

MIL-C-28731D
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~~SUPERSEDING~~
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MILITARY SPECIFICATION

CONNECTORS, ELECTRICAL, RECTANGULAR,
REMOVABLE CONTACT, FORMED BLADE, FORK TYPE
(FOR RACK AND PANEL AND OTHER APPLICATIONS)

GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification covers rectangular, electrical connectors with removable formed blade, fork type contacts, intended for use in electronic and electrical equipment (see 6.1).

2. APPLICABLE DOCUMENTS

2.1 Government specifications and standards. Unless otherwise specified, the following specifications, standards, and handbooks, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-A-591	-	Aluminum Alloy Die Castings.
QQ-B-750	-	Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
QQ-N-290	-	Nickel Plating (Electrodeposited).
QQ-P-416	-	Plating, Cadmium (Electrodeposited).

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MIL-M-14	-	Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-F-14072	-	Finishes for Ground Electronic Equipment.
MIL-W-16878	-	Wire, Electrical, Insulated, General Specification for.
MIL-W-16878/4	-	Wire, Electrical, Polytetrafluoroethylene (PTFE) Insulated, 200 C, 600 volts, Extruded Insulation.
MIL-C-22520/17	-	Crimping Tools, Terminal, Hand, Wire Termination For Crimp Type Removable Contacts, Electric Connectors.
MIL-C-28731/20	-	Connector, Electrical, Contact, Fork Type, Crimp Removable (8.5 Amperes).
MIL-C-28731/25	-	Connector, Electrical, Contact, Fork Type, Wire Hole Removable.
MIL-C-28731/35	-	Connector, Electrical, Contact, Fork Type, Crimp Removable (5.0 Amperes).
MIL-G-45204	-	Gold Plating, (Electrodeposited).
MIL-C-55330	-	Connectors, Electrical and Fiber Optic, Packaging of.
MIL-P-81728	-	Plating, Tin-Lead (Electrodeposited).
MIL-I-81969/4	-	Installing and Removal Tools, Connector Electrical Contact, (Fork Type Wraipost/Crimp, Removable Contacts), Electrical Connectors.
MIL-I-81969/5	-	Installing and Removal Tools, Connector Electrical Contact, (Fork Type, Crimp, Removable), Type 1, Class 1, Composition A.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Electronic Systems Command, ATTN: ELEX 8111, Department of the Navy, Washington DC, 20363, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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- MIL-I-81969/11 - Installing and Removal Tools, Connector Electrical Contacts, (Type CR), Type II, Class 1, Composition C.
 MIL-I-81969/13 - Installing and Removal Tools, Connector Electrical Contact, (Type CR), Type I, Class 1, Composition A.

(See supplement 1 for list of associated specifications)

STANDARDS

FEDERAL

- FED-STD-66 - Steel: Chemical Composition and Hardenability.

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
 MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
 MIL-STD-454 - Standard General Requirements for Electronic Equipment.
 MIL-STD-1130 - Connections, Electrical, Solderless Wrapped.
 MIL-STD-1285 - Marking of Electrical and Electronic Parts.
 MIL-STD-1344 - Test Methods for Electrical Connectors.
 MIL-STD-45662 - Calibration Systems Requirements.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DoD adopted shall be the issue listed in the current DoDISS and the supplement thereto, if applicable.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 484 - General Requirements for Stainless and Heat-Resisting Wrought Steel Products (Except Wire).
 ASTM A 582 - Free-Machining Stainless and Heat-Resisting Steel Bars, Hot-Rolled or Cold Finished.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

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

2.3 Order of precedence. In the event of conflict between the text of this specification and the references other than specification sheets cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets. In the event of any conflict between requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. Connectors and contacts furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5 and 6.3).

3.3 Material. Material shall be as specified herein. When a definite material is not specified, a material shall be used which will enable the connectors and contacts to meet the performance requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

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3.3.1 Contacts. Contacts shall be made of phosphor bronze in accordance with QQ-B-750.

3.3.1.1 Plating. Unless otherwise specified, the contacts shall be plated as follows.

3.3.1.1.1 Contact mating area. The contact mating area shall be gold plated in accordance with MIL-G-45204, type II, grade D, class 1 (50 microinches minimum) gold finish over a nickel underplate in accordance with QQ-N-290, class 2, 50 microinches minimum. The contact mating area shall be as specified (see 3.1).

3.3.1.1.2 Terminations.

3.3.1.1.2.1 Wrappost terminations. Wrappost terminations shall be plated in accordance with MIL-STD-1130.

3.3.1.1.2.2 Solder terminations. Solder terminations shall be tin-lead plated in accordance with MIL-P-81728, .00010 inch (0.0025 mm) minimum thickness, over a nickel underplate in accordance with QQ-N-290, class 2, 50 microinches minimum.

3.3.1.1.2.3 Crimp terminations. Crimp terminations shall be gold plated, 50 microinches minimum over a nickel underplate in accordance with QQ-N-290, class 2, 50 microinches minimum.

3.3.1.1.3 Remaining areas of the contact. Those areas of the contact not included in 3.3.1.1.1 and 3.3.1.1.2 shall be nickel plated per QQ-N-290, class 2 with a minimum thickness of 50 microinches. Overplating is not required in this area.

3.3.1.1.4 Contacts furnished in strip form. If contacts are furnished in strip form, when the contact is separated from the carrier strip, the absence of the nickel or other plating at the broken edge of the contact is acceptable, provided it is in a nonfunctional area or the contact and any corrosion formed as a result of the salt spray test does not creep into the contact mating area.

