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MIL-C-83526A
30 June 1989
SUPERSEDING
MIL-C-83526
19 December 1985

MILITARY SPECIFICATION

CONNECTORS, FIBER OPTIC, CIRCULAR, ENVIRONMENTAL RESISTANT, HERMAPHRODITIC, 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 the characteristics, performance and testing criteria for a circular, environmental resistant, hermaphroditic interface, fiber-optic connector. The connectors must have a consistent and predictable optical performance and must be sufficiently rugged to withstand military field applications.

1.2 Classification. Hermaphroditic connector designs are included in this specification. Hardware associated with the connector is also specified including backshells, protective covers and storage receptacles.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-T-29504	-	Termini, Fiber Optic Connector, Removable, General Specification For.
MIL-F-49291	-	Fiber, Optical (Metric).
MIL-C-55330	-	Connectors, Electrical and Fiber-Optic, Packaging Of.
MIL-I-81969/46	-	Installing and Removal Tools, Fiber Optic, Type I, Class 2, Composition C, Size 16 Termini.
MIL-I-81969/47	-	Installing and Removal Tools, Fiber Optic, Type II, Class 2, Composition C, Size 16 Termini.
MIL-I-81969/48	-	Installing and Removal Tools, Fiber Optic, Type III, Alignment Sleeve, Class 1, Composition C, Size 16 Termini.
DOD-C-85045	-	Cable, Fiber-Optics, General Specifications For (Metric).

Beneficial comments (recommendations, additions deletions) and any pertinent data which may be of use in improving this document should be addressed to 2750 Air Base Wing (AFLC), ATTN: ES, Gentile Air Force Station, Dayton, Ohio 45444 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6060

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STANDARDS

FEDERAL

FED-STD-H28	-	Screw Threads Standards For Federal Services Section 22 Metric Screw Thread Gages (Metric).

MILITARY

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-889	-	Dissimilar Metals.
MIL-STD-1285	-	Marking Of Electrical and Electronic Parts.
MIL-STD-1344	-	Test Methods For Electrical Connectors.
DOD-STD-1678	-	Fiber-Optics Test Methods and Instrumentation.
MIL-STD-2163	-	Insert Arrangements for MIL-C-28876 (Navy) Environment Resisting.
MIL-STD-45662	-	Calibration Systems Requirements.

(See supplement 1 for list of associated specifications).

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099).

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

* EIA-RS-455	-	Standard Test Procedures For Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
* EIA-RS-455-1	-	Standard Test Procedures For Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
* EIA-455-2	-	Impact Test Measurements for Fiber Optic Devices.
* EIA-RS-455-4	-	Fiber Optic Connector/Component Temperature Life.
* EIA-RS-455-11	-	Vibration Test Procedures for Fiber-Optic Connecting Devices
* EIA-RS-455-14	-	Physical Shock Test.
* EIA-RS-455-15	-	Altitude Immersion Test.
* EIA-455-21	-	Mating Durability for Fiber Optic Connecting.
* EIA-RS-455-22	-	Ambient Light Susceptibility.

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* EIA-RS-455-26 - Crush Resistance.

* EIA-455-32 - Fiber Optic Circuit Discontinuities.

* EIA-455-34 - Interconnection Device Insertion Loss Test.

* EIA-RS-455-36 - Twist Test for Fiber Optic Connecting Devices.

* EIA-RS-455-40 - Fluid Immersion Test for Fiber Optic Cable.

* Has been adopted by DOD

(Application for copies of EIA publications should be addressed to the Electronic Industries Association, 2001 Eye Street, N.W., Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets or MS standards), the text of this document shall take precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

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 the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. Fiber optic connectors and accessories furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of award of contract (see 4.4 and 6.3).

3.3 Materials. The connectors, caps, covers, storage receptacles or other protective accessory hardware shall be constructed of material as specified (see 3.1).

3.3.1 General. Materials may be dielectric or conductive as applicable. Materials shall in no manner interfere with or degrade the fiber-optical termination process, termini cleaning operation or optical junction transmission. Materials which are not specified shall be of the lightest practical weight and suitable for the intended purpose.

3.3.2 Metals. Unless otherwise specified (see 3.1), all metals shall be corrosion resistant types (300 series CRES recommended), or shall be suitably plated or otherwise finished to prevent corrosion during service life under any of the environmental conditions specified by the document. All metals shall be nonmagnetic.

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3.3.2.1 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless suitably finished to prevent electrolytic corrosion. The criteria for the selection and protection of dissimilar metal combination shall be in accordance with MIL-STD-889.

3.3.3 Steel parts. Unless otherwise specified (see 3.1), all exposed corrosion-resistant steel parts of the connector assembly shall have a passivated finish which permits the attainment of a surface finish condition compatible with external coatings or platings of the type and color specified (see 3.1).

3.3.3.1 Stainless steel components. Stainless steel components shall be passivated and nonreflective.

3.3.4 Nonmetallic materials. All nonmetallic materials used in the construction of connectors specified by this document shall not be affected by the use of cleaning materials nor shall any substance used in the construction of the connectors be degraded when operating at the environmental conditions herein specified.

3.3.4.1 Insulating materials. Insulating materials shall conform to requirement 11 of MIL-STD-454.

3.3.4.2 Mercury and radioactive material. Mercury and radioactive materials shall not be used in the construction of the connectors, caps, covers, storage receptacles, or other protective accessory hardware specified by this document.

3.3.4.3 Toxic and hazardous products and formulations. Materials used in the connector, backshell, or accessories shall not give off toxic or explosive fumes when exposed to flame. The material shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the appropriate departmental medical service who will act as an advisor to the contracting agency.

3.3.4.4 Solvents, adhesives and cleaning agents. No incompatibility shall exist between the materials employed in the fiber to terminus securing or polishing processes, such that degradation of these materials shall result from in-service use or when tested in accordance with requirements of the temperature life test of 4.7.20.

3.3.4.5 Epoxies. Epoxies are not precluded from use in the construction of the connectors controlled by this specification. However, only those epoxy types which have been tested and found to be fungus-inert shall be specifically defined in the detail specification sheet for the connector type. The detail sheet shall also specify the process to be followed in mixing and curing the epoxy. Epoxies may not be used in the optical path of the connector. The service life of epoxy material shall be consistent with the intended useful lifetime of the connector. Also, the termination and retermination of the connector shall not be affected by the use of epoxy material, as defined by requirement 4 of MIL-STD-454.

3.3.4.6 Sealing compounds. Sealing compounds which may flow at the maximum upper storage temperature specified herein, or crack at the minimum lower storage temperature specified herein shall not be used.

3.3.4.7 Fungus resistance. All materials used in connectors designed to this specification shall be nonnutrient to fungus, as defined by requirement 4 of MIL-STD-454.

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3.4 Design and construction. Connectors, backshells and protective accessories shall be of the design, construction, and physical dimensions specified (see 3.1).

3.4.1 Threads. If threads are used for removable parts, they shall be in accordance with FED-STD-H28.

3.4.1.1 Thread lubricants. Suitable lubricants are allowed on ramps and threads of metal connectors. Lubricants shall not be affected by cleaning solvents which are required to maintain the optical performance of the connectors.

3.4.2 Finishes. Peeling or chipping of the allowable plating or finishes, galling of mating parts, nicks, burrs, or other surface blemishes shall not be permitted.

3.4.3 Sealing. When specified, the connector design shall include environmental sealing capabilities at the interface and rear of the connector. The seals, dynamic, static or both, shall preclude the entrance of moisture, dust, sand, and dirt that might degrade the performance required under specified environmental conditions.

