

A mateable connector assembly as described below is required for each fluid tested.

- a. Wired or unwired - If required, the connector shall be wired as specified. The wire shall be the minimum size O.D. for which the connector was designed and the wire length shall be sufficient to enable the connector to be immersed without the wire ends becoming contaminated with fluid. Teflon TFE insulated wire is recommended because it is fluid resistant and capable of withstanding the test temperatures. When sealing plugs are supplied for use in unwired contact cavities, they should be installed in place of wire in approximately 10 percent of contact cavities.
- b. Mated - When the connectors are required to be maintained in a mated condition for test, the coupling and locking mechanism that is an integral part of the connector design shall be used. If connectors do not have a coupling and locking mechanism, a suitable method of clamping them together must be detailed by the testing agency and must be capable of fitting within the fluid containers and withstand the fluids and test temperatures.
- c. Identification - The connectors shall be suitably identified both as to mating assemblies and with the fluid in which they are to be immersed (1P-a for plug and 1R-a for receptacle in fluid (a)). All wires on each plug and receptacle shall be identified with the corresponding contact designation. All identification marks shall be durable enough to complete the tests without loss of clarity (metal tags for connectors, numbered sleeves or flags for wires).

4. TEST PROCEDURE:

4.1 Initial mating and unmating forces:

The torques or forces required to mate and unmate each connector assembly shall be measured and recorded. Refer to method 2013 for test procedures.

4.2 Fluid immersion:

Before proceeding with the fluid immersion, the specified test fluids shall be preheated until temperature has stabilized.

4.3 Cycle:

A cycle shall be as defined in table I. Transition time between steady state conditions shall be 2 minutes, maximum. Steady state conditions shall be ± 1 minute unless noted. Connectors shall be drained by gravity during drainage portions of cycle. After oven cure, remove connectors and allow to stabilize at room temperature for a minimum of 1 hour.

4.4 Final mating and unmating forces:

The torque or the forces required to mate and unmate shall be measured and recorded. The test procedure shall be in accordance with method 2013.

5. DOCUMENTATION:

The data sheets for the test shall contain the following:

- a. Title of test, date and name of operator
- b. Sample description and identification - include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test fluids used.
- e. Observations, measurements and results arranged in a "before" and "after" style, preferably using one sheet for each connector pair.

6. SUMMARY:

The following details shall be specified in the individual specification.

- a. Test fluids, if other than table I (see 2.e).
- b. Forces or torque requirements (see 4.1).
- c. Final mating and unmating forces (see 4.4).

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METHOD 1017 POROSITY

1. PURPOSE:

The purpose of this procedure is to determine the magnitude of porosity as well as other surface defects inherent in application of gold contact finishes. It is the intent that the defined method be used as an evaluation technique for the acceptability of gold contact finishes. The method described herein has been selected on the basis of simplicity of equipment, setup and operation. This procedure applies only to gold finished with or without underplates applied to copper or nickel base alloy contacts.

2. TEST EQUIPMENT:

Test equipment and materials shall be as follows.

- a. The desiccator or sample chamber shall be constructed from inert materials, having the capability of being sealed with an enclosed volume of 1 to 15 liters.
- b. The size of the desiccator shall be such that no more than 10 in³ (164 cm³) of air space shall be available per 1 in² (6.5 cm²) of nitric acid surface area.
- c. Concentrated Reagent Grade nitric acid: 70 ±1 percent HNO₃.
- d. Sample holder. The holding fixture shall be of inert material, capable of maintaining the measured area in a vertical plane. The fixture shall be constructed in such a manner to assure that the test samples shall be not closer than 1 inch (.25 mm) from the wall of the desiccator and 3 inches (.76 mm) from the solution surface. Adjacent contacts shall be not closer than 0.4 inch (10 mm) from each other. The fixture shall not prohibit the measurement area from being exposed to the test environment. The holding fixture shall not cover more than 50 percent of the cross-sectional area of the test chamber.
- e. Optical microscope capable of 10X magnification.
- f. Collimated incandescent light source capable of oblique angle 15° to 30° to the measurement surface.

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3. TEST SAMPLES:

The number of samples to be tested shall be specified in the individual specification.

3.1 Sample preparation (measurement area):

Prior to being inserted into the test chamber, contacts shall be prepared so that the measurement areas may be easily viewed through a microscope and exposed to the acid fumes.

- a. Contacts shall be tested prior to assembly of shrouds, hoods, or other accessories. During the preparation stage, care shall be taken not to touch or damage the measurement area.
- b. All socket contacts including tulip, box contacts, and multiple tine contacts shall be opened to expose the measurement area (see figure 6). In case of multiple tine contacts, the number of adjacent tines opened or removed shall be as shown in table I.

TABLE I. Samples.

No. of tines per contact	No. of tines to be opened or removed and disregarded
2	1
3	1
4	2
5	2
6	3

3.2 Sample preparation (cleaning):

Cleaning of test specimens prior to testing.

- a. A solvent that will remove any organic film that may be present, such as lubricants or fingerprints, shall be used to clean the test specimens. A suitable cleaning solution is one of the chlorinated or fluorinated solvents. Samples shall then be washed in running distilled or deionized water.
- b. Contacts shall be rinsed in unused reagent grade isopropyl alcohol and dried.
- c. After rinsing, the samples shall be air dried until the alcohol has completely evaporated. If an air blast is used, such air shall be dry and clean. Do not contact samples with bare fingers.
- d. After cleaning, samples shall be visually inspected under 10X magnification for evidence of particulate matter remaining on the surface. If particulates remain on the surface, samples shall be recleaned per a through c.
- e. Materials which absorb vapors (i.e. paper tags, string, tape, etc.) shall be removed from the samples prior to cleaning and placing samples into the desiccator.
- f. Contacts shall be placed in a suitable holding fixture of inert material and shall be held so as to maintain the measurement area in a vertical plane. The test fixture shall be constructed in such a manner to assure that the test samples shall be not closer than 1 inch (.25 mm) from the wall of the desiccator and 3 inches (.76 mm) from the solution surface. Adjacent contacts shall be not closer than 0.4 inch (10 mm) from each other. The fixture shall not prohibit the measurement area from being exposed to the test environment. The holding fixture shall not cover more than 50 percent of the cross-sectional area of the test chamber.

4. TEST PROCEDURE:

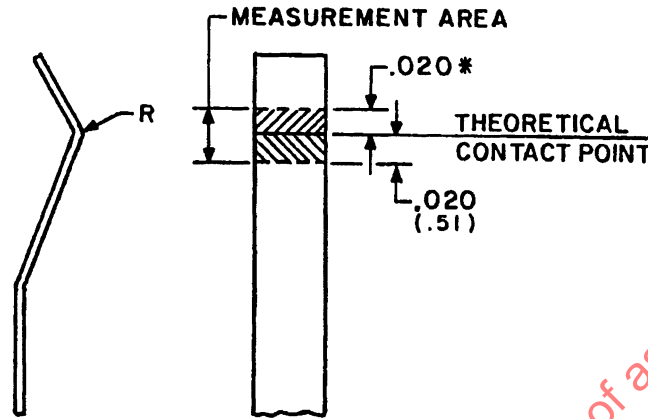
CAUTION: Perform all work in an exhaust hood since the vapors given off are toxic. Chemical goggles completely enclosing eyes shall be worn. Normal precautions in handling corrosive acids should be observed. It is recommended that the exhaust hood be of such a design as to minimize transversing air currents to prevent purging of the desiccator of the acid fumes during the test.

- a. The desiccator and test samples shall be in an environment with a relative humidity less than 60 percent and a temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ during desiccator equalization, and during insertion and removal of the samples into the desiccator.
- b. Prior to each test, desiccators, sample chambers, and other equipment shall be thoroughly cleaned and dried to remove any contaminant or residue remaining from past use.
- c. Place in the desiccator 50 to 100 ml of acid per liter of the desiccator volume. Each test shall require fresh unused acid.
- d. Allow the desiccator to stand for 30 ± 5 minutes at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ (closed desiccator).
- e. Contacts shall then be placed in the desiccator and exposed for 75 ± 10 minutes at $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$. The lid shall be removed as briefly as possible when inserting test samples.
- f. The fixture with the contacts shall then be removed and immediately placed in an air circulating oven for 10 to 15 minutes at $125^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- g. The fixture shall be removed from the oven and allowed to cool to room ambient. Contacts shall be examined within 1 hour of exposure. Each measurement area shall be examined for corrosion products at 10X magnification. Proper illumination is critical in the examination process. A recommended illumination technique is the use of a collimated incandescent light source at an oblique angle 15° to 30° to the measurement surface.

4.1 Measurement area:

The surface to be examined shall be defined as the measurement area. Unless otherwise specified, the following definitions of the measurement area apply.

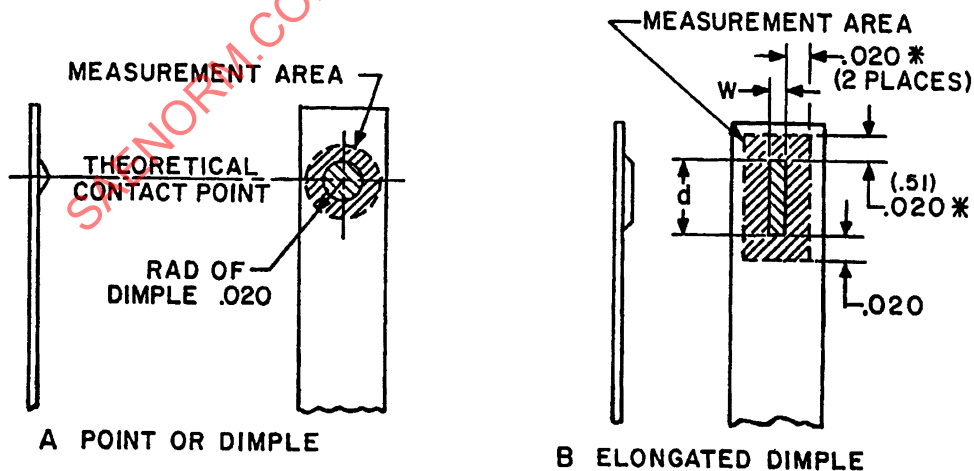
- 4.1.1 Line contact: The measurement area of a line contact (see figure 1) is defined as 0.020 inch (0.51 mm) on each side of the theoretical contact point tangent to point R and shall include the total width of the contact.



* Or to the edge of the contact, whichever is less.

FIGURE 1. Line contact.

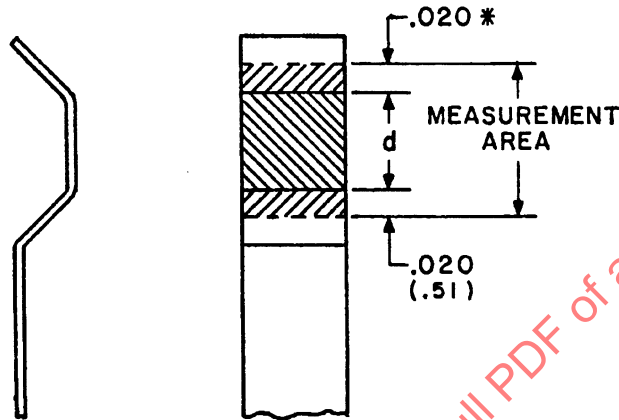
4.1.2 Point contact: A point contact (see figure 2) as established by a dimple or elongated dimple shall be defined by the dimple radius at its base plus 0.020 inch (0.51 mm). The measurement area of an elongated dimple shall be defined by its length 'd' and width 'w' as measured at its base plus 0.020 inch (0.51 mm) surrounding this surface.



* Or to the edge of the contact, whichever is less.

FIGURE 2. Point contact.

- 4.1.3 Surface contact: The measurement area of a surface contact (see figure 3) shall include length 'd' plus 0.020 inch (0.51 mm) at each end and the total width of the contact.



* Or to the edge of the contact, whichever is less.

FIGURE 3. Surface contact.

- 4.1.4 Round and square pin: The measurement area of a round and square pin (see figure 4) shall be defined as equal to the maximum wipe distance plus 0.020 inch (0.51 mm) with the initial area starting at a point where the lead-in chamfer or radius blends into the shank of the pin. Unless otherwise specified, the measurement area shall include the total diameter of a round pin and all sides of a square pin.

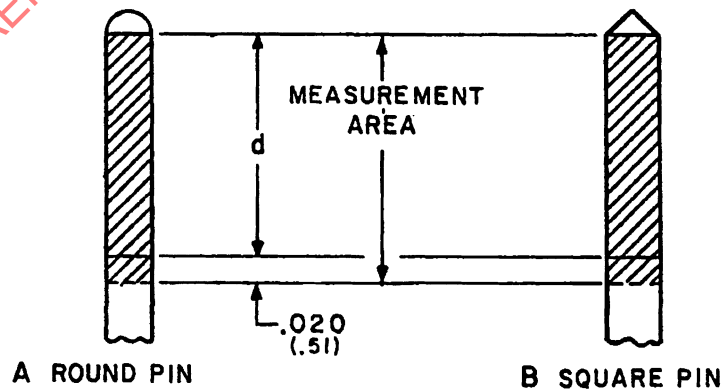


FIGURE 4. Pin.

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4.1.5 Multiple tine socket contact: The measurement area of a multiple tine socket contact (see figures 5 and 6) shall be defined as a region 0.020 inch (0.51 mm) on both sides of the circumferential line of contact.

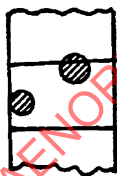
4.1.6 Hermaphroditic contact: The measurement area of a hermaphroditic contact mating coined surface (see figure 7) shall be defined as the entire coined area plus .020 inch (0.51 mm) on all sides.

4.2 Corrosion product definition:

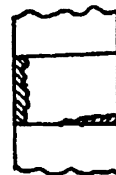
- a. A corrosion product is defined as being usually circular in shape and protruding or lying upon the plated surface.
- b. The size of a corrosion product shall be defined by the major diameter with the longest straight line or chord that can be passed through the corrosion product.
- c. If blisters on the plating surface are observed as a result of the exposure, they shall be counted as a corrosion product as defined above.

4.3 Corrosion product count:

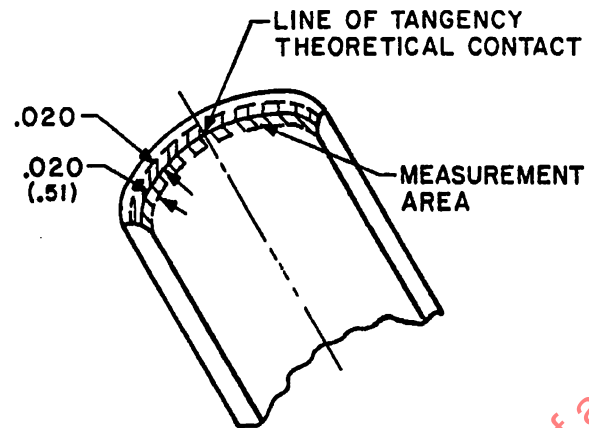
- a. A corrosion product shall be measured and counted when at least 3/4 of the corrosion product falls within the specified measurement area.
- b. Corrosion products which initiate outside the measurement area but fall within it which are irregular in shape shall not be counted.



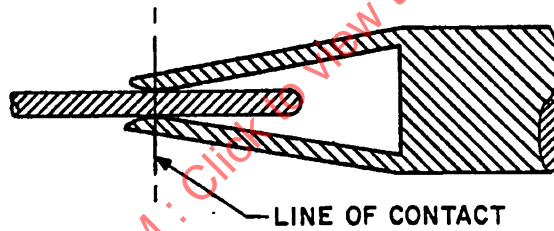
To be counted



Not to be counted if evidence of corrosion products exist on edges or are continuous outside of the measurement zone.



A SOCKET CONTACT TINE PORTION



B LONGITUDINAL SECTION

FIGURE 5. Contact, multiple tine, socket.

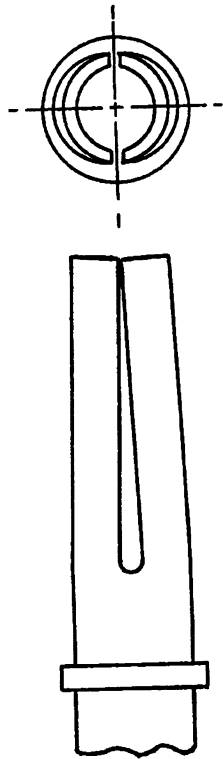


FIGURE 6. Double or multiple tine contact, socket.