3.3.2 Connector shields and clamps. Shields and clamps shall be die-cast aluminum or corrosion-resistant steel. Die-cast aluminum, if used, shall conform to composition number 13, A13, A380, or 360 of QQ-A-591, and workmanship in accordance with QQ-A-591. Sheet metal shall conform to FED-STD-66. All shields and clamps (except nylon strap) shall be plated in accordance with finish no. M225 of MIL-F-14072.

3.3.3 Engaging hardware. All stress bearing hardware shall be type 303 or 416 corrosion-resistant steel in accordance with ASTM A 484 and ASTM A 582. All hardware shall be passivated in accordance with finish no. E300 of MIL-F-14072. Actuating hardware shall be dry film lubricated.

3.3.4 Other hardware. Nonstress bearing hardware shall be type 303 or 416 corrosion resisting steel in accordance with ASTM A 484 and ASTM A 582, or noncorrosion resisting metal parts which shall be plated with cadmium in accordance with QQ-P-416, class 3, type II. All finishes shall be conductive unless otherwise specified (see 3.1).

3.3.5 Insert material. Insert material shall be of a diallyl phthalate material in accordance with type SDG-F or GDI-30F of MIL-M-14.

3.3.6 Dissimilar metals. When dissimilar metals are employed in intimate contact with each other, protection against electrolytic corrosion shall be provided as specified in requirement 16 of MIL-STD-454.

3.4 Design, construction, and physical dimensions.

3.4.1 Connectors. Connectors shall be of the design, construction, and physical dimensions specified (see 3.1). The temperature range shall be from -65 C to +125 C. The connector shall permit individual insertion and removal of the contacts with the insertion and removal tools in accordance with 3.4.2.3. Wire conductors shall be attached to the applicable contacts by crimping, soldering, or wrapping as specified herein (see 3.1).

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3.4.1.1 Insert design. Inserts shall be of one-piece construction and shall be such that they will not crack, chip, or break in normal service or assembly. Split or hollow inserts glued or bonded together shall not be used. The insert dimensions shall be as specified (see 3.1). The contact hole configuration for the contacts shall conform to the dimensions (see 3.1). Contacts when assembled in the male or female plug shall be recessed a minimum of .020 inch (0.51 mm) below the outer protective flange. Contacts when assembled in the female or male receptacle shall be recessed a minimum of .020 inch (0.51 mm) below the face of the plastic insert.

3.4.2 Contacts. Contact configuration shall be as specified (see 3.1).

3.4.2.1 Contact design. Contact design shall provide for crimp, solder, or wrappost terminations and be designed so that they will not be damaged by mating or unmating with the connectors. The contact, for use in both the plug and the receptacle, shall be of the formed blade, fork type. Mating contacts shall be 90° to each other when assembled and provide for positive spring contact wiping action. Each contact shall contain a means of firmly locking itself when installed in the insert. The locking feature shall be such that insertion and removal of the contact may be accomplished using tools as specified in 3.4.2.3.

3.4.2.2 Crimping tool. The crimping tool shall be in accordance with MIL-C-22520/17.

3.4.2.3 Insertion and removal tools. Insertion and removal tools shall be used to assemble and disassemble contacts. These tools shall be in accordance with MIL-I-81969/11, MIL-I-81969/13, MIL-I-81969/4 and MIL-I-81969/5.

3.4.2.4 Wire inspection. Subsequent to crimping of the wire to the contact, visual inspection shall be made to ascertain that the wire fully engages the wire crimp tabs.

3.4.2.5 Wrappost. Wrappost shall meet the wrappost requirements of MIL-STD-1130.

3.4.3 Polarization. Polarization of the plug with its receptacle shall be accomplished by mechanical means such as the protective shell, bosses, guide pins, guide sockets, or jackscrews (see 3.1).

3.4.4 Mating. Unless otherwise specified (see 3.1), connector plugs and receptacles shall be capable of being mated and unmated by hand without the aid of special tools, within the temperature range.

3.4.5 Mounting accessories. Guide pins, guide sockets, shields, and other hardware shall be as specified (see 3.1).

3.4.6 Actuating hardware design. To aid in the engagement of connectors, actuating hardware shall be used as required. This hardware shall be categorized as follows and be denoted by their associated type.

3.4.6.1 Type C jackscrew. Rotatable actuating member with a male thread (engages with a type F fixed socket). The actuating knob includes a screwdriver slot.

3.4.6.2 Type D jacksocket. Rotatable actuating member with a female thread (engages with a type E fixed screw).

3.4.6.3 Type E fixed screw. Fixed actuating member with a male thread (engages with a type D or H jacksocket).

3.4.6.4 Type F fixed socket. Fixed actuating member with a female thread (engages with a type C or G jackscrew).

3.4.6.5 Type G jackscrew. Rotatable actuating member with a male thread (engages with a type F fixed socket). Actuating knob is for hand tightening only.

3.4.6.6 Type H jacksocket. Rotatable actuating member with a female thread (engages with type E fixed screw). Actuating knob includes a screwdriver slot.