3.4.3.1 Optical junction sealing. Optical junctions shall be sealed against moisture and contaminants as specified herein.

3.4.3.2 Cable sealing. Connectors shall seal the terminating cables to meet the environmental requirements specified herein.

3.4.4 Adhesives and sealing compounds. When specified, the connector manufacturer shall specify necessary adhesives for terminating the optical fiber or for sealing the connector. These compounds shall not be used unless otherwise specified (see 3.1).

3.4.5 Interchangeability and intermateability. Connector material and hardware shall be as specified (see 3.1), to insure interchangeability and intermateability.

3.4.5.1 Interchangeability. All connectors, backshells, accessories, and replaceable parts having the same military part number shall be physically and functionally interchangeable without need for modification of such items or of the mating equipment.

3.4.5.2 Intermateability. All connectors having the same termini, insert arrangement and shell size shall be intermateable with their counterpart connectors.

3.4.6 Nontoxic and nonhazardous. The connectors shall not release toxic or explosive fumes exceeding the limits specified when exposed to flame or chemical agents commonly used in the environment in which the connectors are intended for use.

3.4.7 Cleaning. The design of the connector shall permit cleaning of the optical face of the terminus without requiring major disassembly of the connector or removal of the terminus from the connector. The connector shall not be softened, embrittled, etched, or otherwise affected by the optical cleaning agent. Attention shall be given to the criteria for inspection and test of the connector to determine if the cleaning procedure has been successful.

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3.4.8 Scoop proof. The optical mating faces must be suitably protected to prevent degradation of the specified light transfer characteristics as a result of repeated mechanical matings and unmatings. Neither the shell assemblies nor the connector dust cover shall make contact with the optical faces during the mating or unmating of the connector.

3.4.9 Mating characteristics. The connectors specified herein shall satisfy the following operational and human factor requirements.

3.4.9.1 Blind mating. The connector designs shall allow mating and unmating in "blind" conditions where the operator cannot fully observe the connector during the mating process.

3.5 Connectors.

3.5.1 Shell. The connector shell or backshells shall retain the connector insert.

3.5.2 Engagement of connectors. Unless otherwise specified (see 3.1), the connector shall be capable of being mated and unmated without the use of special tools.

3.5.3 Coupling mechanisms. Coupling rings of the connectors shall be knurled or fluted, and designed so that the mating halves optical termini shall approach or recede from each other as the coupling mechanism is respectively tightened by clockwise rotation or loosened in the counter-clockwise direction as viewed from rear of plug connector. The coupling mechanism shall be captive on the plug to mate with the receptacle shell. Coupling ring and coupling screw threads shall be in accordance with FED-STD-H28, and as specified (see 3.1). If the coupling threads must be lubricated to meet the requirements contained herein, the lubricant shall be applied only during manufacture. The lubricant selected shall not be reapplied nor migrate into the optical junctions region during use.

3.5.4 Polarization. Polarization of the mating halves shall be provided and designed to prevent physical contact of the mating optical termini or of the termini with the insert surface of the counterpart connector until properly aligned for engagement. Backshell splines, keys, and keyways shall be polarized and mated prior to coupling (see 3.1).

3.5.5 Termini. Termini shall be sufficiently specified to insure interchangeability and intermateability. Pin, socket, and dummy terminus shall be as specified in MIL-T-29504. Exact slash and dash number is dependent upon fiber size and connector slash number. Requirements for retention, insertion and removal, and environmental sealing of the dummy termini shall be equivalent to those for the optical termini.

3.5.6 Inserts. The connector design shall preclude fiber damage due to potential cable winding (see 3.8.1).

3.5.6.1 Number of termini, arrangement and spacing. The insert pattern, that is, the number of termini, their arrangement and spacing shall be as specified (see 3.1). Every terminus position shall accept either optical or dummy termini. Termini spacing shall permit adequate terminus marking identification and easy terminus insertion and removal.

3.5.6.2 Terminus insertion and removal methods. Optical terminus insertion shall be accomplished by inserting the terminus through the inserts of the connector mating halves and by locking it in place. The individual termini shall be positively retained in the connector when installed with the terminus insertion tool and shall be capable of being removed without terminus or insert damage when using the terminus removal tool. Requirements for these tools shall be as specified (see 3.1).

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3.6 Backshell accessories. Backshells shall conform to the requirements as specified (see 3.1). The backshell shall provide cable strain relief. The backshell shall be free of any sharp edges or other configurations that could cause damage to optical fibers extending through them.

3.7 Protective covers and storage receptacles. Connectors shall be provided with a protective cover or storage receptacle. These protective devices shall maintain the connector free of moisture, prevent entry of air or dust into the connector and comply with the applicable requirements as specified herein and in the specification sheet. When not in place, the protective device shall be protected against the environment so that dirt, dust, moisture, etc., are not carried to the connector mating surfaces by the protective cover.

3.8 Cable strength member terminations. The termination of the cable strength member shall be such that applying the tensile force specified herein to the cable will not damage the optical fibers or degrade optic performance within specified limits.

3.8.1 Cable strain relief. As specified, the cable strain relief shall grip the cable as it exits the connector to prevent degradation of optical performance by:

a. Cable flexing or twisting at or near the termination.

b. Cable pull out by tensile forces.

3.8.2 Cable service loop. Connectors shall be of a design so as to provide room for a service loop in the optical fibers of sufficient length to allow an individual connector terminus to be repaired at least one time before it is necessary to reterminate the entire connector.

3.9 Tools. Tools used to terminate connectors onto cables shall be as specified (see 3.1). The connector manufacturer shall provide the tools when specified in the acquisition documents (see 6.2).

3.10 Optical performance requirements. The optical performance requirements of 3.10.1 through 3.10.5 shall be used to monitor the effects of the inspection requirements specified in 3.11 as required by 4.5.1.2, 4.5.1.3, and 4.5.2.

3.10.1 Interconnection device insertion loss test. When measured in accordance with 4.6.1, the maximum per channel insertion loss under all conditions shall be 1.5 dB for 100 µm core fibers, 1.8 dB for 62.5 µm core fibers and 2.0 dB for 50 µm core fibers.

3.10.2 Fiber optic circuit discontinuities. When measured in accordance with 4.6.2, no discontinuity shall occur. A discontinuity is considered to be a reduction of strength of 2 dB or more for a duration of one microsecond (µs) or more.

3.10.3 Analog modulation. When tested in accordance with 4.6.3, the peak-to-peak analog modulation, bandpass limited to between 4 hertz (Hz) and 40 kilohertz (kHz), shall be not more than one percent of the steady state signal level.

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3.10.4 Crosstalk. The signal power level of each passive channel shall be below the signal on the active channel by at least the amount shown as follows when tested in accordance with 4.6.4.

Independent signal channels	Reduction
2	50 dB
3	53 dB
4 or 5	56 dB
6 or 9	58 dB
10 or more	60 dB

3.10.5 Ambient light susceptibility. When tested in accordance with 4.6.5, the optical power of the light from the optical port(s) (after accounting for cable and optical junction losses between the device and the detector) shall be less than -70 dBm.

3.11 Inspection requirements. The inspection requirements specified in 3.11.1 through 3.11.31 shall be performed as required by 4.7.1 through 4.7.31 and adhere to the optical performance requirements of 3.10.

3.11.1 Size. When examined in accordance with 4.7.1, the dimensions and dimensional tolerances for these connectors, backshells, and accessories shall be as specified (see 3.1).