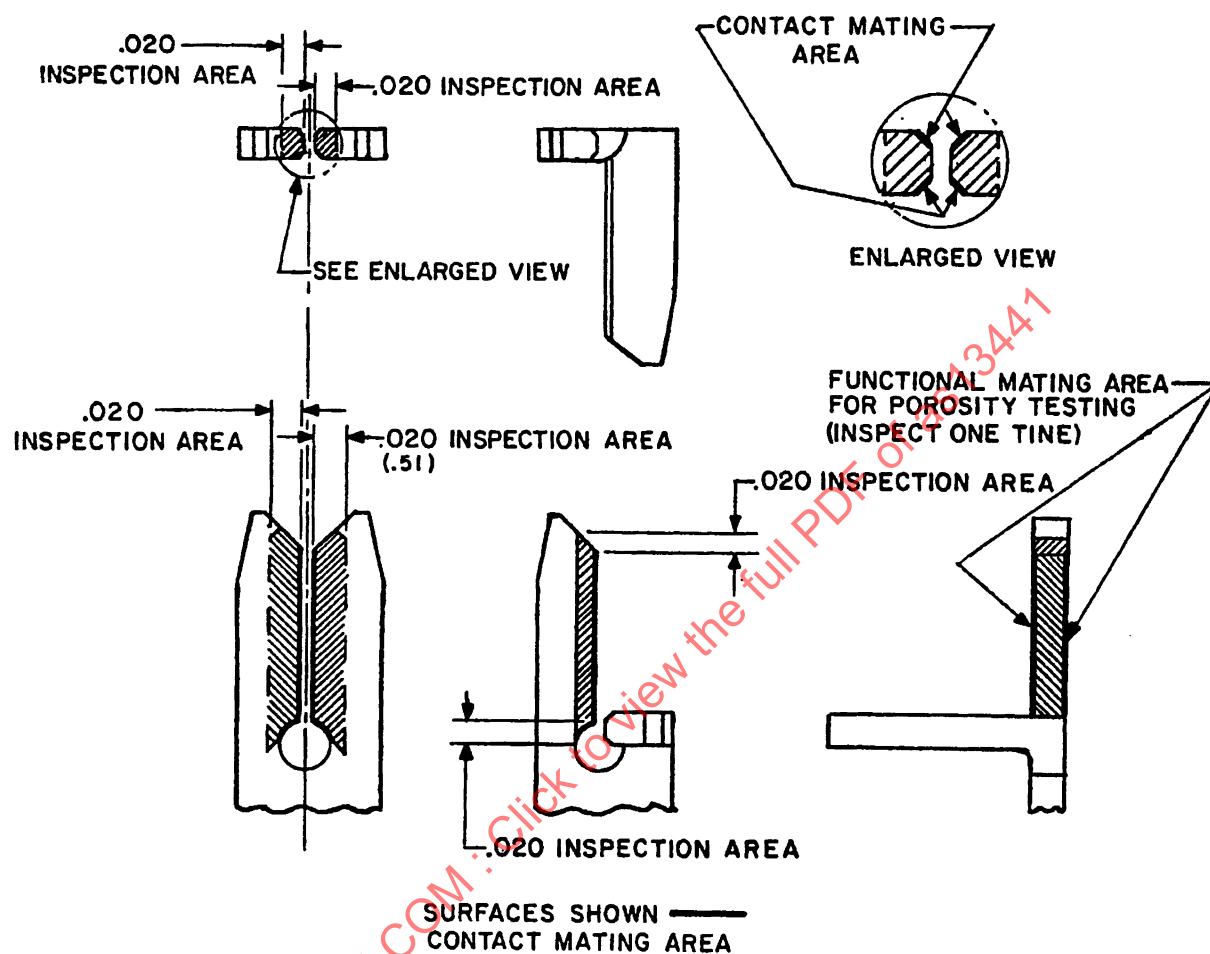


FIGURE 7. Hermaphroditic contact.

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4.3 (Continued):

- c. Corrosion products, as defined in 4.2 shall be sized and counted in accordance with table II when initiating within the specified measurement areas.

TABLE II. Corrosion products.

Corrosion products size	Assigned count
Diameter up to and including 0.002 inch (0.05 mm)	0
> 0.002 inch (0.05 mm) and < 0.020 inch (0.51 mm) < diameter	1
Diameter $\geq$ 0.020 inch (0.51 mm)	2
Coverage in excess of 50 percent of measurement area regardless of size and point of initiation	20

- d. The average corrosion count for a sample lot shall be determined by adding all of the assigned counts and dividing by the total number of measurement areas tested.

4.4 Recommended acceptance criteria:

Unless otherwise specified, the recommended average corrosion count for the sample lot shall be 1.0 or less.

5. DOCUMENTATION:

Data sheets shall contain the following:

- a. Title of test, date, and name of operator.
- b. Sample description: Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the detail specifications:

- a. Number of samples.
- b. Average corrosion count allowed.
- c. Measurement area.

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6.1 Notes:

- a. No conclusions relative to oxide or film growth based on discoloration should be made relative to the reliability of the product. The method described herein does not represent harsh environments found in normal operating areas. This method has been developed to detect pores and should not be construed as an accelerated life test.
- b. This test method is valid for gold or gold alloy (75 percent or more of gold) surfaces applied to copper or nickel base alloy contacts.
- c. It is recommended that a 2 to 3 inch length of bare copper wire be placed with the samples to serve as an indicator that proper reactions occur. However, this test procedure is not valid for underplates which are inert to nitric acid vapors (such as 65-35 tin nickel).
- d. This test is not recommended for durability (wear) evaluation of contact surfaces.
- e. This procedure is not intended to eliminate the need for specifying gold thickness in the measurement area in the detail product specification.
- f. This test shall be classified as a destructive test.
- g. Except as noted in 6.1h this procedure is valid when testing loose contacts prior to assembly to their plastic housing as well as those conditions specified in paragraph 3.1a. If this test method is to be used as an incoming inspection procedure, it is recommended that such action be negotiated between manufacturer and user.
- h. Pins which are molded in their insert may be exposed to this procedure if the assembly is unshrouded and it has been determined that no side effects exist relative to the plastic used.
- i. This procedure is not to be substituted for performance requirements, and is to be used to evaluate the integrity of contact surfaces. For correlation with contact performance, this procedure in combination with performance requirements as specified in the detail specifications should be used.
- j. This test procedure was developed for qualification and periodic requalification purposes for contacts utilizing localized gold contact finishes.
- k. This test procedure is recommended for evaluating gold contact finishes of less than 50 microinches thick.
- l. For military purposes, this test procedure is recommended for qualification/requalification of gold contact finishes less than 50 microinches thick.

CLASS 2000
MECHANICAL TESTS

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METHOD 2001.1 CONTACT AXIAL CONCENTRICITY

1. PURPOSE:

The purpose of this test is to determine the straightness of contacts by measuring a total indicator reading (TIR) value. Axial concentricity can be measured after crimping to determine axial deformation.

2. TEST EQUIPMENT:

2.1 Axial deformation:

- a. Ground precision chuck.
- b. Dial gage indicator, .0005-inch increments with a 3/32-inch diameter tip, spring loaded.
- c. Stand (for holding chuck and indicator in proper position).

3. TEST SAMPLE:

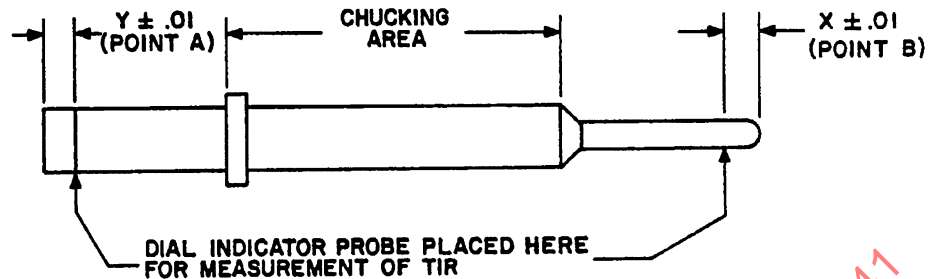
Sample shall consist of a contact or a contact crimped to a wire.

4. TEST PROCEDURE:

4.1 The test procedure shall be as follows:

- a. "Run-out" of chuck shall be less than .0005 inch when measured on a steel gage pin (approximately 1/16-inch diameter), 1/2 inch away from chuck face.
- b. Chuck the contact in the area shown in figure 1.
- c. Position the dial indicator to the measurement points shown in figure 1.
- d. Turn the chuck through 360 degrees and record the difference between the maximum and minimum value at each measurement point; this is the TIR.

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NOTE: For size 12 and larger pins, $X = 1$ pin diameter
 $Y = .05$ inch

For pins smaller than size 12, $X = 2$ pin diameters
 $Y = 1/2$ the distance from the rear of the wire barrel to the beginning of the crimp indent.

FIGURE 1. Axial concentricity (TIR) measurement (typical).

5. DOCUMENTATION:

Data sheets contain the following:

- Title of test, date, and name of operator.
- Sample description - Include fixture, if applicable.
- Test equipment used and date of latest calibration.
- Values and observations.

6. SUMMARY:

The following detail shall be specified in the individual specification:

- Maximum allowable TIR values for samples (see 4.1 d.).

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METHOD 2002.1 MAINTENANCE AGING

1. PURPOSE:

1.1 Purpose:

The purpose of this test is to determine the degradation to the test connector when subjected to stresses similar to those which may be expected by inserting and removing contacts during maintenance. Degradation to the connector shall be measured by subsequent tests as follows:

- a. Contact retention values (force in pounds and metric equivalents).
- b. Insertion and removal forces (force in pounds and metric equivalents), refer to method 2012 for insertion and removal force measurement technique.
- c. If the connector is environmental type, visual inspection for damage to wire seals shall be done before altitude immersion or moisture resistance test.
- d. Any other tests that are necessary to evaluate the effect of the maintenance aging shall be specified. The same tests are performed before and after a conditioning procedure.

1.2 Application:

This procedure applies only to connector assemblies containing removable contacts and shall be used when a connector is to be stressed in the areas of contact retention and conductor sealing.

2. TEST EQUIPMENT:

Test equipment shall consist of the insertion and removal tools specified. A force gage of suitable range for the forces being measured, so that the reading shall lie in the middle 50 percent of the scale, where practical, with a nominal accuracy of ± 2 percent.

3. TEST SAMPLE:

The sample shall consist of a connector with all contacts installed, wired with wire types, gages and lengths, as specified.

4. TEST PROCEDURE:

4.1 Contact insertion and removal:

If applicable, loosen or remove hardware to permit removal and reinsertion of contacts. (Hardware shall remain loose or be removed during the specified number of insertions and removals of the contacts.) Unless otherwise specified, there shall be 10 insertion and removal cycles. The force required to insert and remove each contact in and from the connector shall be measured during the first and final maintenance aging cycles in accordance with method 2012.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Degradation allowed due to maintenance aging test (see 1.1).
- b. Design or type of insertion and withdrawal tools (see 2).
- c. Installation requirements (see 3).
- d. Number of test cycles, if other than 10 (see 4.1).
- e. Requirement of insertion and removal forces (see 4.1).

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METHOD 2003.1 CRIMP TENSILE STRENGTH

1. PURPOSE:

The purpose of this test is to determine the mechanical strength of the crimped contact to conductor joint. The values obtained give an indication as to the relative strength of the joint.

2. TEST EQUIPMENT:

The testing device shall require the following:

- a. Clamps, jaws, or other means, that will not distort the contact in the crimp area, to hold the contact and conductor.
- b. A mechanism to separate the holding devices at a constant rate of speed of $1 \pm 1/4$ inch per minute.
- c. A gage to register the amount of tension being exerted between the contact and conductor.

3. TEST SAMPLE:

A test sample shall consist of an identified contact and a 2-inch minimum conductor crimped together with the specified tool.

4. TEST PROCEDURE:

- 4.1 Place crimped sample into test fixture of tensile tester.
- 4.2 Activate tensile equipment so that an axial force is exerted at a speed of $1 \pm 1/4$ inch per minute separating contact and conductor.
- 4.3 Record tensile data and examine sample.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Identification of contact, wire, and crimp tool used (including tool selector position, if applicable).
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations:
 - (1) Tensile data.
 - (2) Type of separation shall be recorded in accordance with the following modes:
 - (a) Slip (pull out).
 - (b) Conductor broken in crimp area (some or all).
 - (c) Contact broken in crimp area (some or all).
 - (d) Conductor broken outside crimp area (not in gripping area).
 - (e) Contact broken outside of crimp area.
 - (f) Other (define).

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Quantity and identify of contact-conductor assemblies required for test (see 3.).
- b. Identity of crimp tool to be used and applicable controls and instructions (see 3.).
- c. Minimum tensile strength requirements (see 4.3).

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METHOD 2004.1 SHOCK (SPECIFIED PULSE)

1. PURPOSE:

This test is conducted to determine the suitability of connectors and connector assemblies when subjected to shocks such as those expected from rough handling, transportation, and military operations.

2. TEST EQUIPMENT:

2.1 Shock machine:

The shock machine utilized shall be capable of producing the specified input shock pulse as shown on figures 1 or 2, as applicable. The shock machine may be of the free fall, resilient rebound, nonresilient, hydraulic, compressed gas, or other activating types.

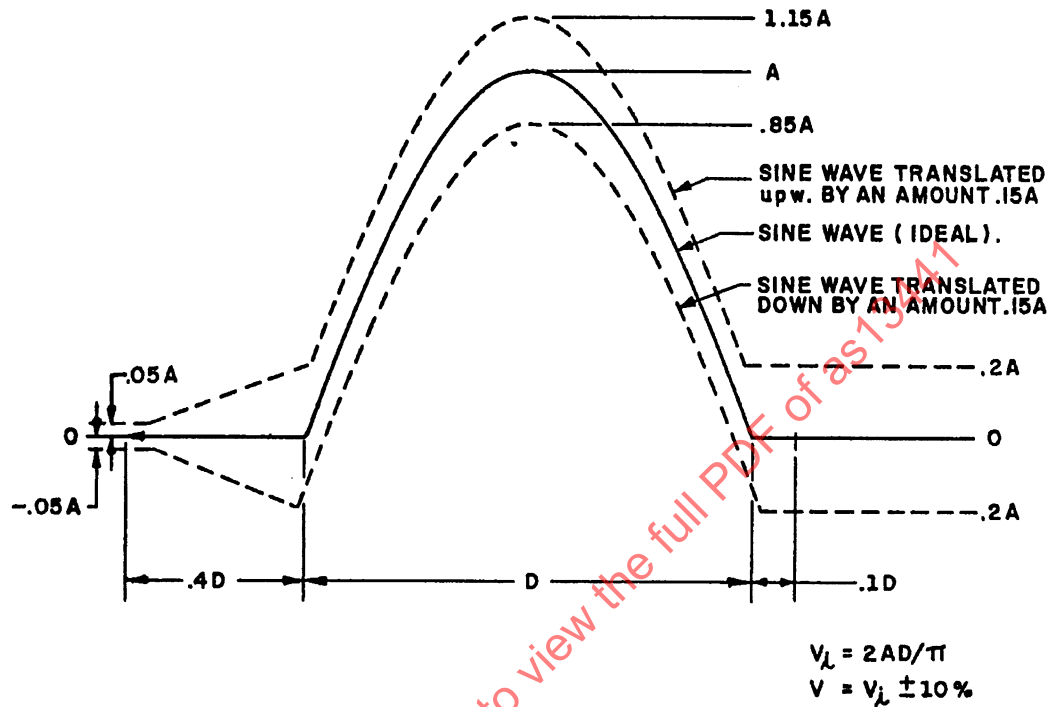
- 2.1.1 Shock machine calibration: The actual test item, or a dummy load which may be either a rejected item or a rigid dummy mass, may be used to calibrate the shock machine. (When a rigid dummy mass is used, it shall have the same center of gravity and the same mass as that of the test item and shall be installed in a manner similar to that intended for the test item.) The shock machine shall then be calibrated for conformance with the specified waveform. Two consecutive shock applications to the calibration load shall produce waveforms which fall within the tolerance envelope given on figures 1 or 2. The calibration load shall then be removed and the shock test performed on the actual test item. If all conditions remain the same, other than the substitution of the test item for the calibration load, the calibration shall then be considered to have met the requirements of the waveform.

NOTE: It is not implied that the waveform generated by the shock machine will be the same when the actual test item is used instead of the calibration load. However, the resulting waveform is considered satisfactory if the waveform with the calibration load was satisfactory.

2.2 Instrumentation:

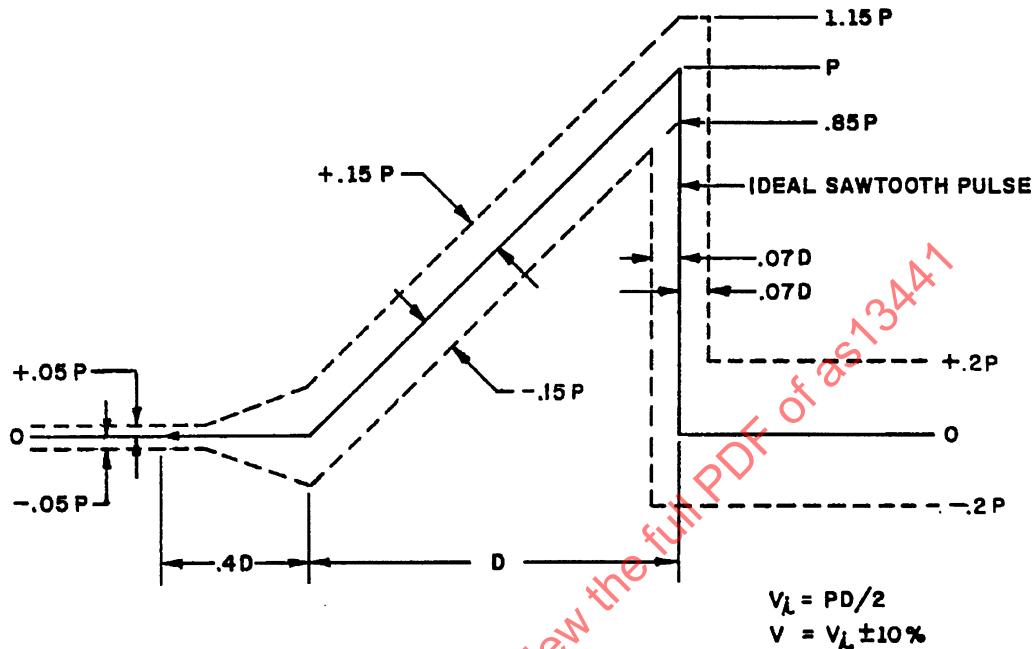
In order to meet the tolerance requirements of the test procedure, the instrumentation used to measure the input shock shall have the characteristics specified in the following.

- 2.2.1 Frequency response: The frequency response of the complete measuring system, including the transducer through the readout instrument, shall be as specified on figure 3.

**NOTE:**

The oscillogram should include a time about 3D long with the pulse located approximately in the center. The integration to determine velocity change should extend from .4D before the pulse to .1D beyond the pulse. The acceleration amplitude of the ideal half sine pulse is A and its duration is D. Any measured acceleration pulse which can be contained between the broken line boundaries is a nominal half sine pulse of nominal amplitude A and nominal duration D. The velocity-change associated with the measured acceleration pulse is V.

FIGURE 1. Tolerances for half sine shock pulse.