3.5 Interchangeability. All contacts shall be capable of being assembled in the molded insulators (see 3.1) and be completely interchangeable with each other with

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respect to installation (physical) and performance (function) as specified herein. All complete connectors including their complement of contacts, having the same part number shall be completely interchangeable with each other with respect to installation (physical) and performance (function) as specified herein. Tools shall be capable of properly inserting and removing the contacts from the molded inserts. Evidence, such as dimensional data, may be required by the Government in order to assure that contacts, complete connector assemblies, and tools, will be interchangeable and meet the requirements of this specification.

3.5.1 Plugs and receptacles. Plugs and receptacles of a given size and design, manufactured by one source to the requirements of this specification, shall be capable of mating with associated plugs and receptacles manufactured to the requirements of this specification by other sources. The connector assemblies having the same part number shall be directly and completely interchangeable with respect to installation and performance.

3.5.2 Loose crimp contacts. Removable contacts are to be included with the connector. For connectors supplied with loose crimp contacts, the quantity of crimp contacts to be supplied with each connector shall consist of a full complement of contacts plus one spare contact for connectors using 26 contacts or less. For arrangement utilizing more than 26 contacts, 2 spare contacts of each size used shall be supplied.

3.6 Insulation resistance. When tested as specified in 4.7.2, the resistance shall be not less than 5,000 megohms, except after humidity exposure the resistance shall be not less than 1,000 megohms.

3.7 Temperature cycling. When tested as specified in 4.7.3, the connectors shall not show evidence of physical damage.

3.8 Dielectric withstanding voltage. When tested as specified in 4.7.4, the connectors shall withstand 1,500 volts without flashover.

3.9 Contact retention. When tested as specified in 4.7.5, individual contacts shall withstand an axial load of 10 pounds without damage to the contact, insert, or contact retaining clip.

3.10 Vibration. When the complete connector assembly, wired with the appropriate size wire, is tested as specified in 4.7.6 (10G, 10 to 500 Hz), there shall be no cracking, breaking, or loosening of parts. There shall be no loss of electrical continuity of any of the contact circuits of more than 1 microsecond with 100 milliamperes flowing in each circuit.

3.11 Mechanical shock. When tested as specified in 4.7.7, there shall be no evidence of failure of metallic or dielectric materials, nor shall the mated portions of the connector become disengaged. There shall be no loss of electrical continuity of any of the contact circuits of more than 20 milliseconds for connectors exposed to the high impact shock test, or 1 microsecond for connectors tested for compliance to the specified pulse shock test.

3.12 Mating and unmating forces (connector assembly). When tested as specified in 4.7.8, the force and torque required to either engage or separate any pair of mated connectors (plug and receptacle) shall not exceed the maximum force and torque specified (see 3.1).

3.13 Humidity. When tested as specified in 4.7.9, the connectors shall meet the following requirements:

Insulation resistance - - - - -	Shall not be less than 1,000 megohms
Dielectric withstanding voltage - - - - -	50 percent of specified voltage (see 3.8)

3.14 Durability. When tested as specified in 4.7.10, the connector assembly shall withstand the test without evidence of electrical or mechanical damage that impairs the normal operation of the connector.

3.15 Salt spray (corrosion). When tested as specified in 4.7.11, there shall not be sufficient corrosion on the connectors to interfere with mating or unmating, or

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cause exposure of base metal on contact sets when inspected under 10 \times magnification. Following the test, the contacts only shall meet the following requirement:

Low level circuit - - - - - Shall not exceed the values specified in table II.

3.15.1 Contacts supplied in reels. When contacts are separated from the carrier strip, base metal may be exposed. Following the salt spray test any corrosion that may occur in the region of the separation shall not interfere with the ability of the contacts to meet the subsequent test requirements, either for contacts tested separately, or as part of the connector, including the ability to mate or unmate the connectors.

3.16 Contact resistance. When tested as specified in 4.7.12, the contact resistance of each mated pair of contacts shall not exceed the potential drop requirements in table I.

TABLE I. Contact resistance.

Wire size AWG	Test current	Contact resistance (maximum)	Maximum potential drop
	<u>amperes</u>	<u>mV</u>	<u>mΩ</u>
18	8.5	51.0	6.0
20	7.5	45.0	6.0
22	5.0	40.0	8.0
24	3.0	26.0	8.7
26	2.0	24.0	12.0
28	1.5	22.0	14.7
30	1.0	20.0	20.0

3.17 Crimp tensile strength (crimp contact) (when specified, see 3.1). When tested as specified in 4.7.13, the contact to wire crimp shall not break or pull out at less than the minimum tensile strength specified in 4.7.13.

3.17.1 Crimp tensile strength (adapter to crimp contact). When tested as specified in 4.7.13.1, the adapter to contact crimp shall not break or pull out at less than the minimum tensile strength specified (see 3.1).

3.18 Contact separating forces (contacts). When contacts are tested as specified in 4.7.14, unless otherwise specified (see 3.1), the forces required to disengage the contacts shall be 12 ounces per contact.

3.19 Low level circuit resistance (contacts). When tested as specified in 4.7.15, the values of contact resistance shall not exceed the potential drop in table II.

TABLE II. Low level circuit.

Wire size AWG	Contact resistance (maximum) ^{1/}	Maximum potential drop
	<u>mΩ</u>	<u>μV</u>
18	7	7.0
20	9	9.0
22	15	15.0
24	20	20.0
26	25	25.0
28	40	40.0
30	50	50.0

^{1/} Test current shall be 0.001 amperes.

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3.20 Marking.