3.11.2 Weight. When tested in accordance with 4.7.2, the weight of the connectors, backshells and accessories shall be as specified (see 3.1).

3.11.3 Color. The external color of the connector shall be as specified in the acquisition document (see 6.2) in accordance with this paragraph. The preferred colors are as specified (see 3.1). All background colors shall be nonreflective (see 4.7.3).

3.11.4 Identification marking. Marking characters shall be a minimum of 2.0 mm in height. When tested in accordance with 4.7.4, the connectors, backshells and accessories shall be marked as specified in 3.11.4.1, 3.11.4.2 or as specified (see 3.1). All marking characters in any face of the connector, backshell, or accessory shall be identifiable. The connector shall also be marked with a yellow band and the phrase "Fiber-Optics" as specified (see 3.1).

3.11.4.1 Connector, backshell and accessory. The connector, backshell and accessory parts shall be identified by a legible and permanent marking applied in accordance with MIL-STD-1285.

3.11.4.2 Inserts. Markings shall correspond between mating inserts and shall be as specified in MIL-STD-2163. Raised or depressed characters shall not be used on mating faces. Terminus locations shall be designated by identifiable characters on the front of the insert or the insert assembly. Character position and arrangement shall assure appropriate terminus cavity identification.

3.11.5 Terminus cleaning. After cleaning the terminus in accordance with 4.7.5, the optical insertion loss of 3.10.1 and the marking requirements of 3.11.4 shall be met.

3.11.6 Insert retention axial strength. When tested in accordance with 4.7.6, connector inserts shall withstand an applied minimum pressure of 100 pounds per square inch in both the forward direction and the backward direction for a minimum period of one minute without cracking, breaking or being dislocated from their normal position in the connector shell. No axial displacement detrimental to performance shall be observed between the inserts and their shell body during or after the test exposure.

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3.11.7 Insert retention radial strength. When tested in accordance with 4.7.7, connector inserts shall withstand the clockwise and counter clockwise radial torque specified (see 3.1) for a minimum period of one minute. No rotational displacement detrimental to performance shall be observed between the inserts and their shell body during or after the test exposure.

3.11.8 Terminus retention. When tested in accordance with 4.7.8, and subjected to axial loads of 22.0 pounds, locked termini shall be retained in their inserts and axial displacements of the termini shall not exceed 0.012 inch. No damage to termini or inserts shall occur.

3.11.9 Terminus insertion and removal forces. When tested in accordance with 4.7.9, the insertion force and the force required to remove unlocked termini shall not exceed 22.0 pounds.

3.11.10 Maintenance aging. When tested in accordance with 4.7.10, connectors shall show no visible evidence of wear or degradation which may degrade their ability to perform as specified. The connector insertion loss shall be within the limits specified in 3.10.1.

3.11.11 Coupling forces. When tested in accordance with 4.7.11, the maximum coupling forces for mating and unmating of the counterpart connectors shall be as specified (see 3.1).

3.11.12 Coupling torques. When tested in accordance with 4.7.12, the maximum torque for mating and unmating of counterpart connectors shall be as specified (see 3.1).

3.11.13 Mating durability for fiber-optic interconnecting devices. When tested in accordance with 4.7.13, the connector shall show no defects detrimental to the operation of the connector and shall have coupling forces and insertion losses in accordance with 3.10.1 and 3.11.11.

3.11.14 Impact test measurements for fiber-optic devices. When tested in accordance with 4.7.14, connectors shall show no evidence of broken, loose, deformed or displaced parts, cracks, chips or other damage which would result in a degradation of optical performance. Insertion loss shall not exceed the limits specified in 3.10.1.

3.11.15 Twist test for fiber-optic connecting devices. When tested in accordance with 4.7.15, the cable/connector interface shall have no damage detrimental to the operation of the cable or connector. The connector insertion loss shall not exceed the limits specified in 3.10.1.

3.11.16 Cable seal flexing. When tested in accordance with 4.7.16, connector strain relief mechanisms shall prevent loss of environmental sealing or other damage which may impair the connector operation.

3.11.17 Cable retention test procedure for fiber-optic cable interconnecting devices. When tested in accordance with 4.7.17, there shall be no evidence of cable jacket damage, cable clamp failure, cable to connector seal damage, distortion or bending of metallic connector parts, or cable disengagement from the clamp. The minimum cable to connector pull-out strength shall be 400 pounds.

3.11.18 Crush resistance. When tested in accordance with 4.7.18, connectors shall show no broken parts, no degradation of mating-unmating, or no damage to the seals. After testing, the connector shall also meet the optical requirements for insertion loss, crosstalk, and ambient pickup of 3.10.1, 3.10.4, and 3.10.5.

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3.11.19 External bending moment. When tested in accordance with 4.7.19, connectors shall show no evidence of damage detrimental to their normal operation nor shall there be any interruption of their ability to perform as specified (see 3.1).

3.11.20 Fiber optic connection/component temperature life. When tested in accordance with 4.7.20, connectors subjected to these specified accelerated aging exposures shall not exhibit visual evidence of dimensional change, opening of seals, cracking or crazing of components or finishes, identification marking impairment, fusion or seizure of mating parts, leakage of waterproofing compounds or other effects detrimental to connector operation. No evidence of adhesive degradation shall be present.

3.11.21 Temperature cycling of fiber-optic connectors (thermal shock). When tested in accordance with 4.7.21, a post-test visual examination of the tested connectors shall reveal no evidence of connector part dimensional change, no leaking of waterproofing compounds or other apparent loss of sealing capability, no surface or identification marking impairment, no coupling-thread binding or other evidence of mating/unmating incapability and no other damage detrimental to the operation of the connector. During the thermal stress the insertion loss of the mated connector shall be measured at the extremes as well as at ambient and shall be within the limits in 3.10.1. The thermal stress shall be at least as great as the expected operating temperatures of the cable assembly and shall be as specified herein.

3.11.22 Physical shock test. When tested in accordance with 4.7.22, the connectors shall show no evidence of broken, loose, deformed or displaced parts, cracks, chips, or other damage which would result in a degradation of optical performance. Insertion loss shall not exceed the limits in 3.10.1.

3.11.23 Vibration test procedures for fiber-optic connecting devices. When tested in accordance with 4.7.23, there shall be no transient change in optical performance beyond specification limits and there shall be no disengagement of the mated connectors, backing off from the coupling mechanism, evidence of cracking, breaking, or loosening of parts.

3.11.24 Humidity test procedures for fiber-optic connecting devices. When tested in accordance with 4.7.24, the connectors shall operate without degradation beyond the performance limits specified in 3.10 during and after exposure to the humidity conditions specified. There shall be no visual evidence of deterioration of component parts or constituent materials, loosening of finishes, physical distortion, corrosion of metals, entrapment of materials, separation of bonded surfaces or other damages.

3.11.25 Salt spray. When tested in accordance with 4.7.25, the mated connectors shall not show exposure of base metal or corrosion products which will adversely affect performance. No visible evidence of salt penetration into the connector sealed area shall be observed. Following the test, insertion loss shall be within the limits in 3.10.1.

3.11.26 Altitude immersion. When tested in accordance with 4.7.26, assembled, mated connectors shall show no deterioration which will adversely affect performance of the connectors. Insertion loss shall be within the limits in 3.10.1.

3.11.27 Fluid immersion test for fiber-optic cable. When tested in accordance with 4.7.27, visual examination of the test connector shall reveal no swelling or softening of material, no loss of sealing capability or identification marking and no discoloration or other effects detrimental to the intended use of these connectors.