NOTE:

The oscillogram should include a time about 3D long with the pulse approximately in the center. The integration to determine the velocity change should extend from .4D before the pulse to .1D beyond the pulse. The peak acceleration magnitude of the sawtooth pulse is P and its duration is D. Any measured acceleration pulse which can be contained between the broken line boundaries is a nominal terminal-peak sawtooth pulse of nominal peak value, P, and nominal duration, D. The velocity-change associated with the measured acceleration pulse is V.

FIGURE 2. Tolerances for terminal-peak sawtooth shock pulse.

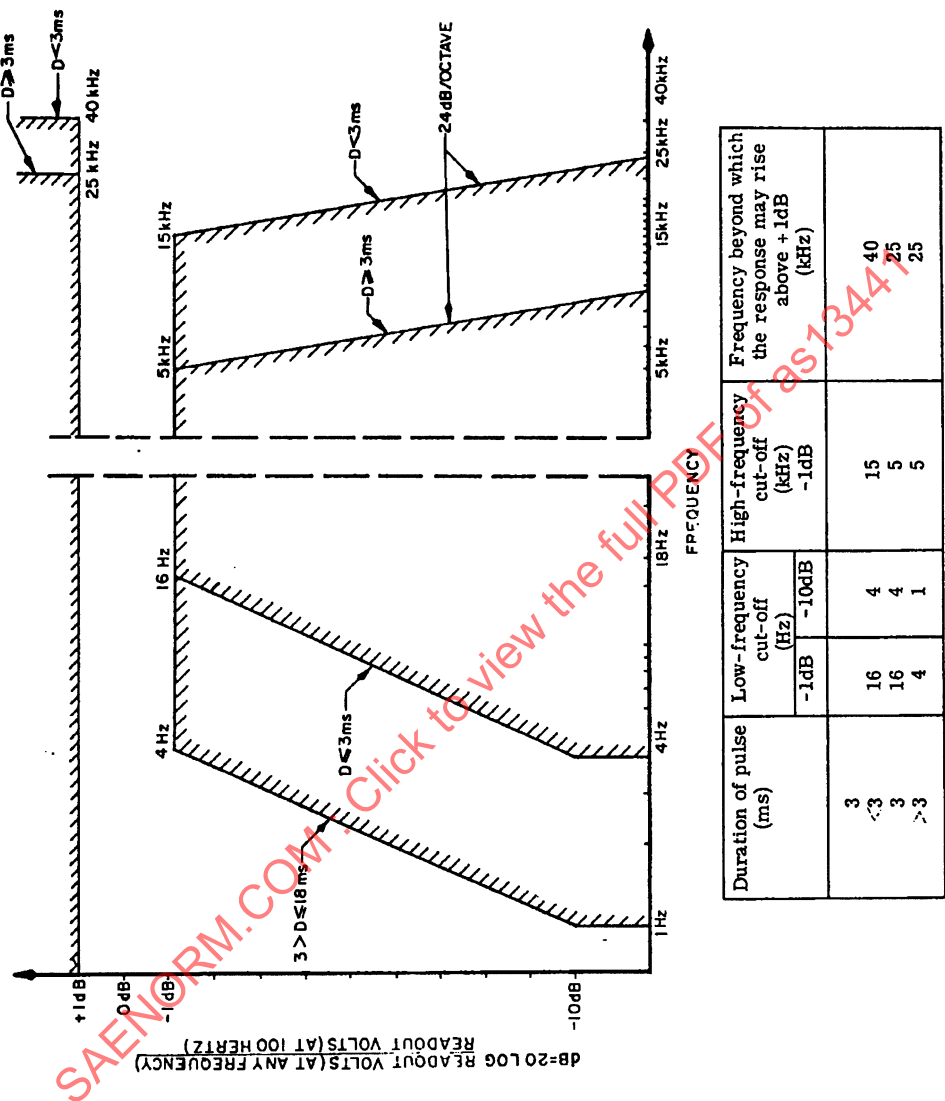


FIGURE 3. Tolerance limits for measuring system frequency response.

- 2.2.1.1 Frequency response measurement of the complete instrumentation: The transducer-amplifier-recording system can be calibrated by subjecting the transducer to sinusoidal vibrations of known frequencies and amplitudes for the required ranges so that the overall sensitivity curve can be obtained. The sensitivity curve, normalized to be equal to unity at 100 Hz, shall then fall within the limits given on figure 3.
- 2.2.1.2 Frequency response measurement of auxiliary equipment: If calibration factors given for the accelerometer are such that when used with the associated equipment it will not affect the overall frequency response, then the frequency response of only the amplifier-recording system may be determined. This shall be determined in the following manner: Disconnect the accelerometer from the input terminals of its amplifier. Connect a signal voltage source to these terminals. The impedance of the signal voltage source as seen by the amplifier shall be made as the impedance of the accelerometer and associated circuitry as seen by the amplifier. With the frequency of the signal voltage set at 100 Hz, adjust the magnitude of the voltage to be equal to the product of the accelerometer sensitivity and the acceleration magnitude expected during test conditions. Adjust the system gain to a convenient value. Maintain a constant input voltage and sweep the input frequency over the range from 1.0 to 9,000 Hz, or 4 to 25,000 Hz, as applicable, depending on duration of pulse. The frequency response in terms of dB shall be within the limits given on figure 3.
- 2.2.2 Transducer: The fundamental resonant frequency of the accelerometer shall be greater than 30,000 Hz, when the accelerometer is employed as the shock sensor.
- 2.2.3 Transducer calibration: The accuracy of the calibration method shall be at least ± 5 percent over the frequency range of 2 to 5,000 Hz. The amplitude of the transducer being calibrated shall also be ± 5 percent over the frequency range of 4 to 5,000 Hz.
- 2.2.4 Linearity: The signal level of the system shall be chosen so that the acceleration pulse operates over the linear portion of the system.
- 2.2.5 Transducer mounting: When conformance to 2.3 is required, the monitoring transducer shall be rigidly secured and located as near as possible to an attachment point of the specimen but not on the specimen itself.
- 2.3 Application of shock measuring instrumentation:

Shock measuring instrumentation shall be utilized to determine that the correct input shock pulse is applied to the test specimen. This is particularly important where a multi-specimen test is made. Generally, the shock pulse shall be monitored whenever there is a change in the test setup, such as a different test fixture, different component (change in physical characteristics), different weight, different shock pulse (change in pulse shape, intensity, or duration) or different shock machine characteristics. It is not mandatory that each individual shock be monitored, provided that the repeatability of the shock application as specified in 2.1.1 has been established.

2.4 Shock pulses:

Two types of shock pulses, a half-sine shock pulse, and a sawtooth shock pulse, are specified. The pulse shape and tolerances are shown on figures 1 and 2, respectively. For single degree of freedom systems, a sawtooth shock pulse can be assumed to have a damage potential at least as great as that of a half-sine pulse if the shock spectrum of the sawtooth pulse is everywhere at least as great as that of the half-sine pulse. This condition will exist for two such pulses of the same duration, if over most of the spectrum the acceleration peak value of the sawtooth pulse is 1.4 times the acceleration peak value of the half-sine pulse.

- a. Half-sine shock pulse - The half-sine shock pulse shall be as indicated on figure 1. The velocity change of the pulse shall be within ± 10 percent of the velocity change of the desired shock pulse. The velocity change may be determined either by direct measurement, indirectly, or by integrating (graphically or electrically) the area (faired acceleration pulse may be used for the graphical representation) under the measured acceleration pulse. For half-sine acceleration pulses of less than 3 milliseconds duration, the following tolerances shall apply: The faired maximum value of the measured pulse shall be within ± 20 percent of the specified ideal pulse amplitude, its duration shall be within ± 15 percent of the specified ideal pulse duration, and the velocity-change associated with the measured pulse shall be within ± 10 percent of $V_i = 2 A D/\pi$. See figure 1. The measured pulse will then be considered a nominal half-sine pulse with a nominal amplitude and duration equal to respective values of the corresponding ideal half-sine pulse. The duration of the measured pulse shall be taken as $D_m = D(.1A)/.94$; where $D(.1A)$ is the time between points at .1A for the faired measured acceleration pulse.
- b. The ideal half-sine pulse - An ideal half-sine acceleration pulse is given by the solid curve. See figure 1. The measured acceleration pulse shall lie within the boundaries given by the broken lines. In addition, the actual velocity-change of the shock shall be within 10 percent of the ideal velocity-change. The actual velocity-change can be determined by direct measurements, or from the area under the measured acceleration curve. The ideal velocity-change is equal to $V_i = 2AD/\pi$; where A is the acceleration amplitude and D is the pulse duration of the ideal pulse.
- c. Sawtooth shock pulse - The sawtooth pulse shall be indicated on figure 2. The velocity-change of the faired measured pulse shall be within ± 10 percent of the velocity change of the ideal pulse.
- d. The ideal terminal-peak sawtooth - An ideal terminal-peak sawtooth acceleration pulse is given by the solid line. See figure 2. The measured acceleration pulse shall be within the boundaries given by the broken lines. In addition, the actual velocity-change of the shock pulse shall be within 10 percent of the ideal value. The actual velocity-change can be determined from direct measurements, or from the area under the measured acceleration curve. The ideal velocity-change is equal to $V_i = PD/2$, where P is the peak value of acceleration, and D is the pulse duration.

3. TEST SAMPLE:

The test specimen (mated or unmated) shall be mounted as specified. Whenever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads.

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4. TEST PROCEDURE:

4.1 Basic design test:

Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks). If the test specimen is normally mounted on vibration isolators, the isolators shall be functional during the test. The specified test pulse (half-sine or sawtooth pulse) shall be in accordance with figures 1 and 2, respectively, and shall have a duration and peak value in accordance with one of the test conditions of table I.

TABLE I. Test condition values.

Test condition	Peak value (g's)	Normal duration (D) (MS)	Waveform	Velocity change (V) ft/sec
A	50	11	Half-sine	11.3
B	75	6	Half-sine	9.2
C	100	6	Half-sine	12.3
D	300	3	Half-sine <u>1/</u>	18.4
E	50	11	Sawtooth	8.8
F	75	6	Sawtooth	7.2
G	100	6	Sawtooth	9.7
H	30	11	Half-sine	6.8
I	30	11	Sawtooth	5.3

1/ For test condition D, where the weight of multispecimen and fixtures exceeds 150 pounds, there is a question as to whether the shock pulse is properly transmitted to all specimens. Due consideration shall be given to the design of the test fixture to assure the proper shock input to each specimen.

4.2 Measurements:

Measurements are to be made before and after the required number of shocks unless otherwise specified, and during the test, if specified.

- a. Unless otherwise specified, the electrical load conditions shall be 100 mA maximum for all contacts.
- b. No discontinuities are allowed. A detector capable of detecting a discontinuity of 1 microsecond shall be used.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and names of personnel.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test condition letter.
- e. Photographs, values, and observations necessary for proof of conformance.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Mounting method and accessories (see 3.).
- b. Test specimens (mated or unmated) (see 3.).
- c. Test condition letter (see table I).
- d. Load conditions (see 4.2 a.).

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METHOD 2005.1 VIBRATION

1. PURPOSE:

The purpose of this test is to determine the effects of vibration within the predominant or random vibration frequency ranges and magnitudes that may be encountered during the life of the connector.

2. TEST EQUIPMENT:

Test equipment accuracy, on instruments used to control or monitor the test parameters, shall be verified periodically (at least once every 6 months). All instruments and test equipment used in conducting the tests specified herein shall conform to U. S. Bureau of Standards. The monitoring transducer shall be calibrated against a standard transducer having an accuracy of ± 2 percent. The vibration system consisting of the vibration machine, together with its auxiliary test equipment, shall be capable of generating either a sinusoidal or random excitation. Test equipment for random vibration shall produce random excitation that possesses a gaussian (normal) amplitude distribution, except that the acceleration magnitudes of the peak values may be limited to a minimum of three times the rms (three-sigma (σ) limits)).

3. TEST SAMPLE:

3.1 Type of sample:

A vibration test sample shall be a fully wired connector consisting of one of the following, as applicable:

- a. A connector plug and its mating connector receptacle.
- b. A printed circuit connector receptacle and its mating connector board(s).
- c. An integral, functional connector assembly.

- 3.1.1 Preparation: Each test sample shall be prepared with wire and other materials or processes, simulating field assembly of the connector. If normal connector mating is dependent upon forces external to the connector, then such forces and mounting arrangements shall be as closely duplicated as possible (example: printed circuit connectors). If mating is achieved with normal locking means, then only normal locking means shall be used.

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3.2 Method of mounting:

3.2.1 Test conditions I, II, III, and IV: The connector test specimen shall be attached to a fixture capable of transmitting the vibration conditions specified. The test fixture shall be designed so that resonant vibration inherent in the fixture within the frequency range specified for the test shall be minor. The magnitude of the applied vibration shall be monitored on the test fixture near the specimen mounting points. The test specimen shall be mounted rigidly to the test fixture as specified and shall simulate as closely as possible the normal mounting of the connector. A minimum of 8 inches of wire or cable shall be unsupported on both ends of the connector. For specimens with attached brackets, one of the vibration-test directions shall be parallel to the mounting surface of the bracket. Vibration input shall be monitored on the mounting fixture in the proximity of the support points of the specimen.

3.2.2 Test conditions V and VI: The specimens shall be mounted as specified. The orientation of the specimen or direction of application of the applied vibration motion shall be specified in one or more directions. If the order of application of the different directions is critical, it also shall be specified. Any special test fixtures or jigs required to run the test shall be specified in sufficient detail to assure reproducibility of the input motion applied to the specimen. These details shall include the dimensions, the materials, temper, etc., as applicable.

4. TEST PROCEDURE:

Tests and measurements before, during, and after vibration shall be as specified.

4.1 Test conditions I, II, III, and IV:

4.1.1 Electrical load and discontinuity:

- a. Unless otherwise specified, the electrical load conditions shall be 100 mA, maximum for all contacts.
- b. No discontinuities are allowed. A detector capable of detecting a discontinuity of 1 microsecond shall be used.

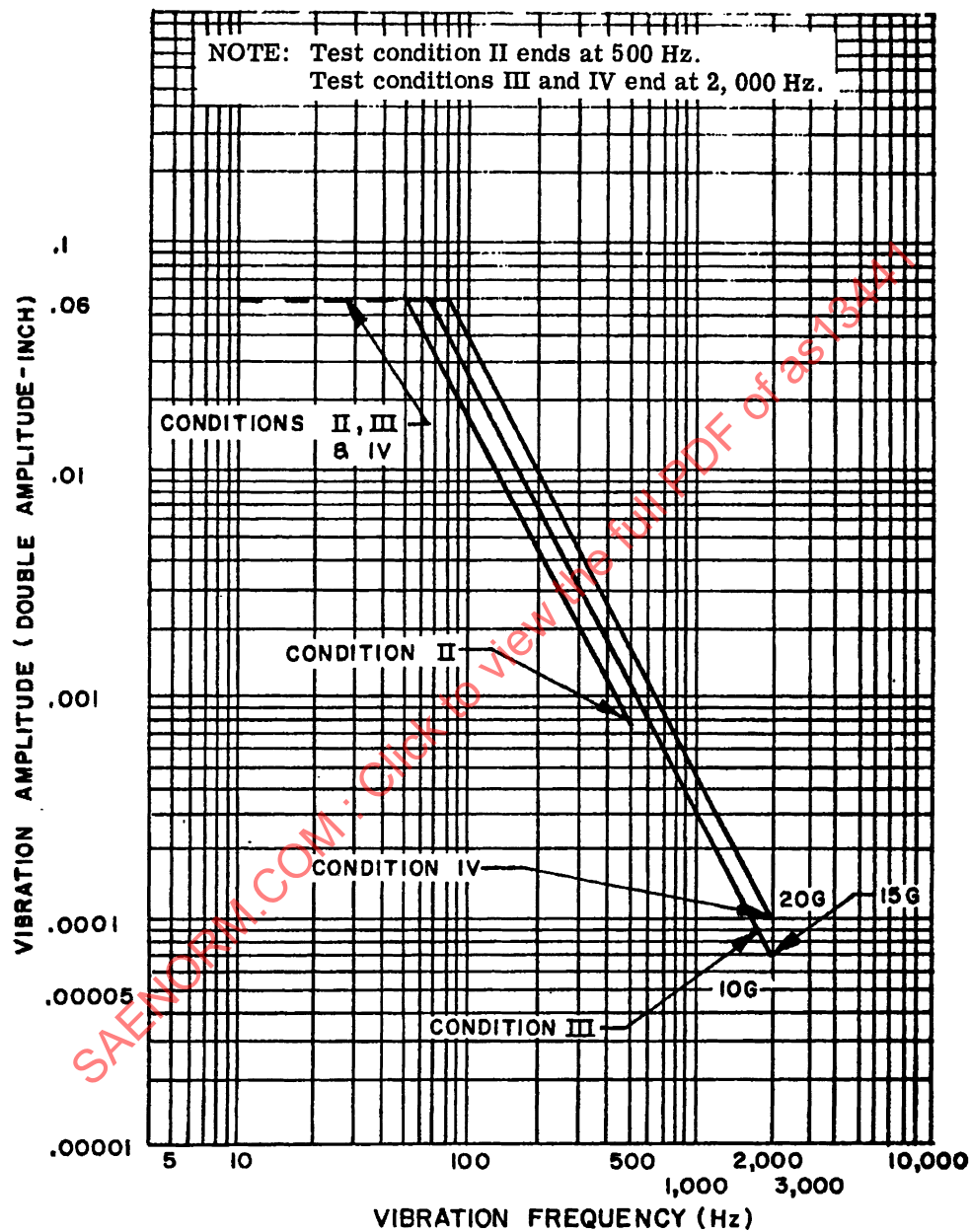
4.1.2 Vibration conditions: Vibration conditions shall be in accordance with table I, as applicable.

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TABLE I. Vibration conditions.