3.20.1 Connectors. Each connector shall be legibly and permanently marked, die cast, or stamped in accordance with MIL-STD-1285. The marking shall be placed on a side of the connector parallel to the long dimension. Wherever possible, the marking information shall be located such that it is not obscured by the subsequent addition of a connector shield.

3.20.2 Contact positions. Letters shall be arranged to avoid confusion between contacts. All letters or numerals shall appear on the front and rear face of each insert. Lettering of the plug insert shall correspond with that of the mating receptacle insert.

3.21 Workmanship. The workmanship shall be in accordance with the requirements contained herein. Connectors shall meet the design and dimensional requirements of this specification. There shall be no evidence of poor molding, or fabricating, damaged or improperly assembled contacts, peeling or chipping of the plating or finish, nicks and burrs of metal parts surfaces. The contacts shall be free from burrs or sharp corners which would damage the plating of mating connectors.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

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

- a. Materials inspection (see 4.3).
- b. Qualification inspection (see 4.5).
- c. Quality conformance inspection (see 4.6).

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

TABLE III. Materials inspection.

Materials	Requirement paragraph	Applicable specification
Aluminum	3.3.2	QQ-A-591
Finish	3.3.3	MIL-F-14072
Steel	3.3.4	ASTM A 484 and ASTM A 582
Cadmium plating	3.3.4	QQ-P-416
Plastic	3.3.5	MIL-M-14

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4.4 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in the "GENERAL REQUIREMENTS" of MIL-STD-1344 and MIL-STD-202.

4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3) on sample units produced with equipment and procedures normally used in production.

4.5.1 Sample size and inspection routine.

4.5.1.1 Connectors - single part qualification. Six each completely assembled plug or receptacle (2 of each type minimum) complete with guide pins, jackscrews, and with the insulator arrangement in accordance with specification sheet (see 3.1), shall be submitted. Mating plugs and receptacles shall be furnished. Contacts shall be installed in the insulator (see 4.5.2). The samples shall then be subjected to the inspections specified in table IV.

4.5.1.2 Connectors - group qualification. When submitting a group of connectors for qualification which have essentially the same design and features, the only difference being the number of contacts and the associated variance in size, six (two of each type) completely assembled plugs and receptacles with the maximum number of contacts and accessories to obtain an assembly with the maximum possible weight shall be subjected to the inspections specified in table IV. For connectors of the same family but with a smaller number of contacts, two plugs and receptacles for each connector with a smaller number of contacts shall be subjected to the inspections specified in table IV, group 1. These samples shall be alternately equipped with available accessories (shields, clamps, jackscrews, etc.) so that each available feature is tested.

4.5.1.3 Contacts. One hundred and sixty (80 sets) plated and 20 unplated contacts shall be subjected to the inspection of groups I through IV, respectively, in the order shown in table V.

4.5.2 Sample preparation.

4.5.2.1 Connectors. Connectors having crimp or solder type contacts shall be wired using number 22 AWG wire conforming to MIL-W-16878/4, 7 or 19 strands, for standard size contacts (MIL-C-28731/20 and /25) and 26 AWG wire for mini size contacts (MIL-C-28731/35).

4.5.2.2 Contacts - crimp type. Contacts shall be crimped with a tool conforming to MIL-C-22520/17 (see 3.4.2.2) to wire conforming to MIL-W-16878. The wire size shall conform to table V.

4.5.2.3 Contacts - solder type. Contacts shall be wired to wire conforming to MIL-W-16878. The wire size shall conform to table V.

4.5.2.4 Contacts - wrappost. Preparation not applicable: See 3.4.2.5.

4.5.3 Failures. One or more failures shall be cause for refusal to grant qualification approval.

4.5.4 Retention of qualification. To retain qualification, the contractor shall forward a report at 12-month intervals for groups A and B inspections and at 36-month intervals for group C to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

- a. A summary of the results of the tests performed for inspection of product for delivery (groups A and B), indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
- b. The results of tests performed for qualification verification inspection (group C), including, the number and mode of any subgroup failures. The test report shall include results of all qualification verification inspection tests. If the test results indicate nonconformance with specification requirements, and corrective action acceptance to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

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TABLE IV. Qualification inspection - connectors.

Inspection	Requirement paragraph	Test method paragraph	Number of samples		Condition
			Groups <u>1/</u>		
			1	2	
			3	3	
Visual and mechanical inspection - - - - -	3.1, 3.3, 3.4, thru 3.4.5, 3.5, 3.20 and 3.21	4.7.1	X	X	All connectors
Insulation resistance - - - - -	3.6	4.7.2	X	---	Unmated
Temperature cycling - - - - -	3.7	4.7.3	X	---	Mated
Dielectric withstanding voltage - - - - -	3.8	4.7.4	X	---	Unmated
Contact retention - - - - -	3.9	4.7.5	X	---	Unmated
Vibration - - - - -	3.10	4.7.6	---	X	Mated
Mechanical shock - - - - - (connector assembly)	3.11	4.7.7	---	X	Mated
Mating and unmating forces - -	3.12	4.7.8	---	X	Mated/unmated
Humidity - - - - -	3.13	4.7.9	---	X	Unmated
Durability - - - - -	3.14	4.7.10	X	---	Mated/unmated
Salt spray (corrosion) - - - -	3.15	4.7.11	X	---	Mated
Contact resistance - - - - -	3.16	4.7.12	X	---	Mated

1/ For group qualification 3 samples of the largest size and 1 sample of each smaller size shall be subjected to group 1 and group 2 test.