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3.11.28 Water pressure/freezing. When tested in accordance with 4.7.28, visual inspection of the test connector shall reveal no penetration of indicator dye into the sealed region of the mated connector.

3.11.29 Sand and dust. When tested in accordance with 4.7.29, the connectors shall show no evidence of physical damage which will adversely affect the operation of the connector and shall have coupling forces and insertion losses within the requirements in 3.11.11 and 3.10.1.

3.11.30 Ozone exposure. When tested in accordance with 4.7.30, there shall be no evidence of cracking of plastic and rubber parts or other damage due to ozone exposure that will adversely affect performance.

3.11.31 Flammability. When tested in accordance with 4.7.31, burning and after-glow extinguishing time shall be three seconds maximum. Dripping which will cause flammable material to ignite and violent burning or an explosive type fire shall not occur.

3.12 Assembly instructions. Complete assembly instructions shall be furnished by the vendor with each connector acquired under this specification. Assembly instructions shall include but not be limited to:

a. Cable preparation-stripping dimensions and tolerances.

b. List and description of crimping or special tools if required.

c. Sufficient pertinent dimensions for verification of correct parts; as a minimum the entry openings shall be specified.

d. Military part number and manufacturer's part number.

3.13 Workmanship. All details of workmanship shall be in accordance with high grade fiber-optic connector manufacturing practice when examined in accordance with 4.8. Connectors and accessories shall be dimensionally uniform and free of manufacturing flaws that would degrade performance, inhibit proper connection to interfacing elements, and otherwise yield an inferior product. The following shall be a minimal level of visual examination to be performed and is not intended to restrict other pertinent workmanship examinations.

a. Loose termini, inserts or other connector parts which adversely affect the environment sealing, permit cable sealant penetration or degrade optical termini alignment shall not be permitted.

b. Peeling or chipping of plating or finish, galling of mating parts indicating excessive wear, nicks, burrs, or other sub-standard connector surface blemishes shall not be permitted.

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 (examinations and tests) 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 this specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

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4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.2 Test equipment and inspection facilities. Provision for test and measuring equipment and inspection facilities of sufficient accuracy, quality and quantity to permit performance of the required inspection(s) shall be the responsibility of 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 and as specified herein.

4.1.3 Assembly plants. Assembly plants must be listed on, or approved for listing on, the applicable qualified products list. The qualified connector manufacturer shall certify that the assembly plant is approved for the distribution of the manufacturer's parts. The assembly plant shall use only piece parts supplied by the qualified connector manufacturer. No testing other than visual examination is required of certified piece parts obtained from the qualified connector manufacturer, except when there is cause for rejection. All assemblies produced at the assembly plant shall be subjected to examination of the product to assure that the assembly process conforms with that established at the qualified manufacturing plant. Quality control requirements, including Government inspection surveillance, shall be the same as required for the qualified connector manufacturer.

4.2 Inspections.

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

a. Materials inspection (see 4.3).

b. Qualification inspection (see 4.4).

c. Quality conformance inspection (see 4.5).

d. Workmanship inspection (see 4.6).

4.2.2 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the test conditions specified in DOD-STD-1678.

4.3 Materials inspection. Materials inspection shall consist of certification supported by verifying data that materials used in fabricating the delivered fiber-optic connectors are in accordance with the requirements of 3.3 and as specified (see 3.1).

4.4 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. This inspection shall consist of performing the inspections and optical tests specified in table I, in the sequence shown therein, on the qualification test samples specified in 4.4.1.

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cable, per the detailed wire and cable specifications

4.4.1 Test sample. Fiber-optic connector, backshell, and accessory samples complying with the specified requirements (see 3.1) shall be submitted for qualification. The manufacturer shall provide a counterpart connector for each connector subjected to qualifying tests requiring mating assemblies. The counterpart connectors provided for this purpose shall be new, previously qualified connectors or new connectors submitted for qualification testing. Manufacturers not producing mating connectors shall submit data substantiating that tests were performed with qualified counterpart connectors. For those tests specifying the use of mated connectors, optical and mechanical test assessment shall be made using the assigned counterpart connector for those test measurements as required.

4.4.1.1 Sample size. The following test samples, manufactured by normal production methods shall be provided for each connector series submitted for qualification testing:

a. Twelve in-line cable connectors.

b. Four jam-nut mounted cable connectors or four wall mounted cable connectors.

4.4.1.2 Sample preparation. Unless otherwise specified, connectors shall be fully assembled into cable-connector assemblies using the types of cable specified in the applicable connector specification sheet. Connector terminals shall be optically finished with termini properly seated within their inserts. For mated connectors full sealing capability shall be provided as specified. Connectors shall be provided with backshell, strain relief cable clamp and attached to a 4 meters minimum length of the specified cable type.

4.4.2 Inspection routine. Connector, backshell, and accessory samples shall be tested in accordance with the sequence of table I. Optical tests shall be made as specified in table I. The connector group samples may be tested simultaneously.

4.4.3 Qualification rejection. Qualification approval will not be granted if any of the connectors, backshells or accessories being tested according to table I fail to meet the requirements of 3.3, 3.4, 3.10, 3.11, and 3.13.

4.4.4 Retention of qualification. To retain qualification, the contractor shall forward a report at 18-month intervals 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, and the group which they failed. The results of tests of all reworked lots shall be identified and accounted for.

b. A summary of the results of tests performed for periodic inspection (group C), including the number of failures. The summary shall include results of all periodic inspection tests performed and completed during the 18-month period. If the summary of the test results indicates nonconformance with specification requirements, and corrective action acceptable 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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Failure to submit the report within 30 days after the end of each 18-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 18-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 two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit the qualified product to testing in accordance with the qualification inspection requirements.

4.5 Quality conformance inspection. Quality conformance inspection shall consist of the inspections and optical tests specified for group A inspection (table II), group B inspection (table III), group C inspection (table IV), and packaging inspection.

4.5.1 Inspection of product for delivery. Inspection of product for delivery shall consist of groups A and B inspections.

4.5.1.1 Inspection lot. The inspection lot shall consist of the number of connectors offered for inspection at one time, and all of the same design as covered by one specification sheet.

4.5.1.1.1 Sample unit. A sample unit shall be selected at random from the inspection lot.

4.5.1.1.2 Sample size. The sample size shall consist of that number of sample units required by the inspection lot size, as determined by the sampling plans in MIL-STD-105.

4.5.1.1.3 Sample unit preparation. Connectors shall be fully assembled into cable-connector assemblies using the types of cable specified in DOD-C-85045. In case of no qualified sources, the following cable or equivalent shall be used.

2 Channel	PIN M85045/2-B2A, 50 micron core, 125 clad, or equal.
4 Channel	PIN M85045/2-C4A, 100 micron core, 140 clad, or equal.
6 Channel	PIN M85045/2-C6A, 100 micron core, 140 clad, or equal.

Connector terminals shall be optically finished with termini properly seated within their inserts. For mated connectors, full sealing capability shall be provided as specified (see 3.1). Connectors shall be provided with backshell, strain relief cable clamp and attached to a six feet length of the specified cable type, and shall be terminated in accordance with the manufacturer's instructions.

4.5.1.1.4 Specimen. A specimen shall be a sample unit prepared in accordance with 4.5.1.1.3.

4.5.1.2 Group A inspection. Group A inspection shall consist of the inspections and optical tests specified in table II. All connectors, backshells, and accessories of the inspection sample shall be subjected to the inspections and optical tests listed.

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TABLE I. Qualification inspection.