Test condition	Frequency range	Peak g level
	<u>Hz</u>	
I	Low - 10 to 55	
II	High - 10 to 500	10
III	High - 10 to 2,000	15
IV	High - 10 to 2,000	20

- 4.1.3 Resonance: A critical resonant frequency is that frequency at which any point on the specimen is observed to have a maximum amplitude more than twice that of the support points. When specified, resonant frequencies shall be determined either by monitoring parameters such as contact opening, or by use of resonance-detecting instrumentation.
- 4.1.4 Test condition I: The specimens shall be subjected to a simple harmonic motion having an amplitude of 0.03 inch (0.06-inch maximum total excursion), the frequency being varied uniformly between the approximate limits of 10 and 55 Hz. The entire frequency range, from 10 to 55 Hz and return to 10 Hz, shall be traversed in approximately 1 minute. Unless otherwise specified, this motion shall be applied for 2 hours in each of three mutually perpendicular directions (total of 6 hours). If applicable, this test shall be made under electrical-load conditions.
- 4.1.5 Test condition II (10g peak): The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 4.1.5.1, 4.1.5.2, and 4.1.5.3, respectively (see figure 1).
- 4.1.5.1 Amplitude: The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 10 gravity units (g peak), whichever is less. The tolerance on vibration amplitude shall be ± 10 percent.
- 4.1.5.2 Frequency range: The vibration frequency shall be varied logarithmically between the approximate limits of 10 and 500 Hz (see 4.1.8) except that the procedure (see 4.1.4) of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.



$$G = .0512f^2DA \text{ (} f^2 = \text{frequency in hertz, } DA = \text{double amplitude in inches.)}$$

FIGURE 1. Vibration-test curves-high frequency.

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- 4.1.5.3 Sweep time and duration: The entire frequency range of 10 to 500 Hz and return to 10 Hz shall be traversed in 15 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 9 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure (see 4.1.4) is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).
- 4.1.6 Test condition III (15g peak): The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 4.1.6.1, 4.1.6.2, and 4.1.6.3, respectively (see figure 1).
- 4.1.6.1 Amplitude: The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 15g (peak), whichever is less. The tolerance on vibration amplitude shall be ± 10 percent.
- 4.1.6.2 Frequency range: The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz (see 4.1.8) except that the procedure (see 4.1.4) of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.
- 4.1.6.3 Sweep time and duration: The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure (see 4.1.4) of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).
- 4.1.7 Test condition IV (20g peak): The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 4.1.7.1, 4.1.7.2, and 4.1.7.3, respectively (see figure 1).
- 4.1.7.1 Amplitude: The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 20g (peak), whichever is less. The tolerance on vibration amplitude shall be ± 10 percent.
- 4.1.7.2 Frequency range: The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz (see 4.1.8).

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4.1.7.3 Sweep time and duration: The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure (see 4.1.4) of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).

4.1.8 Alternate procedure for use of linear in place of logarithmic change of frequency: Linear rate of change of frequency is permissible under the following conditions:

- The frequency range above 55 Hz shall be subdivided into not less than three bands. The ratio of the maximum frequency to the minimum frequency in each band shall be not less than two.
- The rate of change of frequency in Hz per minute shall be constant for any one band.
- The ratios of the rate of change of frequency of each band to the maximum frequency of that band shall be approximately equal.

4.1.8.1 Example of alternate procedure: As an example of the computation of rates of change, assume that the frequency spectrum has been divided into three bands, 55 to 125 Hz, 125 to 500 Hz, and 500 to 2,000 Hz, in accordance with 4.1.8(a). For each band, let "k" be the (constant) ratio of rate of frequency change in Hz per minute to maximum frequency in Hz. Then the rates of change for the three bands will be 125k, 500k, and 2,000k, respectively. The times, in minutes, to traverse the three frequency bands will therefore be respectively:

$$\frac{125 - 55}{125k}, \frac{500 - 125}{500k} \text{ and } \frac{2,000 - 500}{2,000k}$$

Since the minimum total sweep time is 30 minutes,

$$30 = \frac{70}{125k} + \frac{375}{500k} + \frac{1,500}{2,000k}$$

from which: $k = 0.0687$

The required maximum constant rates of frequency change for the three bands are therefore 8.55, 34.2, and 137 Hz per minute, respectively. The minimum times of traverse of the bands are 8.2, 10.9, and 10.9 minutes, respectively.

4.2 Test conditions V and VI:

4.2.1 Control and analysis of random vibration:

- 4.2.1.1 Spectral-density curves: The output of the vibration machine shall be presented graphically as power-spectral density versus frequency.^{1/} The spectral-density values shall be within +40 and -30 percent (± 1.5 dB) of the specified values between a lower-specified frequency and 1,000 Hz, and within +100 and -50 percent (± 3 dB) of the specified values between 1,000 and an upper-specified frequency (2,000 Hz). A filter bandwidth will be a maximum of 1/3-octave or a frequency of 25 Hz, whichever is greater.
- 4.2.1.2 Distribution curves: A probability density-distribution curve may be obtained and compared with a gaussian-distribution curve. The experimentally-obtained curve shall not differ from the gaussian curve by more than ± 10 percent of the maximum value.
- 4.2.1.3 Monitoring: Monitoring involves measurements of the vibration excitation and of the test-item performance. When required in the individual specification, the specimen may be monitored during the test. The details of the monitoring circuit, including the method and points of connection to the specimen, shall be specified.

^{1/} Power-spectral density is the mean-square value of an oscillation passed by a narrow-band filter per unit-filter bandwidth. For this application it is expressed as G^2/f where G^2/f is the mean-square value of acceleration expressed in gravitational units per number of cycles of filter bandwidth. The spectral-density curves are usually plotted either on a logarithmic scale, or in units of decibels (dB). The number of decibels is defined by the equation:

$$\text{dB} = 10 \log \frac{G^2/(f)}{G_r^2/f} = 20 \log \frac{G/\sqrt{f}}{G_r/\sqrt{f}}$$

The rms value of acceleration within a frequency band between f_1 and f_2 is:

$$G_{\text{rms}} = \left[\int_{f_1}^{f_2} G^2/f \, df \right]^{1/2}$$

where G_r^2/f is a given reference value of power-spectral density, usually the maximum specified value.

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4.2.1.4 Vibration input: The vibration magnitude shall be monitored on a vibration machine, on mounting fixtures, at locations that are as near as practical to the test-item mounting points. When the vibration input is measured at more than one point, the minimum input vibration shall normally be made to correspond to the specified test curve (see figures 2 and 3). For massive test-items and fixtures, and for large-force exciters or multiple-vibration exciters, the input-control value may be an average of the average magnitudes of three or more inputs. Accelerations in the transverse direction, measured at the test-item attachment points, shall be limited to 100 percent of the applied vibration. The number and location of the test points shall be specified.

4.2.2 Procedure: The specimen, or substitute equivalent mass, shall be mounted in accordance with 3.2.2 and the monitoring equipment attached, if applicable, in accordance with 4.2.1.3. The vibration machine shall then be operated and equalized or compensated to deliver the required frequencies and intensities conforming to the curves specified in test condition V, figure 2, or test condition VI, figure 3 (see 2.). The specimen shall then be subjected to the vibration specified by the test-condition letter (see tables II and III) for the duration as specified:

3 minutes; 15 minutes; 1-1/2 hours; or, 8 hours;

in each of three mutually perpendicular directions, and in the order specified (see 3.2.2), as applicable. The measurements made before, during, and after the test shall be specified and if the specimen is to be monitored during the test, the details shall be in accordance with 4.2.1.3.

4.2.3 Electrical load and discontinuity:

- a. Unless otherwise specified, the electrical load conditions shall be 100 mA maximum for all contacts.
- b. No discontinuities are allowed. A detector capable of detecting a discontinuity of 1 microsecond shall be used.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and names of personnel.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test condition number.
- e. Values and observations.

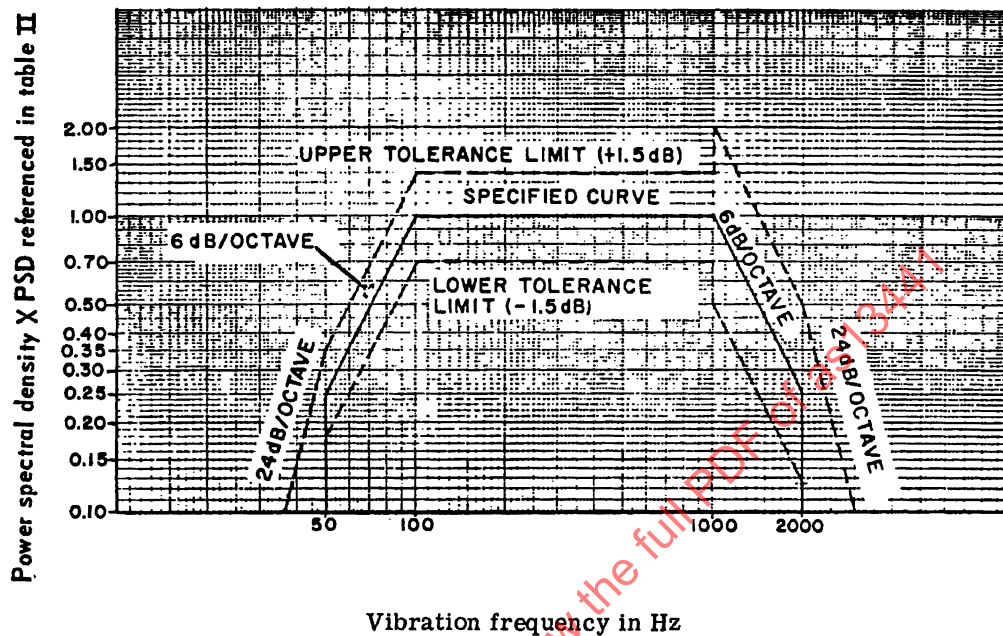


FIGURE 2. Test condition V random vibration test-curve envelope (see table II).

TABLE II. Values for test-condition V 1/

Characteristics		
Test condition letter	Power spectral density	Overall rms G MIN
A	.02	5.2
B	.04	7.3
C	.06	9.0
D	.1	11.6
E	.2	16.4
F	.3	20.0
G	.4	23.1
H	.6	28.4
J	1.0	36.6
K	1.5	44.8

1/ For duration of test, see 4.2.2.

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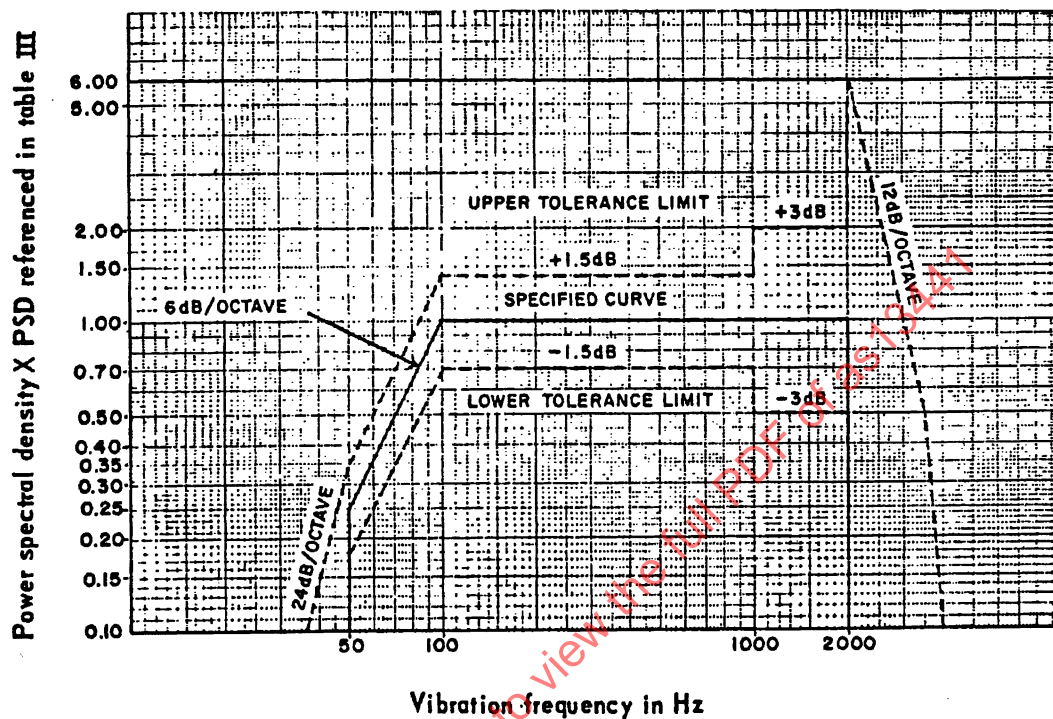


FIGURE 3. Test condition VI, random vibration test-curve envelope (see table III).

TABLE III. Values for test-condition VI ^{1/}

Test condition letter	Characteristics	
	Power spectral density	Overall rms G
A	.02	5.9
B	.04	8.3
C	.06	10.2
D	.1	13.2
E	.2	18.7
F	.3	22.8
G	.4	26.4
H	.6	32.3
J	1.0	41.7
K	1.5	51.1

^{1/} For duration of test, see 4.2.2.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Type of sample (see 3.1).
- b. Method of mounting (see 3.2).
- c. Test condition number (see table I).
- d. Test condition V - Direction of motion and order, if critical (see 3.2.2).
- e. Tests or measurements before, during, and after vibration (see 4.).
- f. Test conditions I, II, III, and IV - Electrical load conditions, all contacts, if other than 100 mA, maximum (see 4.1.1 a.).
- g. Test conditions I, II, III, and IV - Measurement of discontinuities during vibration, (see 4.1.1 b.).
- h. Method of determining resonance, if applicable (see 4.1.3).
- i. Test condition I - Duration of vibration, if other than 2 hours in each of three mutually perpendicular directions (see 4.1.4).
- j. Test conditions V and VI - Monitoring instrumentation, if applicable (see 4.2.1.3).
- k. Test conditions V and VI - The number and location of test points, if applicable (see 4.2.1.4).
- l. Test conditions V and VI - Applicable test condition letter and test duration (see 4.2.2).
- m. Test condition V and VI - Electrical load conditions, all contacts, if other than 100 mA, maximum (see 4.2.3 a.).

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METHOD 2006.2 PROBE DAMAGE (CONTACTS)

1. PURPOSE:

The purpose of this test is to simulate a form of field abuse of contacts during test by inserting probes into connector socket contacts.

2. TEST EQUIPMENT:

Equipment required to perform test shall be probe damage tool similar to that on figure 1.

2.1 Socket contact holding device:

Contacts shall be inserted into a socket contact holding device, except nonremovable type contacts shall be tested in the applicable connector. When a lathe chuck is used for the socket holding device, the holding device shall not support the socket contact pressure member in any way as to alter contact performance. The contact holding device or connector shall be capable of locking the socket contact in a horizontal position to prevent rotation during test.

2.2 Mounting:

The mounting fixture shall be suitable to support the socket contact holding device or connector in a horizontal position and provide 360° rotation during test.

3. TEST SAMPLE:

A test sample shall consist of the contact inserted into the socket contact holding device or connector.

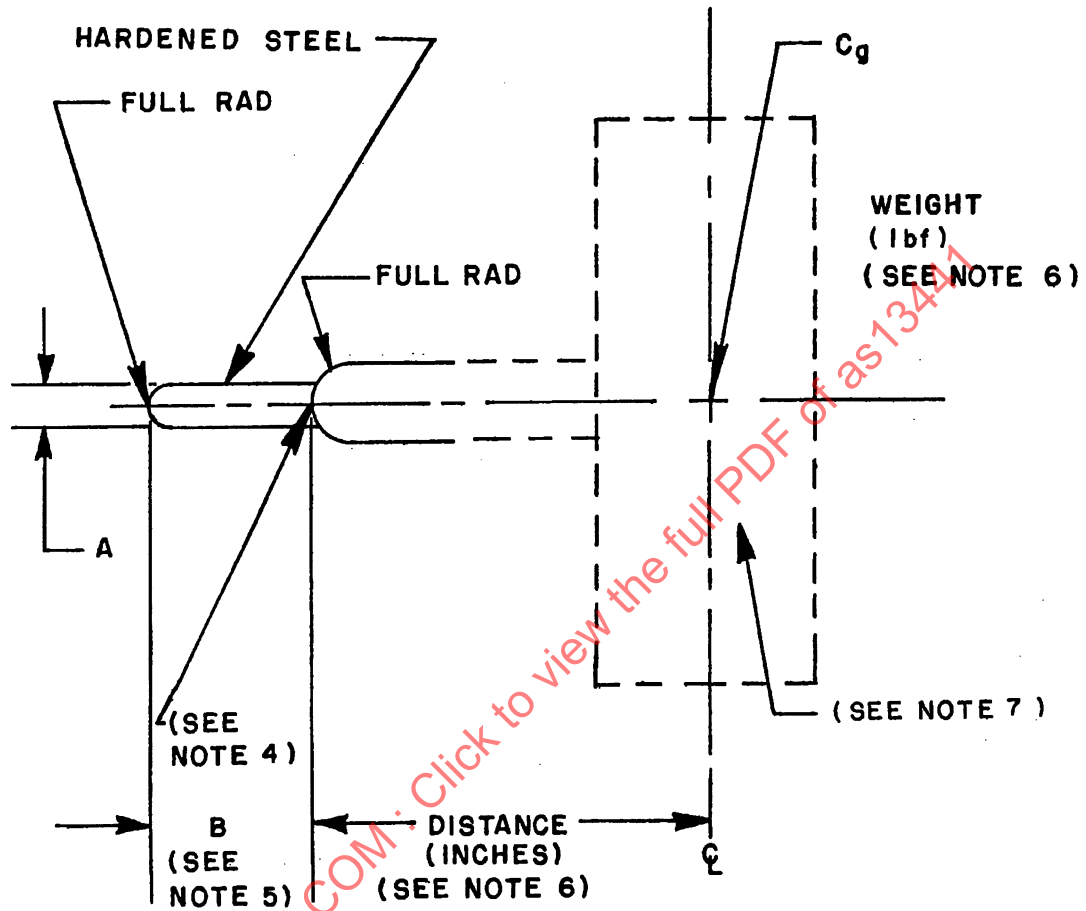


FIGURE 1. Probe damage tool.