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Failure to submit the report within 30 days after the end of each 12- or 36-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time during the 12- or 36-month period that the inspection data indicates failure of the qualified product to meet the requirements of this specification.

In the event that no production occurred during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item. If during 2 consecutive reporting periods there has been no production, the manufacturer may be required at the discretion of the qualifying activity, to submit the connectors to testing in accordance with the qualification inspection requirements.

4.6 Quality conformance inspection.

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

4.6.1.1 Inspection lot. An inspection lot shall consist of all the connectors and associated fittings of the same part number, produced under essentially the same conditions, and offered for inspection at one time.

4.6.1.2 Group A inspection. Group A inspection shall consist of the inspection specified in table VI, in the order shown.

4.6.1.2.1 Sampling plan. Statistical sampling and inspection shall be in accordance with MIL-STD-105 for general inspection level II. The acceptable quality level (AQL) shall be as specified in table VI. Major and minor defects shall be as defined in MIL-STD-105.

4.6.1.2.2 Rejected lots. If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

TABLE VI. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph	AQL (percent defective)	
			Major	Minor
Visual and mechanical inspection	3.1, 3.3, 3.4, thru 3.4.5, 3.5, 3.20, and 3.21	4.7.1	0.65	2.5
Contact separating forces (contacts) <u>1/</u>	3.18	4.7.14	0.65	2.5

1/ Test performed on plated contacts only.

4.6.1.3 Group B inspection. Group B inspection shall consist of the inspections specified in table VII in the order shown, and shall be made on sample units which have been subjected to and have passed the group A inspection. Connector series may be combined for lot purposes during group B inspection and shall be in proportion to the number of connectors produced in each series.

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4.6.1.3.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for special inspection level S-3 and S-4. The sample size shall be based on the inspection lot size from which the sample was selected for group A inspection. The AQL shall be 2.5 percent defective.

4.6.1.3.2 Rejected lots. If an inspection lot is rejected, the manufacturer may rework it to correct the defects, or screen out the defective units, and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

TABLE VII. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Visual and mechanical inspection	3.1, 3.3, 3.4, thru 3.4.5, 3.5, 3.20 and 3.21	4.7.1
Insulation resistance	3.6	4.7.2
Dielectric withstanding voltage	3.8	4.7.4
Contact retention	3.9	4.7.5
Mating and unmating forces (connector assembly)	3.12	4.7.8
Contact resistance	3.16	4.7.12

4.6.1.3.3 Disposition of sample units. Sample units which have been subjected to group B inspection shall not be delivered on the contract or purchase order.

4.6.2 Periodic inspection. Periodic inspection shall consist of group C. Except where the results of these inspections show noncompliance with the applicable requirements, delivery of products which have passed groups A and B shall not be delayed pending the results of these qualification verification inspections.

4.6.2.1 Group C inspection. Group C inspection shall consist of the inspections specified in table IV, in the order shown. Group C inspection shall be made on sample units selected from inspection lots which have passed the groups A and B inspection.

4.6.2.1.1 Sampling plan. Every 36 months, the number of sample units specified in 4.5.1 shall be selected.

4.6.2.1.2 Failures. If one or more sample units fail to pass group C inspection, the sample shall be considered to have failed.

4.6.2.1.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or order.

4.6.2.1.4 Noncompliance. If a sample fails to pass group C inspection, the manufacturer shall notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which are manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the qualifying activity has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the qualifying activity). Groups A and B inspection may be reinstated; however, final acceptance and shipment shall be withheld until the group C inspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

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4.6.3 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-C-55330.

4.7 Methods of inspection.

4.7.1 Visual and mechanical inspection. Connectors and associated fittings shall be inspected to verify that the design, construction, physical dimensions, interchangeability, marking, and workmanship are in accordance with the applicable requirements (see 3.1, 3.4 through 3.4.5 inclusive, 3.20 and 3.21).

4.7.2 Insulation resistance (see 3.6). The insulation resistance shall be measured between closest adjacent contacts and hardware in accordance with method 3003 of MIL-STD-1344. Any number of contacts may be tested simultaneously. The measurements shall be made with the contacts inserted into the molded insert. The test potential tolerance shall be ± 2 percent and the electrification time shall not exceed 1 minute.

4.7.3 Temperature cycling (see 3.7). Complete mated connectors shall be subjected to temperature cycling in accordance with method 1003, MIL-STD-1344. The temperature shall be -55°C to 125°C .

4.7.4 Dielectric withstanding voltage (see 3.8). The unmated connectors shall be tested in accordance with method 3001 of MIL-STD-1344. The connectors shall show no evidence of flashover when the specified voltage (see 3.1) is applied. The voltage shall be applied between contacts and hardware as connected for insulation resistance (see 4.7.2).

4.7.5 Contact retention (see 3.9). Connectors shall be tested in accordance with method 2007 of MIL-STD-1344. Axial loads shall be applied to individual contacts in unmated connectors in the normal removal direction. The load shall be applied uniformly at a rate of 1 pound per second. After 5 insertions and withdrawals from the same contact hole, the contacts shall withstand the specified axial load.

4.7.6 Vibration (see 3.10). Complete mated connectors shall be vibrated in accordance with test condition II, method 2005 of MIL-STD-1344. All contacts shall be wired in series with appropriate size wire and connected to a suitable testing circuit. The mated connectors shall be held together only by the normal locking device. Strain relief shall be provided by the use of junction shells when applicable. Wires shall be supported on a stationary frame not closer than 12 inches from the connectors.