Inspection	Part applicability			Optical tests					Requirement paragraph	Test method paragraph
	Connector	Backshell	Accessories	Interconnection device insertion loss test (3.10.1)	Fiber optic circuit discontinuities (3.10.2)	Analog modulation (3.10.3)	Cross-talk (3.10.4)	Ambient light susceptibility (3.10.5)		
Group I (All sample units)[1]										
Optical conformance										
Interconnection device insertion loss test	x			x					3.10.1	4.6.1
Physical conformance										
Size	x	x	x						3.11.1	4.7.1
Weight	x	x	x						3.11.2	4.7.2
Color	x	x	x						3.11.3	4.7.3
Identification marking	x	x	x						3.11.4	4.7.4
Workmanship	x	x	x						3.13	4.8
Crosstalk	x						x		3.10.4	4.6.4
Ambient light susceptibility	x							x	3.10.5	4.6.5
Group II (2 sample units)				2						
Color	x	x	x						3.11.3	4.7.3
Identification marking	x	x	x						3.11.4	4.7.4
Insert retention axial strength	x								3.11.6	4.7.6
Insert retention radial strength	x								3.11.7	4.7.7
Terminus retention force	x								3.11.8	4.7.8
Terminus insertion and removal forces	x								3.11.9	4.7.9
Maintenance aging									3.11.10	4.7.10
Fiber optic connector/component temperature life	x	x	x	c			c	c	3.11.20	4.7.20
Crush resistance	x	x	x	c					3.11.18	4.7.18
Fluid immersion test for fiber optic cable (1 sample unit per fluid)	x	x	x						3.11.27	4.7.27
Group III (6 sample units)										
Color	x	x	x						3.11.3	4.7.3
Identification marking	x	x	x						3.11.4	4.7.4
Connector engagement and disengagement forces	x								3.11.11	4.7.11
Coupling torques	x								3.11.12	4.7.12
Mating durability for fiber optic interconnecting devices[3]	x			c 3					3.11.13	4.7.13
Twist test for fiber optic connecting devices	x	x		c					3.11.15	4.7.15
Cable seal flexing	x	x		c					3.11.16	4.7.16
Cable retention test procedure for fiber optic cable interconnecting devices	x	x		c					3.11.17	4.7.17
External bending moment	x			c					3.11.19	4.7.19
Temperature cycling of fiber optic connector										
Thermal shock	x	x	x	c			c	c	3.11.21	4.7.21
Altitude immersion	x		x	c					3.11.26	4.7.26
Water pressure/freezing	x		x	c					3.11.30	4.7.30
Ozone exposure	x		x						3.11.22	4.7.22
Physical shock test	x	x		c	c					
Vibration test procedure for fiber optic connecting devices	x	x			c	c			3.11.23	4.7.23

See footnotes at end of table.

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TABLE I. Qualification inspection - Continued.

Inspection	Part applicability			Optical tests					Requirement paragraph	Test method paragraph
	Connector	Backshell	Accessories	Interconnection device insertion loss test (3.10.1)	Fiber optic circuit discontinuities (3.10.2)	Analog modulation (3.10.3)	Cross-talk (3.10.4)	Ambient light susceptibility (3.10.5)		
Group IV (2 sample units)										
Color	X	X	X						3.11.3	4.7.3
Identification marking	X	X	X						3.11.4	4.7.4
Terminus cleaning	X								3.11.5	4.7.5
Connector engagement and disengagement forces	X								3.11.11	4.7.11
Coupling torques	X								3.11.12	4.7.12
Mating durability for fiber optic interconnecting devices	X			a 3/					3.11.13	4.7.13
Humidity test procedure for fiber optic connecting devices	X		X	d					3.11.24	4.7.24
Salt spray	X	X	X						3.11.25	4.7.25
Sand and dust	X	X	X						3.11.29	4.7.29
Impact test measurements for fiber optic devices	X	X	X						3.11.14	4.7.14
Flammability	X	X	X						3.11.31	4.7.31

1/ Sample Units - Number indicated means that the number of connectors, backshell or accessories that shall be tested, for example "2 Sample Units" means 2 connectors and 2 accessories shall be tested when an "X" appears in the part applicability column under "connector" and "accessories."

2/ d - Indicates performance test to be accomplished before, during, and after inspection test.

a - Indicates performance test to be accomplished before and after inspection test.

X - Indicates that this test applies.

3/ After every 100 cycles.

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TABLE II. Group A inspection.

Inspection	Part applicability 1/			Optical tests					Requirement paragraph	Test method paragraph
	Connector	Backshell	Accessories	Interconnection device insertion loss test (3.10.1)	Fiber optic circuit discontinuities (3.10.2)	Analog modulation (3.10.3)	Cross-talk (3.10.4)	Ambient light susceptibility (3.10.5)		
Size	X	X	X						3.11.1	4.7.1
Weight	X	X	X						3.11.2	4.7.2
Color	X	X	X						3.11.3	4.7.3
Identification marking	X	X	X						3.11.4	4.7.4
Terminus insertion and removal forces	X								3.11.9	4.7.9
Connector engagement and disengagement forces	X								3.11.11	4.7.11
Coupling torques	X								3.11.12	4.7.12
Workmanship			X						3.13	4.8

1/ X - Indicates that this test applies.

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TABLE III. Group B inspection.

Inspection	Part applicability			Optical tests					Requirement paragraph	Test method paragraph
	Connector	Backshell	Accessories	Interconnection device insertion loss test (3.10.1)	Fiber optic circuit discontinuities (3.10.2)	Analog modulation (3.10.3)	Cross-talk (3.10.4)	Ambient light susceptibility (3.10.5)		
Color	X	X	X						3.11.3	4.7.3
Identification marking	X	X	X	d			a	a	3.11.4	4.7.4
Terminus cleaning	X			d					3.11.5	4.7.5
Insert retention axial strength	X								3.11.6	4.7.6
Insert retention radial strength	X								3.11.7	4.7.7
Terminus retention force	X								3.11.8	4.7.8
Maintenance aging	X	X	X						3.11.10	4.7.10
Connector engagement and disengagement forces	X								3.11.11	4.7.11
Coupling torques	X								3.11.12	4.7.12
Cable retention test procedure for fiber optic cable interconnecting devices	X	X		d					3.11.17	4.7.17

1/ d - Indicates performance test to be accomplished before, during, and after inspection test.

a - Indicates performance test to be accomplished before and after inspection test.

X - Indicates that this test applies.

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TABLE IV. Group C inspection.

Inspection	Part applicability 1/			Optical tests 1/					Requirement paragraph	Test method paragraph
	Connector	Backshell	Accessories	Interconnection device insertion loss test (3.10.1)	Fiber optic circuit discontinuities (3.10.2)	Analog modulation (3.10.3)	Cross-talk (3.10.4)	Ambient light susceptibility (3.10.5)		
Group 1 (3 sample units)										
Color	X	X	X						3.11.3	4.7.3
Identification marking	X	X	X						3.11.4	4.7.4
Impact test measurements for fiber optic devices	X	X	X						3.11.14	4.7.14
Twist test for fiber optic connecting devices	X	X		d					3.11.15	4.7.15
Cable sealing flexing	X	X		d					3.11.16	4.7.16
Mating durability for fiber optic interconnecting devices	X			a					3.11.13	4.7.13
External bending	X	X		d					3.11.19	4.7.19
Fiber optic connector/component temperature life	X		X	a					3.11.20	4.7.20
Temperature cycling of fiber-optic connectors (thermal shock)	X	X		d					3.11.21	4.7.21
Physical shock test	X	X		a	d				3.11.22	4.7.22
Vibration test procedure for fiber optic connecting devices	X	X		a	d	d			3.11.23	4.7.23
Humidity test procedure for fiber optic connecting devices	X		X				a	a	3.11.24	4.7.24
Group 2 (3 sample units)										
Color	X	X	X						3.11.3	4.7.3
Identification marking	X	X	X						3.11.4	4.7.4
Terminus cleaning	X								3.11.5	4.7.5
Salt spray	X	X	X						3.11.25	4.7.25
Water pressure/freezing	X		X	d			a	a	3.11.28	4.7.28
Sand and dust	X	X	X						3.11.29	4.7.29
Crush resistance	X	X	X	d			a	a	3.11.16	4.7.16
Flammability	X	X	X						3.11.31	4.7.31

1/ d - Indicates performance test to be accomplished before, during, and after inspection test.

a - Indicates performance test to be accomplished before and after inspection test.