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Socket contact	A $\pm .0005$ (0.013 mm)	"C" Moment in-lbf $\pm 10\%$
4/0	.500 (12.70)	8.00
2/0	.406 (10.31)	8.00
0	.357 (9.07)	8.00
2	.283 (7.19)	4.00
4	.225 (5.72)	4.00
6	.178 (4.52)	4.00
8	.142 (3.61)	4.00
10	.125 (3.18)	2.00
12	.094 (2.39)	2.00
16	.0625 (1.588)	2.00
20	.040 (1.02)	0.50
22	.030 (0.76)	0.125
23	.027 (0.69)	0.125
24	.025 (0.64)	0.125

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Millimeters are in parentheses.
4. Fulcrum point for calculating moment "C" (in-lbf). (moment "C" (in-lbf) distance (inches) x weight (lbf).
5. The "B" dimension shall be 1/2 and 3/4 of socket bore minimum depth or as specified.
6. The values for distance and weight may vary. The product of the weight and distance shall be equal to the moment C specified above.
7. The weight and weight shape may vary, but the distance measurements shall be made from the centerline (passing through the center of gravity Cg) to the fulcrum point.

FIGURE 1. Probe damage tool - Continued.

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4. TEST PROCEDURE:

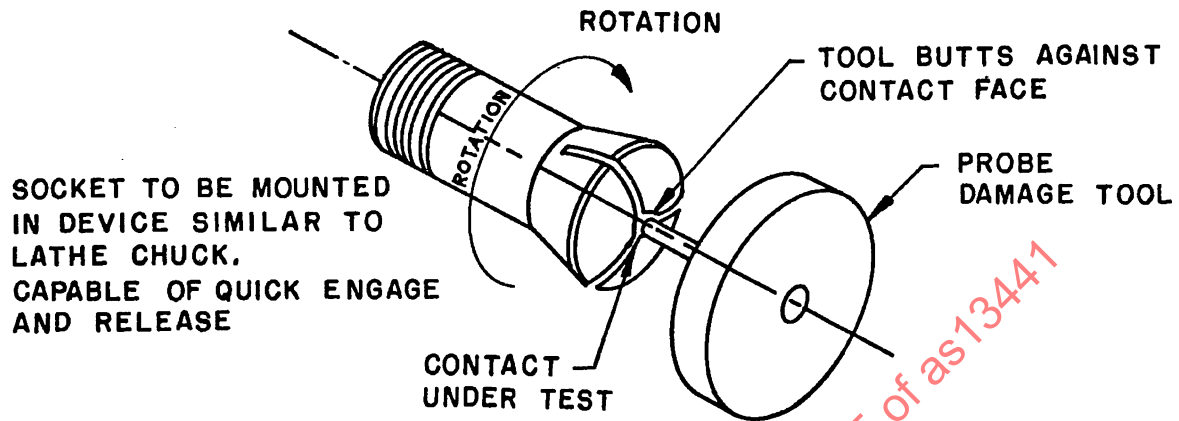
4.1 Test:

- a. The contacts shall be subjected to an examination of product to insure conformance to the design intent.
- b. Wires required for other tests may be terminated to the contacts.
- c. The socket contact holding device or connector with socket contacts fixed in place shall be mounted in a horizontal position to a rotating fixture to allow 360° hand rotation during test (see figure 2).
- d. The probe damage tool (see figure 1), shall be inserted into the contact to a "B" dimension depth as shown on figure 1. The depth of the socket insert dielectric material shall be added to probe length "B" when a connector holding device is used.
- e. When the test setup is in conformance with 4.1c. and 4.1d., the fixture shall be slowly rotated 360° at a uniform rate with the probe damage tool inserted in the contact so that the force is applied uniformly to the inside diameter of the socket. This test shall be performed at each insertion depth specified on figure 1 on all contacts. After probe damage testing, the contacts shall meet the requirements specified in the applicable specification.

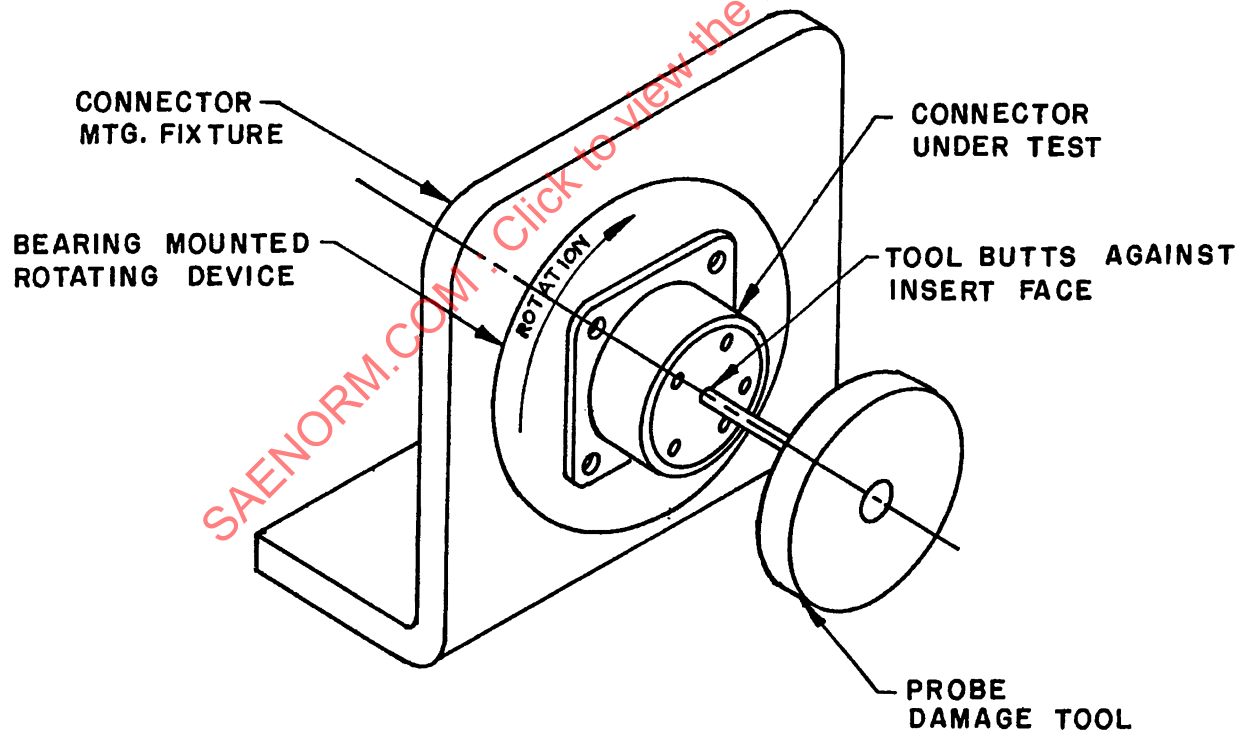
5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description: Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations.



TYPE 1. Socket contact holding device for testing socket contacts.



TYPE 2. Apparatus for testing nonremovable socket contacts within the connector.

FIGURE 2. Typical probe damage test setups.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Size of samples to be tested (see 3).
- b. Probe depth, if other than 1/2 and 3/4 of socket bore minimum depth (see figure 1).
- c. Specify whether socket contact holding device or connector is to be used for testing; if socket contact holding device is used, define (see 2.1).
- d. Requirements for contact separating forces after probe damage testing (see 4.1e.).

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METHOD 2007.1 CONTACT RETENTION

1. PURPOSE:

The purpose of this test is to impose axial forces on the connector contacts to determine the ability of the connector to withstand forces that tend to displace contacts from their proper location within the connector insert and resist contact pullout. These forces may be the result of:

- a. Loads on wire connected to the contact.
- b. Forces required to restrict contact "push-through" during assembly of removable type contacts into connector inserts.
- c. Forces produced by mating contacts during connector mating.
- d. Dynamic forces produced by vibration and shock during normal use of the connectors.
- e. Forces relating to bundling strains on the wire.

2. TEST EQUIPMENT:

Equipment required to perform contact retention test shall be as follows:

- a. Force gages, of suitable range for the contact size under test, so that readings shall lie in the middle 50 percent of the scale, where practical, with a nominal full scale accuracy of ± 2 percent.
- b. Dial indicator gages or other suitable instruments of such range for the contacts under test that the readings shall be in the middle 50 percent of the scale, with a nominal full scale accuracy of ± 2 percent.
- c. Contact removal and insertion tools, as required.
- d. Suitable compression device.
- e. Steel test probes, to adapt the force gage plunger to the particular contact (pin, socket, or hermaphroditic) front or wiring end under test.

3. TEST SAMPLE:

A test sample shall consist of a plug or receptacle with suitable contacts in place. Unless otherwise specified, 20 percent of the contact complement, but not less than 3 contacts of each size shall be tested.

3.1 Preparation:

All backshell hardware and compression rings, if any, shall be removed. When the specification requires the contact retention to be tested from the wire side of the connector, contacts shall have the wires cut off flush or the contacts replaced as specified. All contacts shall be in place. Simulated contacts which duplicate the retention feature Geometry may be used in lieu of actual contacts to facilitate testing.

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3.2 Mounting:

The unmated connector shall be mounted in a position of axial alignment of the contacts with the plunger of the test gage. A minimum of 1/4-inch of space shall be provided on the opposite side under test to permit any "push-through" that may occur.

4. TEST PROCEDURES:

4.1 Test:

The contact retention test shall be applied to the sample contacts as follows:

- a. Determine the direction (axially) in which the test shall be conducted from the detail specification. Apply a sufficient axial seating load ("push" force) to take up any slack of the contact in its retention system. Sudden or excessive loads shall not be applied.
- b. Establish the reference (zero displacement) position of the contact. The contact may be lightly preloaded (3 pounds, maximum) to assure proper seating.
- c. Apply an axial load to the contact at the rate of approximately 1 pound per second, until the specified force has been reached. The specified force shall be maintained for 5 to 10 seconds during which measurement of displacement shall be made or the load shall be removed and the displacement measured, as specified.
- d. If the test is required in two directions, repeat 4.1 a., b., and c. from the second direction.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations:
 - (1) Force applied (see 4.1 c.).
 - (2) Measured contact displacement during application or after removal of specified force, as specified (see 4.1 c.).

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Number of contact positions in sample to be measured, if other than as specified herein (see 3.).
- b. Removal of wires (see 3.1).
- c. Axial direction in which test shall be conducted and whether in two directions (see 4.1 a. and d.).
- d. Applied axial load (see 4.1 c.).
- e. Maximum allowable contact displacement during application of specified force and/or after removal of specified force (see 4.1 c.).
- f. Special requirements or precautions, if any.

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METHOD 2008.1 CRUSH

1. PURPOSE:

The purpose of this test is to determine the ability of a connector to withstand a load that might be encountered when run over by a wheeled vehicle. CAUTION: This test shall only be performed on connectors designed to meet the requirements.

2. TEST EQUIPMENT:

Equipment required to perform crush test shall be as follows:

- a. Two bearing surfaces faced with 1-inch thick rubber with a durometer of 65 to 75A.
- b. A suitable instrument for measuring the applied load to an accuracy of 5 percent.
- c. A suitable press capable of applying the specified load at a rate not to exceed 500 pounds per second.

3. TEST SAMPLE:

A test sample shall consist of a plug, a receptacle, or a mated plug and receptacle, as specified. The sample shall be wired as intended for normal service, complete with accessories. A minimum of 6 inches of cable shall be attached to the sample(s).

4. TEST PROCEDURE:

4.1 Test:

Unless otherwise specified, the test load shall be 1,500 pounds, applied for 5 to 10 seconds. The specified load shall be applied in a direction perpendicular to the longitudinal axis of the connector and cable. In the case of rectangular connectors, the load shall be applied against the longer sides. The number of loads to be applied shall be as specified.

4.2 Acceptance criteria:

Typical indications of damage resulting from this test are:

- a. Inability to mate and unmate.
- b. Broken parts or accessories.
- c. Electrical failure.
- d. Damage to seals.

5. DOCUMENTATION:

The data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Test specimen (mated or unmated (see 3.).
- b. Number of load applications (see 4.1).
- c. Test load, if other than 1,500 pounds (see 4.1).
- d. Load orientation, if other than 4.1.
- e. Acceptance criteria (see 4.2).

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METHOD 2009.1 CABLE PULL-OUT

1. PURPOSE:

The purpose of this test is to determine the axial tensile load which can be applied to a mated pair of connectors and the holding effect of a connector cable clamp without causing any detrimental effects upon the cable or connector when subjected to inadvertent axial tensile loads.

2. TEST EQUIPMENT:

Test equipment shall consist of an apparatus capable of applying gradual axial loads along a connector and a cable axis with devices for holding or clamping a cable. The apparatus shall be capable of applying a minimum force of 1 pound and gradually increasing to a maximum force of 125 pounds. A detector capable of detecting discontinuity in excess of 1 microsecond shall be used.

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a connector made up of a receptacle and plug with a cable clamp and specified cable. The connector shall be mounted to a fixed surface.

3.2 Sample preparation:

The cable shall be securely held in the connector clamp and a visual inspection for harmful effects shall be made of the cable at the clamp. To determine linear motion of the cable when subjected to the axial tensile load, band or mark the cable at the clamp. The connector shall be mated and wired to detect any circuitry interruption during the test.

4. TEST PROCEDURE:

The test sample shall be subjected to the test condition specified. Fully engage the plug to the receptacle and clamp the free end of the connector and cable securely to the pull-test apparatus. The cable clamp shall be rigidly attached to a fixture and clamps to the cable, as specified. Apply the specified load at the rate of approximately 20 ± 1 pounds per minute and maintain for 1 hour. A maximum of 100 milliamperes of current shall be flowing through the contacts (see table I).

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TABLE I. Cable pull-out test loads.

Test condition	Tensile force in pounds
A	25
B	50
C	75
D	100
E	125

4.1 Examination:

After the test, a visual examination shall be made for damage to the connector, the cable retaining device, and the cable. Measurement of the linear motion of the cable in relation to the cable clamp shall be made, as specified.

4.2 Failures:

Potential modes of failure resulting from this test include:

- Cable jacket damage.
- Conductor insulation or conductor damage.
- Cable clamp failure.
- Cable disengagement from the clamp or cable pull-out in excess of the allowed value.
- Cable-to-connector seal damage.
- No discontinuities are allowed.
- Distortion or bending of metal parts on the connectors.

5. DOCUMENTATION:

Data sheets shall contain:

- Title of test, date, and name of operator.
- Sample description - Include fixture, if applicable.
- Test equipment used and date of latest calibration.
- Test condition letter.
- Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Type of cable to be used (see 3.1).
- b. Cable clamping method (see 4.).
- c. When and what measurements to be taken (see 4.1).
- d. Test condition letter (see table I).
- e. Allowable linear motion of the cable with respect to the clamp (see 4.1).

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METHOD 2010.1 INSERT RETENTION

1. PURPOSE:

The purpose of this test is to determine the adequacy of the insert retaining mechanism and the strength of the insert material in electrical connectors and establishes the ability of the connector to withstand the axial load of the combined contact engaging and separating forces.

2. TEST EQUIPMENT:

The test equipment required to perform tests is as follows:

- a. Suitable holding fixtures.
- b. Force gages, of suitable range for the insert under test, so that readings shall lie in the middle 50 percent of the scale, where practical, with a nominal full scale accuracy of ± 2 percent.

3. TEST SAMPLE:

The test sample shall consist of a plug or receptacle, wired or unwired as specified, with all accessories removed.

4. TEST PROCEDURE:

The test sample shall be subjected to an axial load in both directions as specified. The load shall be applied at the rate of approximately 10 pound-force per square inch (lb_f/in^2) per second and held for 5 to 10 seconds. The load may be applied as a fluid pressure or as an equivalent load applied to the maximum practical insert area.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. If connector is wired or unwired (see 3.).
- b. Load to be applied (see 4.).

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METHOD 2011.1 ACCELERATION

1. PURPOSE:

The purpose of this test is to determine the ability of an electrical connector to withstand a specified acceleration force without damage detrimental to its specified performance.

2. TEST EQUIPMENT:

Unless otherwise specified, the acceleration test apparatus shall be the centrifuge-type and shall be capable of subjecting the test specimen to the value of acceleration (g_s) as specified in 4.2. The acceleration gradient across the specimen shall not exceed 15 percent of the specified g level.

3. TEST SAMPLE:

3.1 Sample:

A test sample shall consist of a plug or a receptacle, or mated plug and receptacle, as specified.

3.2 Sample preparation:

All contacts shall be wired as specified. The wires shall be bundled into harnesses and secured to the acceleration table or arm not less than 10 inches from the rear of the connector half to which they are attached. Any extension of the harnesses shall be secured to prevent uncontrolled motion during the test. Provisions shall be made for all electrical connections to be secured.

3.3 Mounting:

Unless otherwise specified, provisions shall be made to permit rigid mounting of the sample by the normal mounting means so that the sample can be tested in two directions, 180 degrees apart, along each of three mutually perpendicular axes.

4. TEST PROCEDURE:

Each sample under test shall be mounted in a rigid position as specified in 3.3 and subjected to the acceleration levels specified in table I, as applicable.

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TABLE I. Acceleration levels.

Test condition letter	Acceleration level (gravity units)
A	50
B	100
C	250
D	500

4.1 Electrical tests:

The sample shall be electrically energized. Any circuit interruption in excess of 1 microsecond shall be recorded.

4.2 Test conditions:

The specimen shall be subjected to 5 minutes acceleration of the specified g level in both directions of each of three mutually perpendicular axes for a total of 30 minutes at the specified g level. The acceleration measured at any point of the component part shall not vary from the selected "g" level by more than 15 percent. The sample shall be brought from zero to the specified acceleration level at a linear rate in not less than 1 minute.

4.3 Post test examinations:

Examination for the following defects shall be made at the completion of the test.