4.7.7 Mechanical shock (see 3.11). Either high impact shock or specified pulse shock testing shall be performed as applicable.

4.7.7.1 High-impact shock. Complete mated connectors shall be tested in accordance with method 207 of MIL-STD-202. All contacts shall be wired in series with the appropriate size wire and 100 milliamperes $+10 -0$, current flowing through the test contacts. The mated connectors shall be held together only by the normal locking device. Strain relief shall be provided by the use of junction shells where applicable. Wires shall be supported on a stationary frame not closer than 12 inches from the connectors.

4.7.7.2 Specified pulse shock. Complete mated connectors shall be tested in accordance with method 2004.1, test condition G, of MIL-STD-1344. All contacts shall be wired in series with appropriate size wire and 100 milliamperes $+10 -0$ of current maximum flowing through the test contacts. Wires shall be supported on a stationary frame not closer than 12 inches from the connectors. The mated connectors shall be held together only by the normal locking device. Strain relief shall be provided by the use of junction shells, where applicable. There shall be 18 shocks, 3 in each direction in each of the three perpendicular planes.

4.7.8 Mating and unmating forces (connector assembly) (see 3.12). Connectors shall be tested in accordance with method 2013 of MIL-STD-1344. Each connector with shields removed, if applicable, and a full complement of contacts shall be mated and unmated. The insertion and withdrawal force and torque, applied gradually, shall be measured after 3 cycles.

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4.7.9 Humidity (see 3.13). Unmated plugs and receptacles shall be tested in accordance with type II, method 1002 of MIL-STD-1344; however, steps 7A and 7B are not required. No measurements are required after initial conditioning, nor voltage applied to connectors during exposure. After completion of step 6 of the final cycle, the connectors shall be removed from the chamber. Excess moisture shall be shaken off surfaces. No mechanical wiping or forced drying shall be used. After the test, the following measurements shall be taken:

Insulation resistance - - - - - Shall not be taken sooner than one-half and not later than 3 hours after removal from the chamber. If a measurement taken early in the specified time period results in a failure, the measurement may be retaken once during the time period specified.

Dielectric withstanding voltage - - - - See 4.7.4.

4.7.10 Durability (see 3.14). The complete connector assemblies shall be subjected to 200 cycles of insertion and withdrawal at a rate not to exceed 100 cycles per hour. Tests shall be conducted using normal engaging hardware. The insertion and withdrawals shall be accomplished similar to that which the connectors shall be subjected to in service. After 200 cycles, the plug and receptacle assemblies shall be inspected.

4.7.11 Salt spray (corrosion) (see 3.15). The mated plugs and receptacles, along with 20 pairs of contacts, mounted in accordance with figure 1, shall be tested in accordance with method 1001, condition B of MIL-STD-1344. Immediately after exposure, the connectors shall be unmated and the exterior surfaces of the connectors and of the individual pairs of contacts shall be washed and dried for 12 hours maximum in a circulating air oven at a temperature of $38^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($100^{\circ}\text{F} \pm 5^{\circ}\text{F}$). After drying, the connectors shall be mated.

4.7.12 Contact resistance (see 3.16). Connectors shall be tested in accordance with method 3004 of MIL-STD-1344. The potential drop across each mated pair of contacts shall be measured at rated current as designated in table I. Potential drop readings shall be taken across the two points as shown in figure 2. For adapter to crimp contacts, figure 3 shall be used.

4.7.13 Crimp tensile strength (crimp contact) (see 3.17). The test shall be performed in accordance with method 2003 of MIL-STD-1344. Samples for test shall be placed in a standard tensile testing machine and the load applied at an approximate rate of 1 inch (25.4 mm) per minute to pull the wire out of the sample or break the wire sample (see table VIII).

4.7.13.1 Crimp tensile strength (adapter to crimp contact) (see 3.17.1). Provisions shall be made for mounting contacts in a suitable position of applying gradually increased loads during separation of the adapter and contact. Samples for test shall be placed in a standard tensile testing machine and the load applied at an approximate rate of 1 inch (25.4 mm) per minute to pull the adapter out of the contact.

TABLE VIII. Crimp tensile strength.

Wire size AWG (7 or 19 strand)	Minimum tensile strength pounds
18	40.0
20	25.0
22	15.0
24	10.0
26	5.0
28	3.0
30	1.5

4.7.14 Contact separating forces (contacts) (see 3.18). Provisions shall be made for mounting contacts in a suitable position of applying gradually increased loads during separation of the contact. The depth of the engagement shall be equal to the maximum length of the contact for the mating connector.

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4.7.14.1 Contact separating forces (unplated contacts) (see 3.1). Separating forces of contacts when measured with the gage shown in figure 4 shall be as specified.

4.7.14.2 Contact separating forces (plated contacts) (see 3.1). Separating forces of contacts when mated to each other shall be as specified.

4.7.15 Low level circuit resistance (contacts) (see 3.19). The low level circuit test shall be performed in accordance with method 3002 of MIL-STD-1344. For adapter to crimp contacts, figure 5 shall be used.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-C-55330.

5.2 Loose crimp contacts. For connectors supplied with loose crimp contacts, these contacts shall be supplied in accordance with MIL-C-55330. The quantity of crimp contacts to be supplied with each connector unit package shall consist of a full complement of contacts plus one spare contact for connectors using 26 contacts or less. For arrangements utilizing more than 26 contacts, two spare contacts shall be supplied.