X - Indicates that this test applies.

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4.5.1.2.1 Visual examination (group A inspection). Each connector shall be visually examined for completeness, workmanship, and identification requirements. Attention shall be given to those assemblies that require a gasket to determine the condition of the gasket. Gaskets missing, twisted, buckled, kinked, or damaged in any way shall be cause for rejection. Each connector shall be visually inspected for the presence of compound between fiber termination end of insert and shell.

4.5.1.2.2 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 one percent for major defects and four percent for minor defects. Major and minor defects shall be as defined in MIL-STD-105.

4.5.1.2.3 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct the defects, or screen out the defective units (if possible), and resubmit them for inspection. Resubmitted lots shall be inspected using tightened inspection in accordance with MIL-STD-105. Such lots shall be separate from new lots, and shall be clearly identified as reinspected lots.

4.5.1.2.4 Disposition of sample units. Sample units that have failed any of the Group A inspection tests may be reworked to correct defects if possible and subjected to Group A inspection again. Sample units that pass all tests of group A inspection may be delivered on the purchase order or contract or tested to group B inspection (see 4.5.1.3). Units that have not been corrected shall not be delivered on any order even though the inspection lot submitted is accepted.

4.5.1.3 Group B inspection. Group B inspection shall consist of the inspections and optical tests specified in table III, in the order shown, and shall be made on sample units which have been subjected to and have passed the Group A inspection.

4.5.1.3.1 Sampling plan. The sampling plan shall be in accordance with MIL-STD-105 for special inspection S-4. Major and minor defects shall be as defined in MIL-STD-105. 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.

4.5.1.3.2 Rejected lots. If an inspection lot is rejected, the contractor may rework the lot to correct the defects or screen out the defective units and resubmit for reinspection. Resubmitted lots shall be inspected using tightened inspection in accordance with MIL-STD-105. Such lots shall be separate from new lots and shall be clearly identified as reinspected lots.

4.5.1.3.3 Disposition of sample units. Sample units used in Group A or B inspections may be used for group C inspection or delivered on the contract or purchase order only if the following requirements are met:

a. The lot is accepted.

b. The connector has removable termini and the ones that were terminated for testing are replaced with unterminated ones.

c. The sampling unit passed group B inspection, or the sample unit failed group B inspection but was reworked and successfully retested to group B requirements.

Sample units not meeting criteria a, b, and c shall not be delivered on the contract or purchase order, or used for group C inspection.

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4.5.2 Periodic inspection. Periodic inspection shall consist of group C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.5.2.1.4), delivery of products which have passed group B inspection shall not be delayed pending the results of these periodic inspections.

4.5.2.1 Group C inspection. Group C inspection shall consist of the tests specified in table IV in the order shown. Group C inspection shall be performed on sample units of each style and selected from inspection lots which have passed groups A and B inspections. Group C inspection sample shall be representative of production.

4.5.2.1.1 Sampling plan. Every 36 months, connector, backshell, and accessory sample units which have passed group B inspection shall be selected in sufficient quantity to provide three samples per applicable test group.

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

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

4.5.2.1.4 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 and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all tests and examinations or the test which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstituted; 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 and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

4.5.3 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.

4.6 Optical conformance test methods. An equilibrium mode simulator and cladding mode stripper shall be installed between the source and connector (in that order) as well as between the connector and detector (in that order) when making optical measurements. A one kilometer section of fiber may be substituted for the equilibrium mode simulator and cladding mode stripper between the source and connector if desired. In connectors with one, two or three optical channels, optical measurements shall be made in rapid succession on each channel. In connectors with four or more channels, optical measurements shall be made in rapid succession on three randomly selected channels unless otherwise specified herein.

4.6.1 Interconnect device insertion loss test. Insertion loss tested in accordance with method A of EIA-455-34 (see 3.10.1).

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4.6.2 Fiber optic circuit discontinuities. The connector shall be tested in accordance with EIA-455-32 (FOTP-32). The optical termini of the connector shall be connected through a minimum of 4 meters of optical test cables to an appropriate optical signal source and detector. Unused termini shall be capped. The source shall produce a constant level, static signal easily detected by the detector. The output of the detector shall be monitored for discontinuities while the connector is subjected to a mechanical or environmental test exposure. The detector and monitoring equipment shall possess sufficient sensitivity and high frequency response to detect discontinuities in the optical signal. The monitoring equipment shall include transient capture capability (such as provided by an electronic counter or by an oscilloscope with an adjustable sweep trigger and oscilloscope camera) (see 3.10.3).

4.6.3 Analog modulation. The optical termini of the connector shall be connected through a minimum of 4 meters of optical cables to an optical signal source and detector. Unused termini shall be capped. The source shall produce a constant level, static signal easily detected by the detector. The output of the detector shall be monitored for analog modulation while the device under test is subjected to a mechanical or environmental test exposure. The detector and monitoring equipment shall possess sufficient sensitivity and frequency response to discern analog modulation at the acceptance level. The monitoring equipment shall include signal recording capability (such as provided by a triggerable oscilloscope and an oscilloscope camera) (see 3.10.3).

4.6.4 Crosstalk. The termini of the connector shall be connected to a minimum of 4 meters of optical test cables or opaquely capped as appropriate. The input to one optical channel (the active channel) shall be connected via its test cable to an optical signal source, the signal of which shall be either continuous or amplitude modulated. The output port(s) of the other channels (passive channel(s)) shall be connected to test cable(s). The other input ports shall be opaquely capped. The output signal power from both the active and passive channels shall be measured. When there is more than one passive channel, the output of all passive channels shall be summed. This test shall be repeated, making each remaining input port the active channel (see 3.10.4).

4.6.5 Ambient light susceptibility. The optical termini shall be tested in accordance with EIA-RS-455-22 (FOTP-22). The optical termini of the connector shall be either opaquely capped or connected to a minimum of 4 meters of optical test cables as appropriate. The far ends of these test cables shall be either capped or connected to suitable optical power monitoring instruments. The light shall be broad spectrum with infrared, visible, and ultraviolet components and shall illuminate the connector with an irradiance (power density) of 112 ±5 milliwatts per square centimeter. Light eminating from each optical part of the device under test shall be measured by optical power monitoring equipment, having a broad spectral response compatible with the source (see 3.10.5).

4.7 Inspection methods.

4.7.1 Size. Each of the dimensions specified (see 3.1) for the connector, backshell, and accessory parts shall be measured using calibrated measuring devices with the precision and accuracy appropriate for the tolerances specified (see 3.1 and 3.11.1).