- Unintended separation of mated connectors.
- Inability to mate or unmate counterpart connector within specified mating and unmating force values.
- Cracked, broken or bent parts.
- Loosening of parts.
- Missing parts.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable (photographs may be used).
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations:
 - (1) Post test examinations.
 - (2) Electrical tests.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Type samples to be tested and whether mated (see 3.1).
- b. Wiring of contacts (see 3.2).
- c. Mounting of sample, if other than herein (see 3.3).
- d. Acceleration level, applicable test condition letter (see table I).
- e. Electrical tests (see 4.1).
- f. Post test examinations, if other than herein (see 4.2).

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METHOD 2012.1 CONTACT INSERTION AND REMOVAL FORCE

1. PURPOSE:

The purpose of this test is to determine the forces required to insert contacts into and remove contacts from their normal position in a connector.

2. TEST EQUIPMENT:

Test equipment shall be as follows:

- a. Force gage or weight scale of suitable range.
- b. Arbor press or equivalent (optional).
- c. Means for adapting gage to press (optional).
- d. Applicable insertion and removal tools.
- e. Suitable clamping fixture for holding connector.

3. TEST SAMPLE:

3.1 Sample:

A test sample shall consist of a contact and complementary connector. Unless otherwise specified, 20 percent of the contacts in a plug or receptacle, but not less than three contacts per connector mating half, shall be measured.

3.2 Sample preparation:

All contacts shall be installed in the connector as specified in 3.1 and wired with the wire type, gage, and length as specified. The following shall apply:

- a. The sealing member shall be relaxed or removed if the design permits.
- b. Gang retention devices shall be indexed to the release position.
- c. The unmated plug or receptacle shall be mounted securely in a suitable clamping fixture.
- d. The force gage or weight scale shall be mounted to indicate the applied force.
- e. The applicable insertion and removal tools shall be adapted for use with the force gage or weight scale.

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4. TEST PROCEDURE:

Unless otherwise specified, all testing shall be conducted as follows at standard ambient conditions.

4.1 Insertion force:

- a. The plug or receptacle shall be mounted in a suitable position for the insertion of contacts.
- b. The insertion tool, with the contact, shall be engaged in the approved manner.
- c. Axial alignment shall be maintained and sufficient force applied to insert the contact into its normal position in the connector. This force shall be recorded.

4.2 Removal force:

- a. The plug or receptacle shall be mounted in a suitable position for removal of contacts. For rear release systems, the mounting shall be on a load cell, or equivalent, that indicates both compression and tension forces.
- b. The removal tool shall be engaged with the contact and contact locking device in the approved manner.
- c. Axial alignment shall be maintained and sufficient force applied to release the locking mechanism and effect removal of the contact (until the tool plunger has traveled its full distance, when applicable). The peak force shall be recorded.

4.3 Failures:

Potential modes of failure resulting from this test are forces in excess of those specified for insertion or removal of contacts from the connector.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Sample description and contact identification.
- f. Values of contact insertion and removal force.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Number of contacts to be tested, if other than specified herein (see 3.1).
- b. Wire type, gage, and length (see 3.2).
- c. Test conditions, if other than standard ambient (see 4).
- d. Allowable insertion and removable forces (see 4.1 and 4.2).
- e. Insertion and removal tool (see 3.2 e.).

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METHOD 2013.1 MATING AND UNMATING FORCES

1. PURPOSE:

The purpose of this test is to determine the mechanical forces required to mate and unmate electrical connectors, or protective caps with connectors, before and after the connectors are subjected to various environmental stresses.

2. TEST EQUIPMENT:

Test equipment shall be as follows:

- a. Force or torque gages of applicable range.
- b. Mounting fixtures which allow the samples to be mounted in their normal manner.
- c. Attachments and accessory type equipment as required to mate the test samples and attach the force or torque gages (i.e., arbor, press, etc.).

3. TEST SAMPLE:

3.1 Sample:

The test sample shall consist of a plug and receptacle with applicable contacts in place.

3.2 Sample preparation:

The sample shall be wired using the appropriate wire type, gage and length specified. All applicable hardware shall be assembled to the sample including skirts, hoods, cable clamps, jack screws or guide pins, and sockets. Unless otherwise specified, the sample shall not be lubricated or cleaned in any manner.

3.3 Mounting:

Unless otherwise specified, the sample shall be mounted to mounting fixtures by the normal mounting means.

4. TEST PROCEDURE:

Unless otherwise specified, all testing shall be performed as follows at standard ambient conditions:

4.1 Mating force:

- a. The two mating connectors shall be brought to a position where mechanical mating begins and the force or torque gage is at zero indication.
- b. The connectors shall then be fully mated or coupled at a rate specified and the force or torque required for mating shall be recorded.

4.2 Unmating force:

The mated connectors shall be fully unmated at a rate specified and the force or torque required shall be recorded.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Special mounting means, if applicable (see 3.2).
- b. Lubrication or cleaning, if required (see 3.2).
- c. Wire type, gage, and length (see 3.2).
- d. Applicable hardware (see 3.2).
- e. Force or torque requirements (see 4.).
- f. Test conditions, if other than standard ambient (see 4.).
- g. Rate of mating and unmating (see 4.1 and 4.2).

METHOD 2014
CONTACT ENGAGEMENT AND SEPARATION FORCE

1. PURPOSE:

The purpose of this test is to determine the forces required to engage and separate standard test pins or blade with individual contacts. The force recorded during the engagement and separation cycle is indicative of the normal force pressure exerted on a mating unit by the socket contact spring member.

2. TEST EQUIPMENT:

Test equipment shall be as follows:

- Force gage for procedure I (see figure 1).
- Test pin or blade conforming to the applicable configuration and surface finish specified in MS3197 or as specified.
- Adapter for attaching test pin or blade to force gage for procedure I.
- Fixture for applying axial engaging and separating forces (see figure 1).
- Solution for cleaning test pin or blade, if applicable.

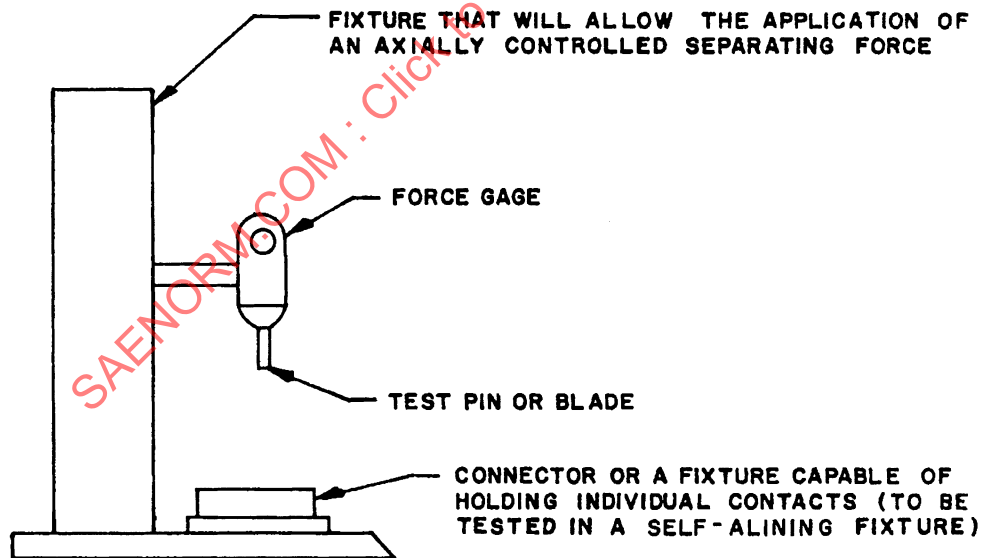


FIGURE 1. Typical contact separating force test fixture.

3. TEST SAMPLES:

The samples shall consist of spring member contacts, individual or assembled, whichever is applicable.

4. TEST PROCEDURES:

- a. The test pin or blade shall be cleaned periodically to remove any foreign surface film which may affect the engagement and separation force recorded.
- b. During the test, each spring member contact, whether assembled or individual, shall be aligned with the test pin or blade similar to actual conditions in the field.
- c. Unless otherwise specified, axial forces shall be applied gradually. Depth of engagement shall be as specified.
- d. Measure the separating forces by using one of the following procedures, unless otherwise specified, as specified in the specification:
 - (1) Procedure I, (using a pin or blade):
 - (a) Condition the spring member of the contact by inserting and withdrawing the force gage one time.
 - (b) Insert the maximum size pin or blade and measure the engagement force. Remove pin or blade.
 - (c) Insert the minimum size pin or blade and measure the separation force as it is withdrawn. Remove pin or blade.
 - (2) Procedure II, (using a qualified contact):
 - (a) Condition the spring member contact by inserting and withdrawing the maximum size gage one time.
 - (b) Insert a qualified contact and measure the engagement force. As the qualified contact is withdrawn, measure the separation force.

5. DOCUMENTATION:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Applicable test pin or blade (see 2.b.).
- b. Depth of test pin or blade engagement (see 4.c.).
- c. Procedure for engaging and separating forces (see 4.d.(1)).

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METHOD 2015 IMPACT

1. PURPOSE:

The purpose of this test is to determine the ability of a connector to withstand impacts of the type that might be encountered when a connector is uncoupled and dropped to the floor. This test shall only be performed on connectors designed to meet such requirements.

2. TEST EQUIPMENT:

- a. A test fixture similar to that shown in figure 1 shall be used. Unless otherwise specified, this fixture shall be capable of being mounted to any convenient, rigid, vertical structure at a height of 2 feet.
- b. The impact surface shall be a concrete slab at least 4 inches (101.6 mm) thick.

3. TEST SAMPLE:

- a. A test sample shall consist of a plug or a receptacle.
- b. The test sample shall be wired as intended for normal service, complete with accessories. Unless otherwise specified, the combined length of the pipe fixture and cable shall be 7 feet (2.134 m), with a minimum length of 18 inches (457.2 mm) of cable. In the case of a mated sample, the connector on the free end shall be wired with 6 inch (152.4 mm) leads.

4. TEST PROCEDURE:

- a. The cable, with the sample attached, shall be securely fastened to the test fixture such that the cable assembly can hang freely.
- b. Unless otherwise specified, the cable assembly shall be extended its full length from the test fixture to a drop height that is specified in table I. Drop requirements shall be in the sequence and number as shown in table I. The connector shall fall by the pendulum action of the pipe and cable assembly and strike the impact pad. The radial orientation for each series of 8 drops shall be dictated by using the index feature of the test fixture and each drop shall originate from a different index position.

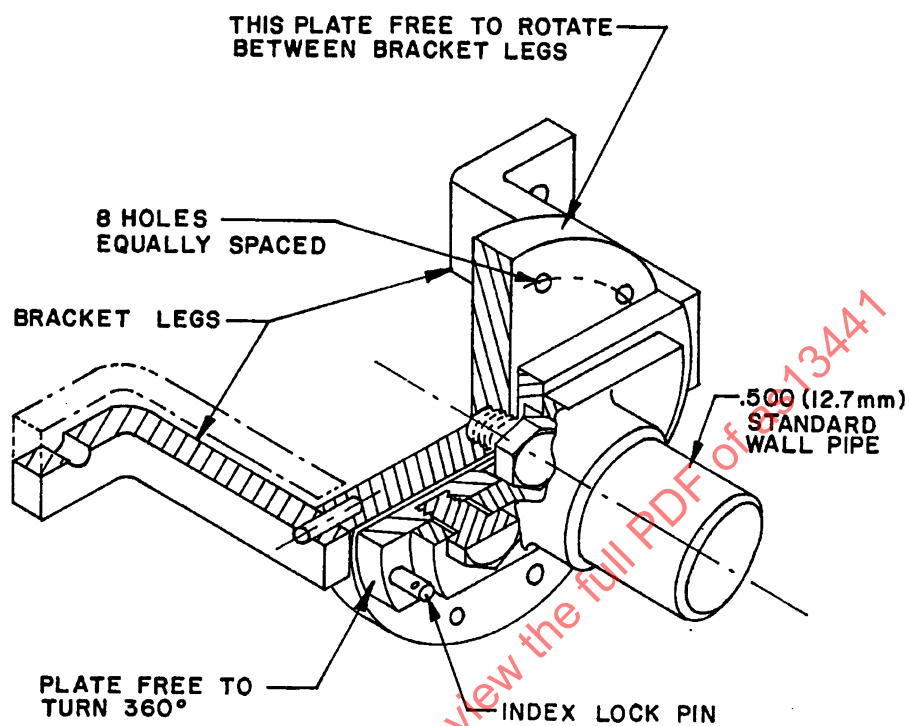


FIGURE 1. Test fixture (typical).

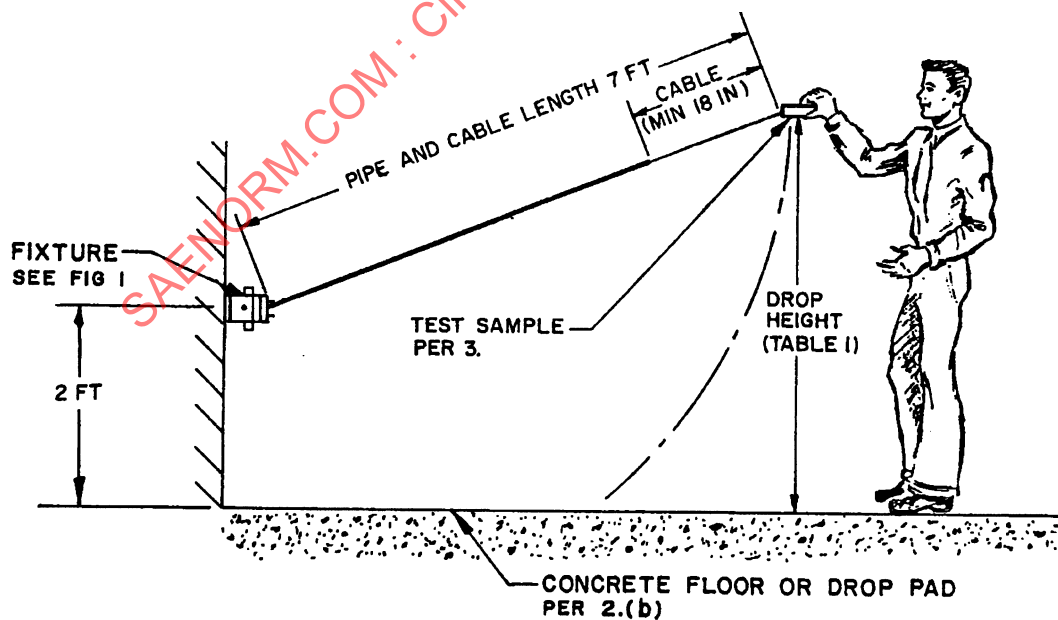


FIGURE 2. Impact test procedure per 4.(b).

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TABLE I. Drop height and number of drops.

Drop height	Service class		
	Light	Moderate	Severe
8 feet (2.438 m)	---	8	8
6 feet (1.829 m)	8	---	8
4 feet (1.219 m)	---	8	8
2 feet (.610 m)	---	---	8
4 inches (101.6 mm)	---	---	8
Total drops	8	16	40

4. (Continued):

c. Acceptance criteria shall be as specified. Typical indications of damage resulting from this test are:

- (1) Inability to mate or unmate.
- (2) Broken parts or accessories.
- (3) Electrical failure.
- (4) Damage to seals.

5. DOCUMENTATION:

The data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Test sample description (see 3. a.).
- b. Length of pipe and cable, if other than specified in 3. b.
- c. Drop height, if other than specified in 4. b.
- d. Number of impacts, if other than specified in 4. b.
- e. Acceptance criteria (see 4. c).
- f. Service class (see table I).

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METHOD 2016 DURABILITY

1. PURPOSE:

The purpose of this test is to determine the effects of subjecting connectors or contacts to mating and unmating cycles simulating the expected life of such connectors.

2. TEST EQUIPMENT:

- a. Test blade as shown in figure 1 to simulate a mating printed wiring board of maximum thickness for card-edge receptacles.
- b. Clamps, jaws, or other means to hold the receptacle, plug, test blade, or contacts.
- c. Automatic or semiautomatic tester to mate and unmate the connector at the specified rate.

NOTE: While manual cycling of the connectors is permitted, proper alignment and orientation is most readily maintained in a mechanical device specifically designed for this test.