6. NOTES

6.1 Intended use. Connectors and contacts covered by this specification are intended for use in airborne, ground support, and shipboard electrical and electronic equipment.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following

- a. Title, number, and date of this specification.
- b. Connector part number, including insert arrangement.

6.2.2 Removable contacts. Removable contacts are available for separate acquisition through specification sheets of this document (see 3.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the contractors is so called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Electronic Systems Command (ELEX 8111), Washington, DC 20363, however, information pertaining to qualification of products may be obtained from Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45444-5000.

6.3.1 Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Definitions. For purposes of this specification, the following definitions shall apply.

6.4.1 Connector assembly. A complete connector assembly consists of a mated plug and receptacle.

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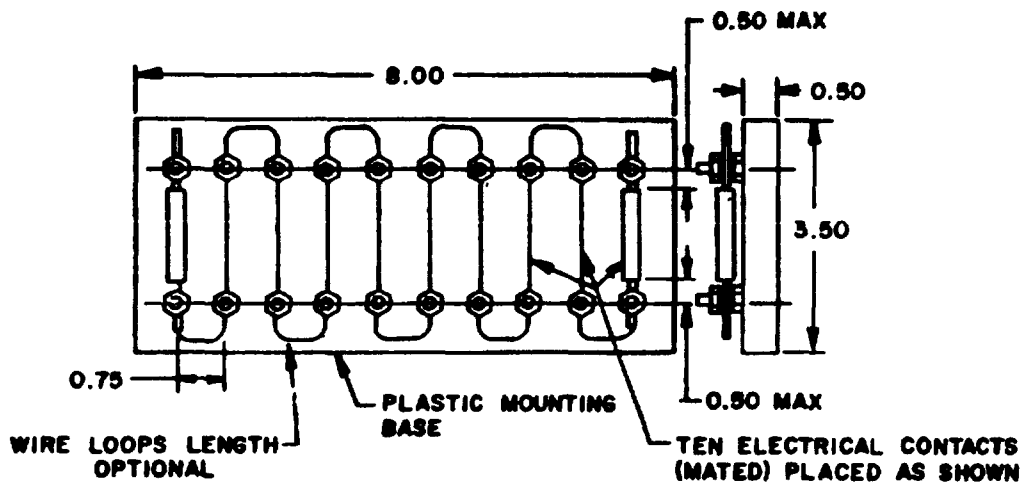


FIGURE 1. Salt spray-contacts.

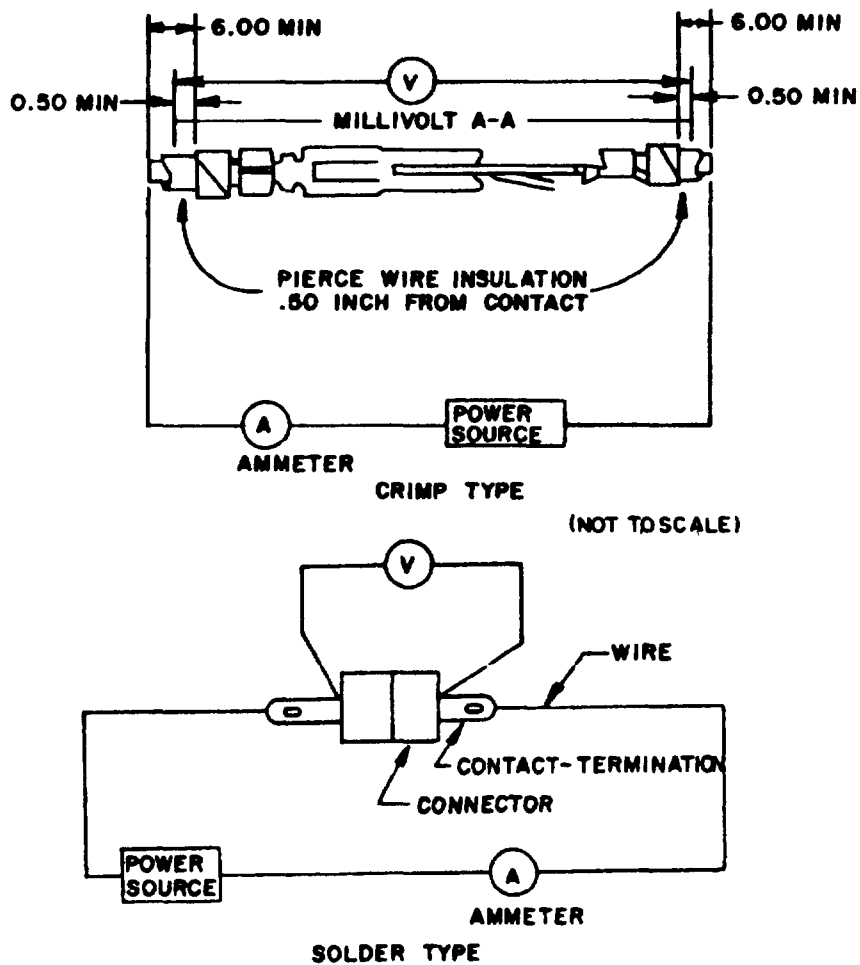


FIGURE 2. Contact resistance.