4.7.2 Weight. The connector, backshell and accessories shall be weighed using calibrated scales having the range, precision and accuracy appropriate for the tolerances specified (see 3.1 and 3.11.2).

4.7.3 Color. The colors of connectors, backshells and accessories shall be nonreflective (see 3.11.3).

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4.7.4 Identification marking. Identification markings on connectors, backshells and accessory parts shall be visually examined and measured for conformance with the requirements of 3.11.4.

4.7.5 Terminus cleaning. The optical face of each terminus shall be cleaned according to the instructions supplied by the connector manufacturer. (The terminus shall not be removed from its operational position within the connector to facilitate cleaning (see 3.11.5)).

4.7.6 Insertion retention axial strength. Unmated connector samples shall be tested in accordance with method 2010 of MIL-STD-1344. Termini positions within the insert shall be fully filled. Pressure shall be applied up to the minimum pressure specified herein and the axial displacement measured. The pressure shall be applied in the other direction up to the minimum specified (see 3.1) and the displacement measured (see 3.11.6).

4.7.7 Insert retention radial strength. Unmated connector samples shall be tested, where specified (see 3.1), for radial strength as described herein. Counterpart test devices for the connector shall be supplied by the connector manufacturer which are capable of applying torque forces between the insert and its shell body. Outermost termini positions or other means may be used for application of these torques, however, no damage shall occur to the insert as a result of the test exposure. Torque loading shall be applied up to the maximum specified (see 3.1) in each rotational direction (see 3.11.7).

4.7.8 Terminus retention force. Unmated connector samples shall be tested in accordance with method 2007 of MIL-STD-1344. Termini shall be subjected to axial compressive loads applied to the front face of the optical terminal tending to push the terminus to the rear of the shell body. Care must be exercised in the design of the terminus plunger mechanism to not physically touch the terminal optical region. Axial loads shall be applied up to the maximum load specified herein (see 3.11.8).

4.7.9 Terminus insertion and removal forces. Unmated connector samples shall be tested in accordance with method 2012 of MIL-STD-1344. Cable clamping shall be relaxed and the connector backshell removed for the performance of these tests (see 3.11.9).

4.7.10 Maintenance aging. The optical termini shall be tested in accordance with method 2002 of MIL-STD-1344). The termini selected for insertion and removal shall be the same termini to be used subsequently for optical testing. Insertion and withdrawal tools shall be in accordance with MIL-I-81969/46, MIL-T-81969/47, and MIL-I-81969/48. There shall be 10 insertion and removal cycles, unless otherwise specified.

4.7.11 Coupling forces. Mateable connectors or accessories shall be tested for axial engagement and disengagement forces in accordance with method 2013 of MIL-STD-1344 at an optional rate (see 3.11.11).

4.7.12 Coupling torques. The connector mated and unmated shall be tested for radial engagement and disengagement torques in acccordance with method 2013 of MIL-STD-1344 at an optional rate (see 3.11.12).

4.7.13 Mating durability for fiber-optic interconnecting devices. The terminated assembly made of one cable mounted connector and one wall or jam-nut mounted connector shall be mated and unmated in accordance with EIA-455-21 (FOTP-21). One thousand complete (part separating) cycles (mate and unmate) shall be accomplished by hand at an optional rate. The change in insertion loss and coupling forces after the durability tests shall be measured (see 3.11.13). The coupling forces shall be measured in accordance with the requirements of this specification and the specification sheet. The connector termini may be cleaned

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prior to insertion loss measurements (see 4.7.5) and shall be so noted on data sheets. Connector coupling hardware shall not require cleaning to meet coupling force requirements (3.11.13).

4.7.14 Impact test measurements for fiber-optic devices. Each wall or jam-nut piece of each connector to be qualified shall be subjected to the test (impact) in accordance with EIA-455-2. The individual specification shall state the acceptance/rejection criteria for the test.

4.7.15 Twist test for fiber-optic connecting devices. Mated cable-connector assemblies shall be tested in accordance with EIA-RS-455-36. Connector-held fixture shall be rotated ±90 degrees at a rate of one cycle per five seconds for a total of 1,000 cycles. The cable assemblies shall be stretched with a minimum tension of 11.0 pounds to their maximum lengths and clamped at a distance of about 10 times the cable diameter from the connector to the fixture table top. The fixturing and cable clamping are to be done in a manner that does not affect the cable's optical transmittance beyond acceptable limits as specified (see 3.11.15) Measurements shall be taken before and after testing.

4.7.16 Cable seal flexing. Unmated cable-connector assemblies, of each type to be qualified shall be tested in accordance with test procedure I, method 201 of MIL-STD-1344 (see 3.11.16).

4.7.17 Cable retention test procedure for fiber-optic cable interconnecting devices. Mated connector samples shall be tested in accordance with EIA-RS-455 (FOTP-6). The axial tensile load shall be applied up to the load specified (see 3.11.17) and shall be maintained for 10 minutes. Elongation of the cable shall have no effect on the insertion loss while the load is applied for the specified time. Tests and measurements before, during, and after test shall be taken as required by the detail specification.

4.7.18 Crush resistance. Cable connector assemblies shall be tested in accordance with EIA-455-21. The test load used shall be 225 pounds and shall be applied for a period of 5 to 10 seconds (see 3.11.18).

4.7.19 External bending moment. The wall or jam-nut mounted connector shall be mounted as in normal service to a rigid panel. Before mating the cable connector to the wall or jam-nut mounted connector, an adapter or test torque arm shall be attached as shown on figure 1. After mating the two connectors, the distance "L" from the point of load application "P" to the mounting panel shall be determined. The load to be applied at point "P" shall then be determined as the bending moment specified divided by the lever arm "L". This load shall be applied at a rate of approximately 49.5 newtons per seconds until the required load of 71 newton meters is achieved. The applied load shall be held for one minute, then the load shall be released. Insertion loss of the termini shall be monitored during the test (see 3.11.19).

4.7.20 Fiber-optic connector/component temperature life. Mated connectors shall be subjected to temperature test condition B and test time condition B in accordance with EIA-455-4. The change in insertion loss shall be measured during and after the test (3.11.20).

4.7.21 Temperature cycling of fiber-optic connectors (thermal shock). Cable-connector assemblies (at least one mated and one unmated) shall be tested in accordance with test condition A of EIA-RS-455-1 (FOTP-3). The fiber shall be in accordance with MIL-F-49291. The number of fibers will be given by the specification sheet. The mated and unmated cable-connector assemblies shall be examined for satisfaction of the mechanical requirements of 3.11.21. The cycles performed shall be in accordance with test condition A-D.

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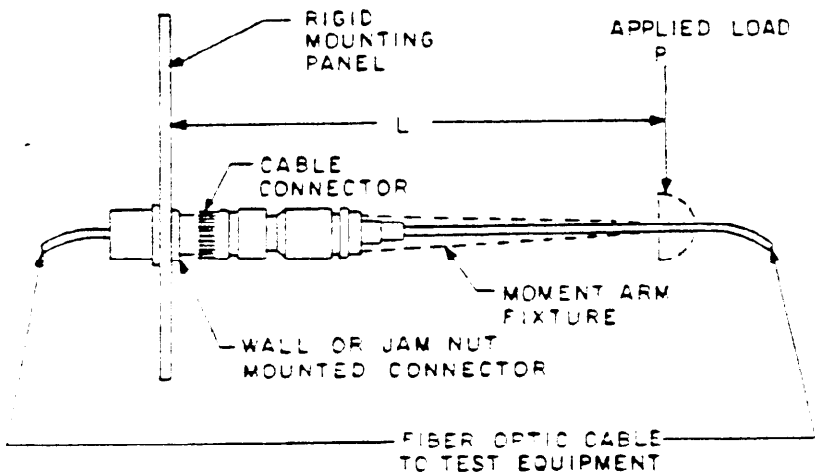

NOTE: Moment of fixture shall be of a convenient design.