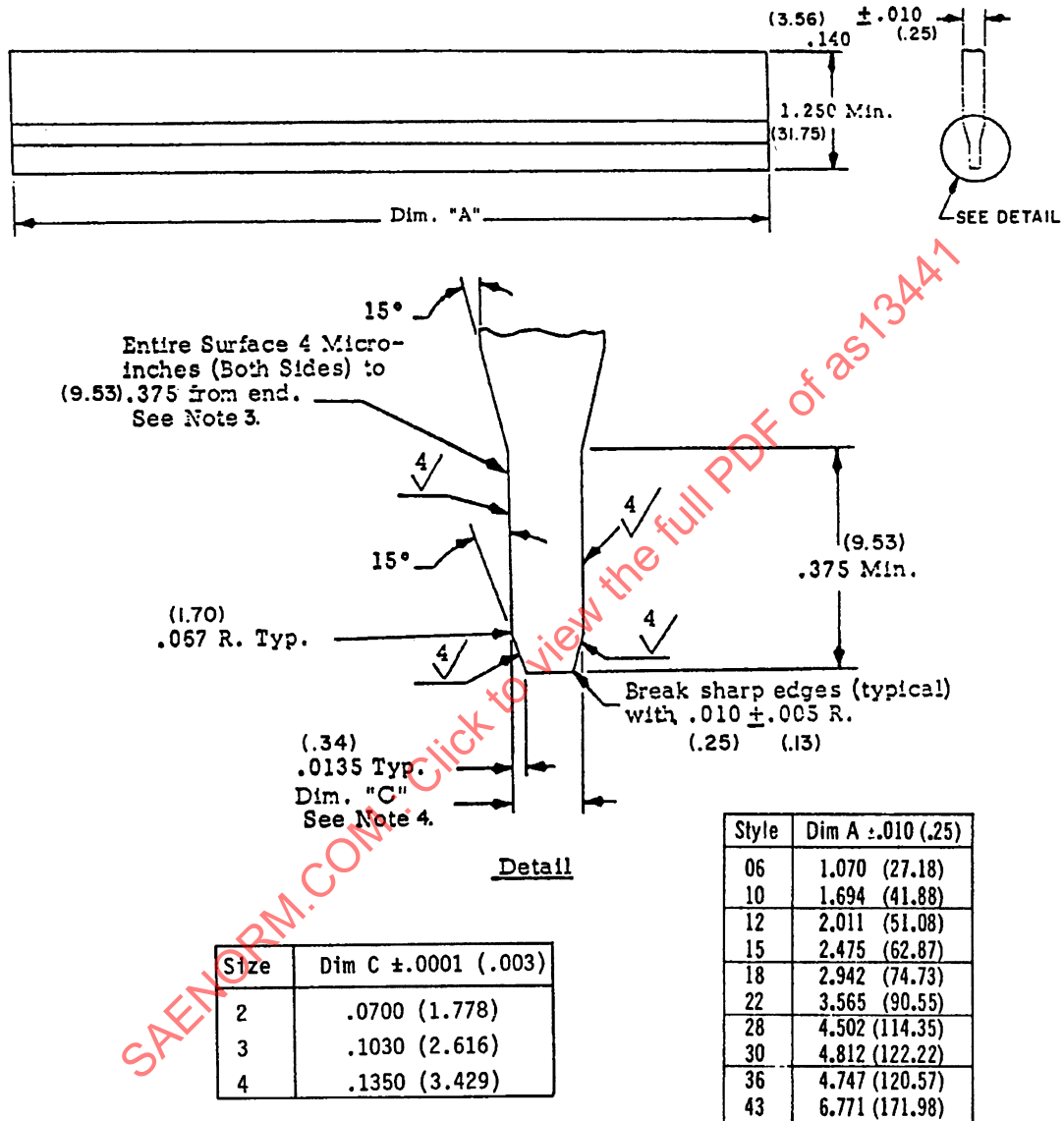
3. TEST SAMPLE:

- a. A connector (plug and receptacle or contacts) complete with all applicable guide, keying, and engaging hardware or a card-edge receptacle.
- b. Unless otherwise specified, the test samples shall not receive special lubrication or coating prior to or during this test.

4. TEST PROCEDURE:

- a. The sample shall be mounted in the tester, carefully aligned, and fully mated and unmated the number of cycles specified.
- b. Unless otherwise specified, the cycle rate shall not exceed 300 per hour and no electrical load shall be applied to the samples during the test.
- c. At the intervals specified, inspections or tests may be performed.
- d. At the completion of the specified number of cycles, the sample shall be visually examined, as applicable for evidence of the following:
 - (1) Wear on engaging hardware.
 - (2) Uneven wear, galling, or removal of plating on contacts, guide hardware, etc.
 - (3) Free metal chips in the contact area.
 - (4) Displaced, bent, or broken contacts.
 - (5) Pierced resilient inserts or broken or chipped hard dielectrics.

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NOTES:

1. Dimensions are in inches.
2. Unless otherwise specified, tolerance is $\pm .005$ (.13 mm) for three place decimals.
3. Only the working surfaces designated 4 shall be finished.
4. .002 (.05 mm) TIR warpage permitted for full length of dimension A.
5. Metric equivalents are given for general information only and are based upon 1.00 inch = 25.4 mm.
6. Millimeters are in parentheses.

FIGURE 1. Test blade.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Lubrication or coating, if required (see 3. b.).
- b. Number of mating and unmating cycles (see 4. a.).
- c. The minimum individual contact separation force during or after the test. Cycle rate, if other than 300 cycles per hour (see 4. b.).
- d. Inspections or tests, before, during, and after tests (see 4. c.).

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METHOD 2017 CABLE SEAL FLEXING

1. PURPOSE:

- 1.1 The purpose of this test is to determine the effectiveness of circular jacketed cable to plug interface, or flat cable to plug interface to withstand strain under repeated alternating cable-flexing stresses as experienced in use with cable strain-relief design electrical connectors.

2. TEST EQUIPMENT:

2.1 Test equipment applicable to test procedure I (circular jacket cable, see figure 1):

- a. Apparatus capable of applying forces to a molded plug assembly, so as to cause such assembly to be flexed in a plane, through 180° of arc, alternately from a position 90° from the vertical on one side to a position 90° from the vertical on the other side, at an adjustable frequency which includes a frequency of 12 to 14 complete cycles (of 360° total traverse) per minute.
- b. Rollers (or rolls). Two smooth, cylindrical, equal-diameter steel, fixed position. Diameter of rollers to be:
 - (1) Approximately but not less than 2-1/2 times the maximum overall diameter of the cable (for cables of less than 0.800 inch); or,
 - (2) As specified in the cable specification.
- c. Equipment, such as magnifiers (approximate 3X) for examining cable-to-plug seal or cable jacket prior to and subsequent to testing.
- d. Equipment for checking the electrical continuity of the conductor to contact joints, prior to, during, and subsequent to testing.

2.2 Test equipment applicable to test procedure II (flat cable, see figure 2):

- a. A fixture capable of gripping the cable 12 inches from the connector with a uniform tension of $2 + .1$ pounds per inch-of-cable-width and capable of moving either the cable or connector through an arc of $140^\circ \pm 10^\circ$ (see method 2, figure 2).
- b. Equipment capable of monitoring current flow of 100 mA, maximum and to indicate discontinuity of 1 microsecond interruption of current flow.

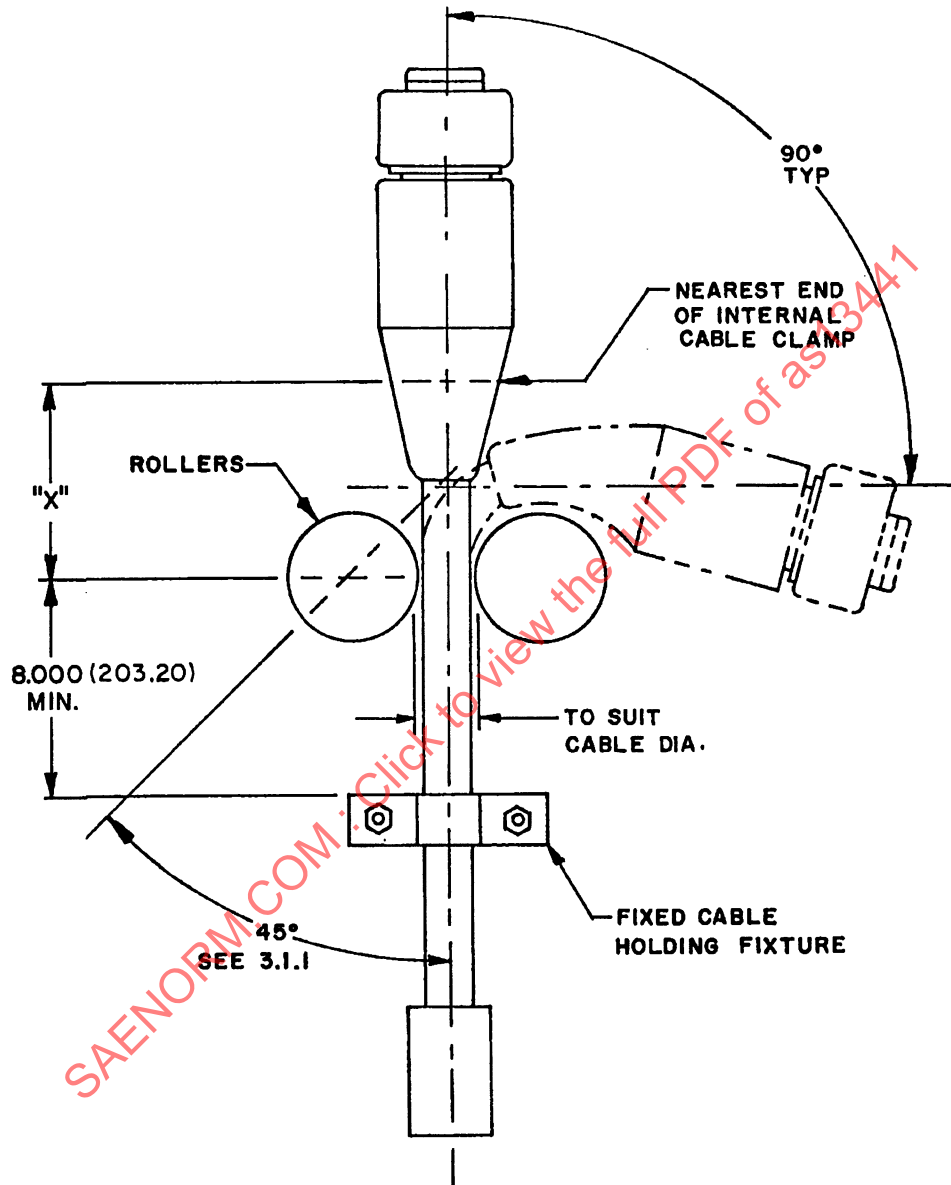
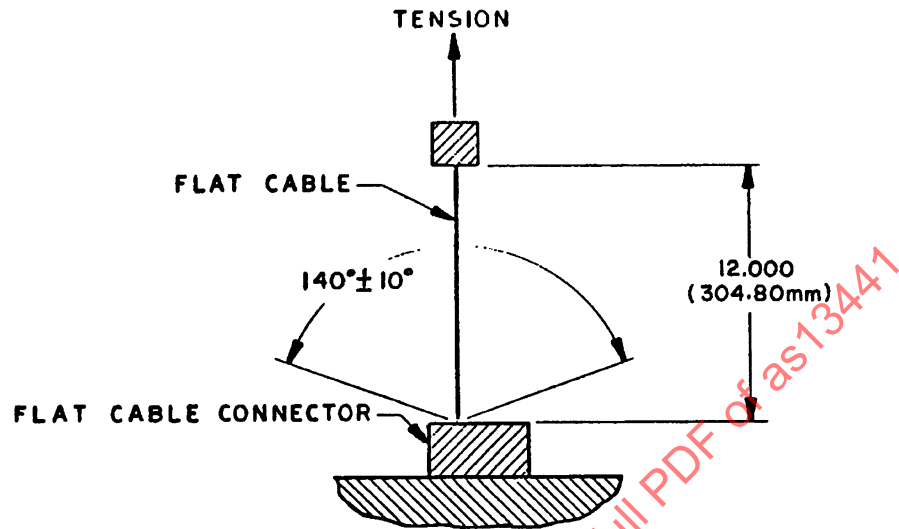
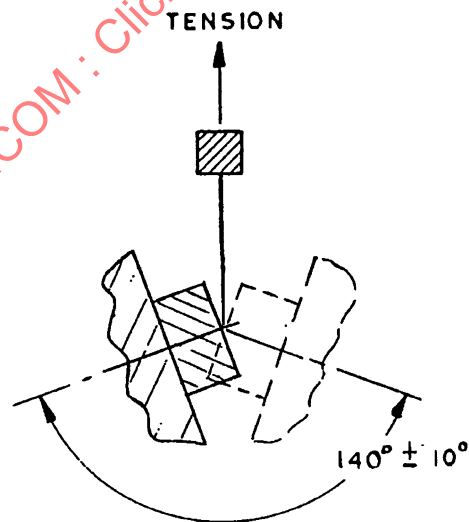


FIGURE 1. Circular cable flexing test setup.



METHOD NO. 1



METHOD NO. 2

FIGURE 2. Flat cable flexing methods.

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3. TEST SAMPLE:

3.1 The test sample shall consist of a wired connector of the type described in 1.1, unmated.

3.1.1 Test procedure I mounting (circular jacket cable, see figure 1):

- a. Its cable is loosely but almost tangentially situated between the two rollers (chosen in 2.1 b. and spaced apart slightly more than the maximum diameter of the cable).
- b. The bonded joint at the junction of the molded boot and the cable jacket shall be located approximately at 45° above the center line through the two rolls as shown in figure 1, in the case in which there is no cable clamp within the molded boot. If the molded boot contains a cable clamp, the dimension "X" (figure 1) in the individual specification shall be used to determine the position of the bonded joint (at the junction of the molded boot and the cable jacket). This is necessary to prevent damage to the internal cable clamp during flexing over the rollers.
- c. The nonfree section of the cable shall be clamped by a fixed cable holding fixture capable of applying uniform radial pressure to the cable core, so that slippage is minimized. Care shall also be exercised that clamping pressure is not excessive to damage connector cable.

3.1.2 Test procedure II mounting (flat cable, see figure 2):

- a. The assembled wired connector shall be installed in the fixture described in 2.2 a.
- b. Connector mounting and cable tension fixture shall be clamped so slippage is minimal. Care shall be taken that applied clamping pressure is not too excessive to damage connector or cable.

4. TEST PROCEDURE:

4.1 Test procedure I (circular jacket cable):

- a. With the test sample mounted as in 3.1.1 and figure 1, forces are applied so as to cause the molded boot to be repeatedly flexed 180° in opposite directions in the plane, over the rollers. A traverse of 180° in one direction plus 180° in the opposite direction shall be called one cycle. Unless otherwise specified, the cycling rate shall be 12 to 14 cycles per minute.
- b. At the completion of 100 cycles, examination of seal, jacket and cable holding fixture shall be made to determine the presence or absence of failure modes (reference 4.1.1 a.). Electrical continuity shall then be checked to determine presence or absence of failure mode (see 4.1.1 b.).
- c. The cable holding fixture shall then be sufficiently loosened to allow rotation of the cable 90°. The cable holding fixture shall then be retightened as in 3.1.1 c. and the procedure in 4.1 a. and 4.1 b. repeated.

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4.1.1 Potential failure modes: Check the following:

- a. Damage to cable-to-plug seal, or cable jacket, which could allow undesired substances (air, water, etc.) to enter, and to deteriorate further the seal or jacket, ultimately impairing the effectiveness of either or both.
- b. Weakening of, or destruction of conductor to contact joints, resulting in improper or defective electrical performance. There shall be no evidence of partial intermittent or complete shorting between conductors during and after test. There shall be no evidence of discontinuity between conductors during and after test.

4.2 Test procedure II (flat cable):

- a. With test sample mounted as in 3.1.2 a., each cable shall be individually loaded with specified weight.
- b. The cable or the connector shall be moved through an arc of $140^{\circ} \pm 10^{\circ}$ for 500 cycles using either method 1 or 2 of figure 2.
- c. One complete cycle shall consist of the rotation of the cable or connector from the neutral position to $70^{\circ} \pm 5^{\circ}$ in both directions. Unless otherwise specified, the cycling rate shall be 10 ± 1 cycles per minute.
- d. A monitoring current of 100 mA maximum shall be applied through the conductor of the test cables and the contacts of the connector in series. Either a dummy plug or receptacle or the actual test counterpart connector may be mated to the connector under test to facilitate making the series circuit.
- e. After the completion of 500 cycles, a visual inspection shall be made to check for flaws or damage of 4.1.1 a and electrical continuity of 4.1.1 b. The dielectric withstanding voltage shall be measured as specified in method 3001, with the following exceptions:
 - (1) Preparation - Wired, assembled and unmated. Flat cable conductor free ends may be prepared as the test sample is prepared in method 3003.
 - (2) Insulation resistance shall be as specified in method 3003.
 - (3) Magnitude and nature of test voltage - As specified in table I.

TABLE I. Test voltage at sea level.

Contact center spacing (inches)	Voltage at 60 cycles rms
0.050	800
0.075	1,500
0.100	2,000

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Test procedure.
- e. Values and observations:
 - (1) Test conditions and environments.
 - (2) Electrical continuity checks.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Applicable test condition (see 2., 3., and 4.).
- b. Diameter of rollers, if other than herein (see 2.1 b.).
- c. Allowable electrical discontinuity (see 4.1.1 b and 4.2 e.).
- d. Cycling rate, if other than herein (see 4.1 a and 4.2 c.).
- e. Total cycles for complete test, if other than herein (see 4.1 and 4.2).
- f. Special environmental conditions (see 4.1 and 4.2).
- g. Cable to be used (see 1.1).
- h. Dimension "X" in figure 1 (circular jacket cable).
- i. Use of method 1 or 2 of figure 2 (flat cable).
- j. Dielectric withstanding voltage (see 4.2 e.).
- k. Insulation resistance (see 4.2 e.(2)).

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METHOD 2018 GAGE LOCATION AND RETENTION

1. PURPOSE:

The purpose of this test is to determine the ability of a connector to comply with specified location and retention measurements through the use of location and retention test gages.

2. TEST EQUIPMENT:

- a. Retention test gage.
- b. Location test gage.
- c. Measurement device, English or metric, as applicable.
- d. Force gage with accuracy of ± 2 percent.
- e. Test fixture.

3. TEST SAMPLE:

A test sample shall consist of a plug or receptacle.

3.1 Preparation:

The cavities to be tested shall be unwired, no accessory hardware, and unmated.

3.2 Mounting:

Test sample shall be mounted in a position of axial alignment with gage.

4. TEST PROCEDURE:

4.1 Gage location test:

Applicable test gages specified shall be installed in three randomly selected cavities of each contact size of each connector. With the gages fully seated against the contact retention device, the axial location of the front of the gages shall be measured relative to the specified reference plane.

4.2 Gage retention test:

Applicable test gages specified shall be installed in three randomly selected cavities in each connector. The axial load specified shall be applied to the individual test gages in both directions. The load shall be applied at a rate of approximately 1 pound per second until the specified load has been reached. Gage displacement shall be measured with respect to the connector shell after an initial load of 2 pounds has been applied to assure that all slack has been taken up. The axial displacement of the gage shall not exceed 0.012 inch or as specified: No damage to gage or insert shall occur.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Test gages (see 4.1 and 4.2).
- b. Reference point for gage location measurement (see 4.1).
- c. Maximum allowable displacement after initial load has been applied, if other than specified herein (see 4.2).
- d. Applied axial load (see 4.2).