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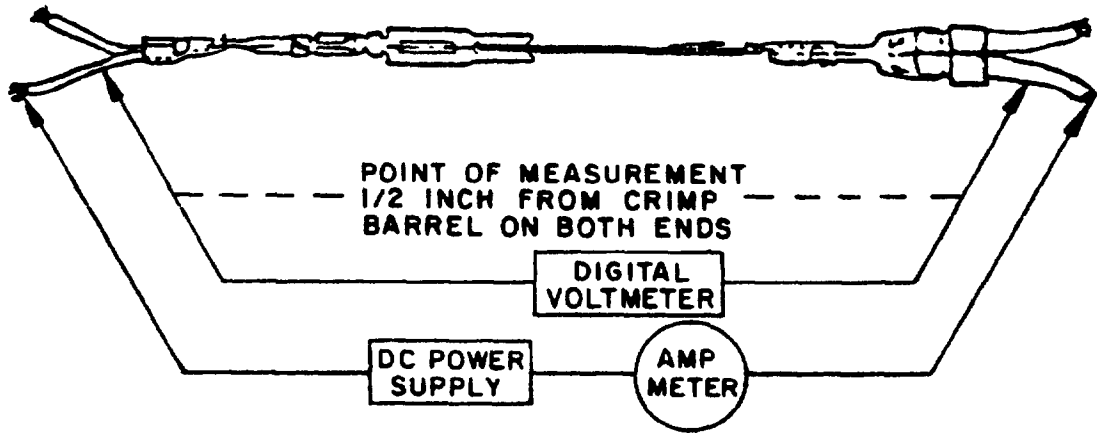


FIGURE 3. Contact crimp resistance.

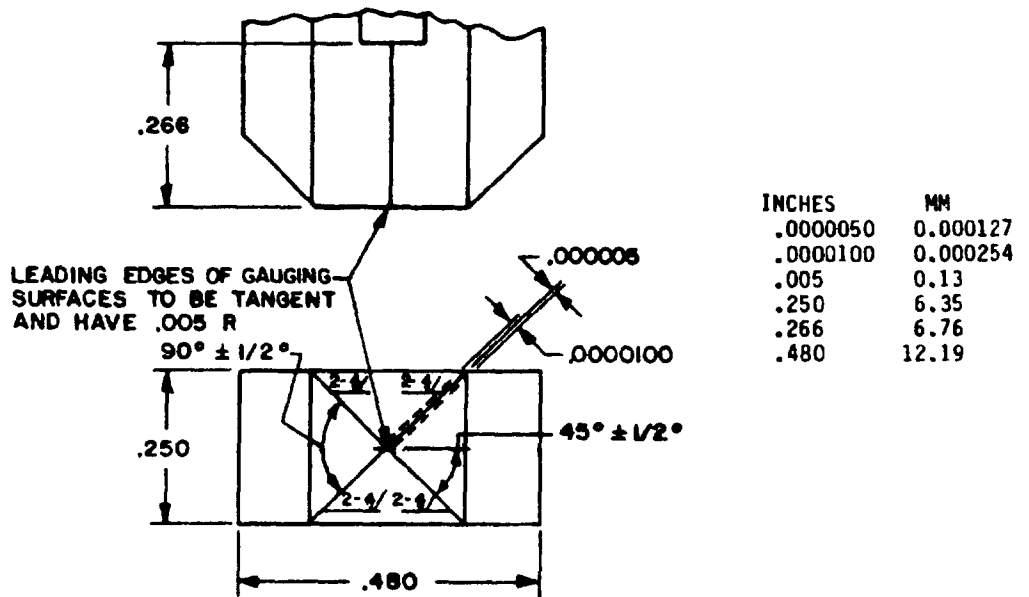


FIGURE 4. Gauge tip, test fixture, contact separation force

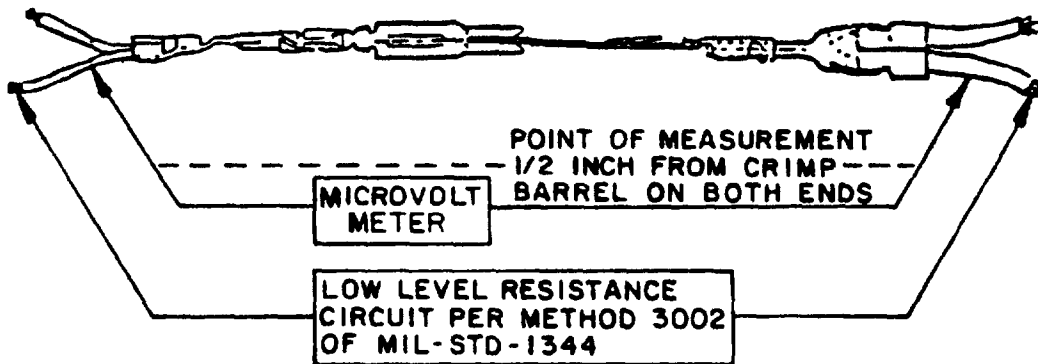


FIGURE 5. Low level circuit resistance.

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6.4.2 Receptacle. A connector receptacle is that portion of the connector assembly which is normally "fixed", that is, rigidly attached to a supporting surface.

6.4.3 Plug. A connector plug is that portion of the connector assembly which is normally "removable".

6.5 Patent notice. Patent No. 3,248,686 owned by Elco Corporation. The Government has a royalty-free license under the above patent for the benefit of manufacturers of the items called for in this specification, either for the Government or for use in equipment to be delivered to the Government.

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6.7 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

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