FIGURE 1. External bending moment test setup.

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4.7.22 Physical shock test. Mated cable-connector assemblies shall be tested in accordance with test condition DI of EIA-RS-455-14. The cable shall be clamped to the shock table approximately 8 inches from the rear of the connector. The change in insertion loss shall be measured after the shock test (see 3.11.22).

4.7.23 Vibration test procedures for fiber-optic connecting devices. Mated cable-connector assemblies shall be tested in accordance with method 2005 of MIL-STD-1344. The cable-connector assemblies shall be attached to a fixture capable of transmitting the vibration conditions specified. The change in insertion loss shall be measured during and after the vibration test (see 3.11.23).

4.7.24 Humidity test procedure for fiber-optic connecting devices. Cable-connected assemblies (at least one mated and one unmated), shall be tested in accordance with test type II of method 1002 of MIL-STD-1344. The subcycle will be included. The cable used shall be in accordance MIL-C-85045. Measurements shall be made of the sample after conditioning process and after humidity test (see 3.11.24).

4.7.25 Salt spray (corrosion). Mated cable-connector assemblies shall be tested in accordance with test condition C of method 1001 of MIL-STD-1344. After test exposure the assemblies shall be externally cleaned and examined under 3 power magnification for salt penetration into the connector junction area and damage to external parts (see 3.11.25).

4.7.26 Altitude immersion. Mated connectors shall be tested in accordance with EIA-RS-455-15. Cables used shall be in accordance with MIL-C-85045. Fibers used shall be in accordance with MIL-F-49291. The change in insertion loss shall be measured after the test (see 3.11.26).

4.7.27 Fluid immersion test for fiber-optic cable. Connectors shall be immersed in the fluids specified herein in accordance with EIA-RS-455-40. The fluid temperature, number of cycles, and whether mated or unmated shall be specified herein. After immersion and cleaning as required, coupling forces and the change in insertion loss shall be measured (see 3.11.27).

4.7.28 Water pressure/freezing. Mated cable-connector assemblies shall be tested for water pressure susceptability as follows. The assemblies shall be immersed in an aqueous dye penetrant solution to a minimum depth of 1.85 m for a period of not less than 48 hours. The solution temperature shall be maintained between 10°C and 35°C during the exposure period. The dye concentration shall be adequate to visibly indicate liquid exposure. The connector will be removed from the container and placed in a chamber at -20°C for one hour with the optical insertion loss being examined during the test. The connector assemblies shall be externally cleaned, unmated, examined for dye penetration into the connector, mated and optically tested (see 3.11.28).

4.7.29 Sand and dust. Connectors mated and unmated, as applicable, shall be subjected to the dust (fine sand) test of MIL-STD-202, method 110 (see 3.11.29).

4.7.30 Ozone exposure. Mated cable-connector assemblies shall be tested in accordance with method 1007 of MIL-STD-1344. After test exposure, the assemblies shall be examined for damage (see 3.11.30).

4.7.31 Flammability. Flammability of connectors and accessories (at least one mated and one unmated) shall be tested in accordance with method 1012 of MIL-STD-1344 with the flame applied for 60 seconds (see 3.11.31).

4.8 Workmanship inspection. The connectors and accessories shall be visually examined to verify that they meet the workmanship requirements of 3.8.

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5. PACKAGING

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

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The fiber-optic connectors specified herein are intended for use with low loss optical fiber cables in military, ground based, fiber-optic data transmission systems.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of the specification.

b. Isssue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).

c. Specification sheet number, title and date.

d. Part or identifying number (PIN).

e. Quantity of connectors required.

f. Inclusion of terminating tools, if desired (see 3.9).

g. Color (see 3.11.3).

6.3 Qualification. Awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the contractors is 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 2750 Air Base Wing (AFLC), ATTN: ES, Gentile Air Force Station, Dayton, OH 45444. However, information pertaining to qualification of products may be obtained from Defense Electronics Supply Center (DESC-E), 1507 Wilmington Pike, Dayton, Ohio 45444.

6.3.1 Conformity to qualified sample. It is understood that connectors supplied under the contract shall be identical in every respect to the qualification sample tested and found satisfactory, except for changes previously approved by the Government. Any unapproved changes from the qualification sample shall constitute cause for rejection.

6.3.2 Provisions governing qualification SD-6. Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

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6.4 Patent notice. The Government does not have royalty-free license under the specified patents (sec 3.17), for the benefit of manufacturers of the item, neither for the Government nor for use in equipment to be delivered to the Government:

Patent no.	Patent expiration date
US 3,994,564	11/30/1993
US 4,054,366	10/18/1994
US 4,060,308	11/29/1994

6.5 Application information.

6.5.1 Fiber-optic test plugs. Fiber-optic test plugs are plug assemblies that are used to simulate short or long lengths of fiber. This can be accomplished in a number of different ways; i.e., fiber core match or mismatch, fiber numerical aperture match or mismatch, etc. The test plug is simply a fiber-optic connector plug which uses a short length of the required fiber that is "looped back" in the backshell. These test plugs finc applications in many system functions. The following is a partial list:

a. A test plug containing a fiber with characteristics like that of the deployment fiber can simulate a short length of fiber (low optical loss).

b. A test plug containing a fiber with characteristics unlike that of the deployment fiber can simulate a long length of fiber (high optical loss).

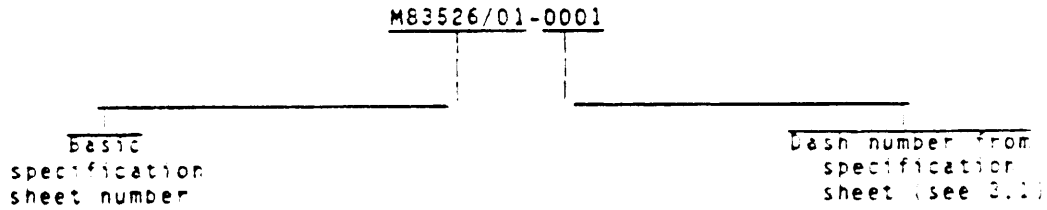
c. Using a combination of the above test plugs the user can evaluate the dynamic range of this system.

d. Can be used in field situations where an optical time domain reflectometer is not available to determine fault locations.

e. Allows system checkout to be performed without the actual deployment of cable assemblies.

6.6 Part or Identifying Number (PIN). The PIN shall consist of the letter "M" followed by the basic specification sheet number, and a sequentially assigned dash number (see 3.1 and 6.2).

Example:



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6.7 Subject term (key word) listing.

Backshells
Cable, fiber optic
Covers, protective
Epoxies
Inserts
Optical performance requirements
Strain relief, cable
Termini
Test plugs

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - EC
Air Force - 85

Review activities:
Air Force - 11, 17, 19, 80, 90, 99
Army - MI
Navy - AS, SH
DLA - ES
NASA - NA

User activities:
Air Force - 13, 14
Navy - MC, OS, YD

Preparing activity:
Air Force - 85

Agent:
DLA - ES

(Project number 6060-0065)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-C-83526A	Connectors, Fiber Optic, Circular, Environmental Resistant, Hermaphroditic, General Specification For

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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