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METHOD 2019 SOLDER WICKING

1. PURPOSE:

The purpose of this test is to assure that a connector can be wave soldered to a printed circuit board, without sustaining damage caused by solder wicking onto the contacting surfaces.

2. TEST EQUIPMENT:

- a. A machine capable of providing all wave solder variables listed in 4.1a through 4.1e shall be used.
- b. A 10X microscope or magnifying glass shall be used for final examination of the sample.

3. TEST SAMPLE:

A test sample shall consist of a connector.

3.1 Sample preparation:

The sample shall be mounted on a printed wiring board with terminals inserted in plated-thru-holes. The printed wiring board shall be NEMA grade G10 or FR-4 glass epoxy with 2 ounces (56 grams) copper on both sides, .062 inch (1.59 mm) thick. The terminal holes shall be plated-thru in accordance with MIL-P-55110. Hole size shall be such that diametral clearance between the plated-thru-holes and the test connector terminals shall not exceed .015 inch (.38 mm). The physical dimensions of the printed wiring board and the number of samples mounted shall be as specified.

4. TEST PROCEDURE:

The printed wiring board with test samples installed shall be mounted on a conveyor and at a controlled speed, shall pass through the following processes:

- a. Foam flux: The bottom surface of the board shall pass through a mildly activated warm flux, type RMA per MIL-F-14256 or equivalent.
- b. Pre-heat: The board shall pass through electric heaters which raise the top surface of the board to 100°C ±5°C.
- c. Solder wave: The board shall pass through the solder wave (see 4.1).

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4.1 Solder wave description:

- a. The solder alloy shall be composition SN60 or SN63 per QQ-S-571.
- b. Soldering fluid, if used, shall be mixed with the molten solder for reduction of solder surface tension. If used, the soldering fluid shall be water soluble or petroleum based.
- c. A solder temperature of $260^{\circ}\text{C} \pm 3^{\circ}\text{C}$ shall be maintained and measured at the top of the wave.
- d. The printed wiring board shall be immersed to a depth of 1/2 to 2/3 the board thickness while traversing the solder wave.
- e. Solder wave contact length (see 4.2) shall be not less than 1 inch (25.4 mm), and not greater than 3 inches (.76 mm).

4.2 Time duration of exposure to the solder wave:

Let S = Speed of the conveyor in feet/minute.

Let D = Solder wavelength (distance a point on the printed wiring board must travel within the solder wave) (inches).

Let T = Time for a point on the printed wiring board to traverse the solder wave (seconds).

$$\text{Then } T = \frac{5D}{S}$$

5 = Conversion constant for Ft/Min to In/Sec.

4.3 Examination:

At the conclusion of the test, the connector shall be disassembled and examined under 10X magnification for any solder damage. Solder damage is defined as any solder on the contact mating surface, solder that interferes with the operation of spring pressure mechanisms, or solder that interferes in any way with the intended mating function of the contact.

5. DOCUMENTATION:

Data sheets shall contain the following:

- a. Title of test, date, and name of operator.
- b. Description of sample connector and printed wiring board.
- c. Test equipment.
- d. Test procedure.
- e. Results. A description of the condition of the contacts following solder exposure.

6. SUMMARY:

The following details shall be specified in the individual connector specification.

- a. Special preparation or conditions, if required.
- b. The inside diameter of plated-thru-holes in the printed wiring board.
- c. The diameter (if round) or width (if flat) of the test connector terminals.
- d. Examination of specimen.
- e. Define test connector. Any special conditions.
- f. Number of samples to be tested.
- g. The dimensions of the printed wiring board.

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METHOD 3001.1 DIELECTRIC WITHSTANDING VOLTAGE

1. PURPOSE:

The purpose of this test is to prove that a given electrical connector or coaxial contacts can operate safely at its rated voltage and withstand momentary overpotentials due to switching, surges, and other similar phenomena. The dielectric withstanding voltage shall be established as 75 percent of the minimum breakdown voltage of the connector or coaxial contacts. It is suggested that the operating rated voltage of the connector or coaxial contacts be established as one-third of the dielectric withstanding voltage.

2. TEST EQUIPMENT:

2.1 High voltage source:

The nature of the potential (ac or dc) shall be as specified. When an alternating potential is specified, the test voltage provided by the high-voltage source shall be nominally 60 hertz in frequency and shall approximate, as closely as possible, a true sine wave in form. Other commercial power frequencies may be used for inplant quality conformance testing, when specified. All alternating potentials shall be expressed as root-mean-square values, unless otherwise specified. The kilovoltampere rating and impedance of the source shall be such as to permit operation at all testing loads without serious distortion of the waveform and without serious change in voltage for any setting. When the test specimen demands substantial test source power capacity, the regulation of the source shall be specified. When a minimum kilovoltampere rating is required, it shall be specified. When a direct potential is specified, the ripple content shall not exceed 5 percent rms of the test potential. When required, a suitable current-limiting device shall be used to limit current surges to the value specified.

2.2 Voltage measuring device:

A voltmeter shall be used to measure the applied voltage to an accuracy of at least 5 percent, unless otherwise specified. When a transformer is used as a high-voltage source of alternating potential, a voltmeter connected across the primary side or across a secondary or tertiary winding may be used provided it is previously determined that the actual voltage across the test specimen will be within the allowable tolerance under any normal load condition.

2.3 Leakage current measuring device:

When any leakage current requirement is specified, a suitable method shall be used to measure the leakage current to an accuracy of at least 5 percent of the specified requirement. Since deterioration due to excessive leakage currents may have an adverse effect on the electrical parameters or physical characteristics of the connector or coaxial contacts, the leakage current during the test shall be limited to a maximum of 5 milliamperes.

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2.4 Fault indicator:

Suitable means shall be provided to indicate the occurrence of disruptive discharge and leakage current in case it is not visually evident in the specimen. The voltage measuring device of 2.2, the leakage current measuring device of 2.3, an appropriate indicator light, or an overload protective device may be used for this purpose.

2.5 Test chamber:

The test chamber used for the barometric-pressure test shall consist of a vacuum pump and a suitable sealed chamber having means for visual observation of the specimen under test when necessary. A suitable pressure indicator shall be used to measure the simulated altitude in the sealed chamber.

3. TEST SAMPLE:

A test sample shall consist of a plug, a receptacle, a mated plug and receptacle, or a coaxial pin and socket contact.

4. TEST PROCEDURE:

4.1 Preparation:

When special preparations or conditions such as special test fixtures, reconnections, grounding, isolation, or immersion in water are required, they shall be specified.

4.2 Test voltage:

Samples shall be subjected to a test voltage of the magnitude and nature (ac or dc) specified.

4.3 Points of application:

The test voltage for connectors shall be applied between the most closely spaced contacts and between connector shell and the contact closest to the shell. The test voltage for coaxial contacts shall be applied between the inner and outer conductors. The method of connection of the test voltage to the sample shall be specified only when it is a significant factor.

4.4 Rate of application:

Unless otherwise specified, the test voltage shall be raised from zero to the specified value as uniformly as possible, at a rate of approximately 500 volts (rms or dc) per second, unless otherwise specified. At the option of the manufacturer, the test voltage may be applied instantaneously during inplant quality conformance testing.

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4.5 Duration of application:

Unless otherwise specified, the test voltage shall be maintained at the specified value for a period of 60 seconds. For inplant testing, when specified, the time may be reduced to 5 seconds, minimum.

4.6 Examination and measurement of specimen:

During the dielectric withstanding voltage test, the fault indicator shall be monitored for evidence of disruptive discharge and leakage current.

4.7 Barometric pressure (at sea level):

Since the barometric pressure greatly affects the withstanding voltage characteristics of the connector or coaxial contacts between the terminals through air, this shall be specified as a requirement of the test. Test voltages shall be specified that allow for the decrease in withstanding voltage capability that occurs at reduced barometric pressures. A basic withstanding voltage requirement shall be specified in every case for sea level applications. If required, depending on the connector or coaxial contacts application, a basic withstanding voltage requirement shall be given for a reduced pressure that approximates the reduced pressure under which the connectors or coaxial contacts are expected to operate (see General Requirements test conditions).

- 4.7.1 Reduced barometric pressure: The connectors or coaxial contacts shall be mounted in the test chamber as specified and the pressure reduced to the value indicated in one of the test conditions in table I, as specified. While the connectors or coaxial contacts are maintained at the specified pressure, and after sufficient time has been allowed for all entrapped air in the chamber to escape, the connectors or the coaxial contacts shall be subjected to the specified tests.

TABLE I. Test conditions.

Test condition	Pressure	Altitude	
		<u>feet</u>	<u>meters</u>
I	760	0	0
II	226	30,000	9,144
III	87	50,000	15,240
IV	33	70,000	21,336
V	8	100,000	30,480
VI	2.4×10^{-6}	656,000	200,000

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, date, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Nature of potential (ac or dc) (see 2.1).
- b. Special high-voltage source, if applicable (see 2.1).
- c. Minimum kilovoltampere rating, if applicable (see 2.1).
- d. Current surge limits, and limiting device, if applicable (see 2.1).
- e. Voltmeter accuracy, if other than at least 5 percent (see 2.2).
- f. Leakage current limit, if other than 5 milliamperes maximum (see 2.2).
- g. Special preparations or conditions, if required (see 2.2 and 4.1).
- h. Define test sample (mated or unmated) (see 3.).
- i. Magnitude of test voltage (see 4.2).
- j. Inplant testing, if applicable (see 4.5).
- k. Points of application of test voltage (see 4.3).
- l. Method of connection of test voltage to sample, if significant (see 4.3).
- m. Examination and measurement of sample (see 4.6):
 - (1) Detail requirements, if required.
- n. Barometric pressure test condition (see 4.7):
 - (1) Dielectric withstanding voltage requirement at sea level (see 4.7).
 - (2) Dielectric withstanding voltage requirement at reduced pressure, if applicable (see 4.7).
 - (3) Tests during and after subjection to reduced pressure (see 4.7.1).
 - (4) Method of mounting in test chamber (see 4.7.1).

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METHOD 3002.1 LOW-SIGNAL LEVEL CONTACT RESISTANCE

1. PURPOSE:

The purpose of this test is to evaluate contact resistance characteristics of electrical contacts under conditions where applied voltages and currents do not alter the physical contact interface or modify the nonconductive oxide films which may be present. The applied test voltage shall not exceed 20 millivolts open circuit, and the test current shall be limited to 100 milliamperes. Performance at these levels is indicative of contact interface performance using lower levels of electrical excitation.

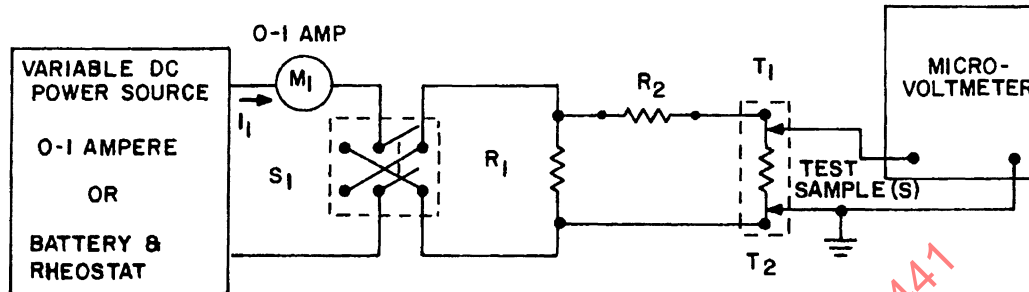
2. TEST EQUIPMENT:

- a. Microvoltmeter (digital or analog) of suitable range certified to provide a measurement accuracy of 2 percent of reading.
- b. Low-level circuit of figure 1 or equivalent, delivering 100 milliamperes at 20 millivolts open circuit dc potential.

3. TEST SAMPLE:

- a. A test sample may consist of a mated pair of contacts or a terminated conductor.
- b. Contacts shall be wired as shown in figure 2, if applicable, with the wire required for the contact under test as specified in the contact or connector specification.
- c. Test samples may be installed in a suitable connector and engaged as in normal service. Samples not installed in a connector shall not be rigidly fixed by any method that might influence the forces acting on the interface between the mating contacts. Connectors that do not have a locking feature shall be secured to provide mechanical stability.

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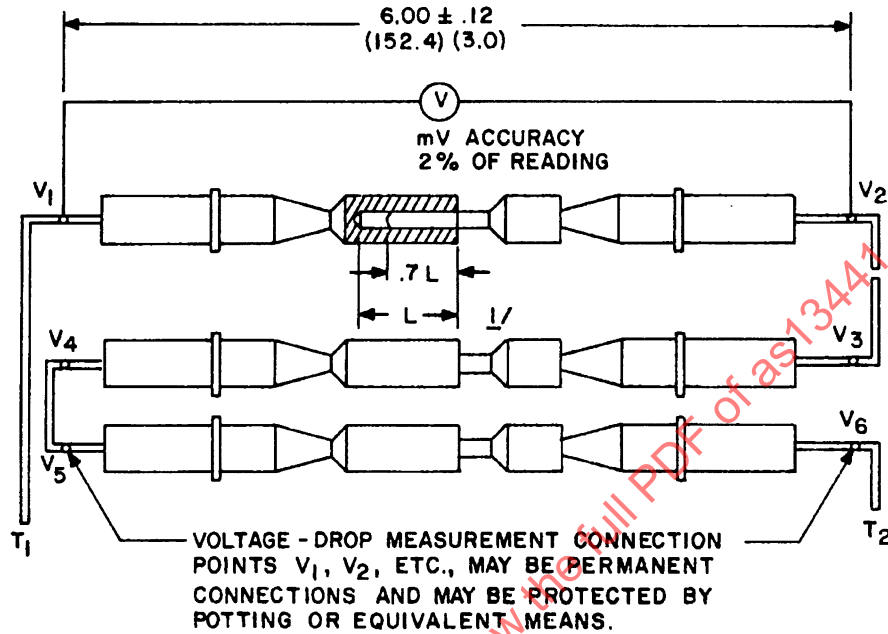
NOTE: Circuit requirements at sample position; terminals $T_1 - T_2$

Open circuit voltage	20 mV	maximum
Short circuit current	100 mA	maximum

- M_1 - DC ammeter, 1 amp F.S., $\pm 10\%$. This meter is optional, and is used to provide rough indication of applied open circuit voltage. ($I_1 \times R_1 = \text{Open circuit voltage}$).
- R_1 - Standard resistor, .020 ohms. Suggest an ammeter shunt giving 20 mV at 1 ampere.
- R_2 = Resistor .2 ohms minimum. May serve as a current limiting resistor and a current measuring resistor. This resistor may be replaced with a dc milliammeter, zero center, 100 mA F.S., 1% accuracy. If this meter has a shunt resistance less than .2 ohms, add enough resistance to bring total up to .2 ohms minimum.
- S_1 - Reversing switch, center off position.

FIGURE 1. Typical low level circuit.

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1/ Nominal socket bore depth.

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only and are based upon 1.00 inch = 25.4 mm.
3. Metric equivalents are in parentheses.

FIGURE 2. Typical wiring diagram.

4. TEST PROCEDURE:

- a. The low-level test shall be conducted using the circuit shown in figure 1, or an equivalent power source circuit that will deliver a maximum applied voltage of 20 mV open circuit and a maximum test current of 100 mA between T_1 and T_2 . A measurement of the voltage drop across the test specimen while carrying a known current will yield the parameters necessary to determine contact resistance. The contact resistance shall be calculated to exclude errors due to voltage null offset and thermal potentials by using the equation in (1). This equation shall be used in all cases wherein forward and reverse currents are not equal.

$$(1) \text{ Sample resistance} = \frac{|V \text{ forward}| + |V \text{ reverse}|}{|I \text{ forward}| + |I \text{ reverse}|}$$

It has been assumed that V reverse and I reverse have opposite polarity to those values observed as V forward and I forward. If polarity reversals are not noted (for instance, when thermal potentials are very large), appropriate sign changes must be made in the above expression. In the special case wherein the magnitudes of forward and reverse currents are exactly equal, this equation reduces to:

$$(2) \text{ Sample resistance} = \frac{1}{2I} [|V \text{ forward}| + |V \text{ reverse}|]$$

or

$$(3) \text{ Sample resistance} = \frac{\text{forward resistance} + \text{reverse resistance}}{2}$$

The sample resistance shall not exceed the maximum allowable contact resistance defined in the individual specification. If the total resistance between T_1 and T_2 of figure 2 results in voltage drop measurement out of the required accuracy range of the instrumentation, then the total contacts in series shall be reduced for accurate results.

- b. The following precautions shall be observed before and during the test.
- (1) The test sample shall not be subjected to a potential of more than 20 millivolts dc open circuit voltage either before or during the test.
 - (2) In the circuit shown in figure 1 the three-position switch shall be open before each contact resistance measurement to zero the voltmeter.
 - (3) Acceptance criteria shall be established as the maximum resistance level at which stable electrical contact is maintained. This resistance is an inherent characteristic of any given connector contact design and when the connector is properly applied, is well below the resistance level required for circuit function.
 - (4) Voltage-drop measurement connection points may be permanent connections and may be protected by potting or equivalent means.

5. DOCUMENTATION:

Data sheets shall contain:

- a. Title of test, data, and name of operator.
- b. Sample description - Include fixture, if applicable.
- c. Test equipment used and date of latest calibration.
- d. Identification of test method.
- e. Values and observations:
 - (1) Identify each contact pair in the test sample.
 - (2) Record the measured current and voltage drop in each direction for each contact pair, as applicable.
 - (3) Calculate and record the contact resistance in both directions, as applicable.

6. SUMMARY:

The following details shall be specified in the individual specification:

- a. Size wire specified (see 3. b.).
- b. Maximum allowable contact resistance (see 4. a.).
- c. Individual contact mating depth, if applicable (figure 2).
- d. Voltage drop measurement points, if test sample configuration differs from figure 2 (see figure 2).