METRIC
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DOD-S-24623
25 March 1985
(See 6.14)

MILITARY SPECIFICATION

SPLICE, FIBER OPTIC, SHIPBOARD,
GENERAL SPECIFICATION FOR

This specification is approved for use by the Naval Sea Systems Command based upon currently available technical information but it has not been approved for promulgation as a coordinated revision of DOD-S-24623. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in acquisition.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for fiber optic splices. It covers the requirements for both fiber splices and cable splices (see 6.4.2 and 6.4.5). It includes both single-mode and multimode splices of either mechanical or fusion design. The splices include single fiber and multiple fiber terminations.

1.2 Classification. Splices covered by this specification are classified as specified in 1.2.1 through 1.2.3.

1.2.1 Splice type. The splice type designation defines the type of splices.

F - Fusion

M - Mechanical

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5105 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

1.2.2 Fiber style. The fiber style designation defines the optical fiber for which the splice is used.

SM - Single-mode

MM - Multimode

1.2.3 Class. The class designation defines the splice as either a cable or a fiber splice.

A - Fiber splice

B - Cable splice

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

FEDERAL

QQ-P-35 - Passivation Treatments for Corrosion-Resistant Steel.
TT-I-735 - Isopropyl Alcohol.

MILITARY

MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-H-5606 - Hydraulic Fluid, Petroleum Base; Aircraft, Missile, and Ordnance.
MIL-T-5624 - Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-F-16884 - Fuel, Naval Distillate.
MIL-L-17331 - Lubricating Oil, Steam Turbine and Gear, Moderate Service.
MIL-L-23699 - Lubricating Oil, Aircraft Turbine Engine, Synthetic Base.
DOD-F-49291 - Fiber, Optical, (Metric) General Specification for.
MIL-C-55330 - Connectors, Electrical and Fiber Optic, Packaging of.
DOD-C-85045 - Cables, Fiber Optics, (Metric) General Specification for.

STANDARDS

FEDERAL

FED-STD-313 - Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities.

MILITARY

MIL-STD-130 - Identification Marking of US Military Property.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
MIL-STD-889 - Dissimilar Metals.
MIL-STD-1344 - Test Methods for Electrical Connectors.
DOD-STD-1678 - Fiber Optics Test Methods and Instrumentation.

(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 document(s) 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)

455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
455-2 - Impact Test Measurements for Fiber Optic Devices. (DoD adopted)
455-4 - Fiber Optic Connector/Component Temperature Life.
455-5 - Humidity Test Procedure for Fiber Optic Connecting Devices.
455-6 - Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices.
455-12 - Fluid Immersion Test Procedure for Fiber Optic Connecting Devices.
455-13 - Visual and Mechanical Inspection of Fibers; Cable, Connectors and/or Other Fiber Optic Devices.
455-16 - Salt Spray (Corrosion) Test for Fiber Optic Components.
455-20 - Measurement of Change in Optical Transmittance. (DoD adopted)
455-22 - Ambient Light Susceptibility of Fiber Optic Components.
455-34 - Interconnection Device Insertion Loss Test. (DoD adopted)
455-35 - Fiber Optic Connector Dust (Fine Sand) Test.
455-36 - Twist Test for Fiber Optic Connecting Devices.
455-42 - Optical Crosstalk in Fiber Optic Components.
455-49 - Procedure for Measuring Nuclear Radiation Irradiation Effects in Fiber Optic Components.
455-71 - Procedure to Measure Temperature Shock Effects on Fiber Optic Components.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, NW, 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 specification sheets), the text of this document takes 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 sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.4) in accordance with 4.4.

3.3 Materials. The splice shall be constructed of material as specified (see 3.1). The materials selected shall have an intended lifetime of 20 years. They shall be of lightest practical material suitable for its intended purpose. All combinations of materials shall be nonmagnetic and nonnutrient.

3.3.1 Recovered materials. Unless otherwise specified herein, all material incorporated in the products covered by this specification shall be new. Products may be fabricated using raw materials produced from recovered bulk materials to the extent practicable if the intended use of the product is not jeopardized. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become part of a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of partially processed, assembled, used or rebuilt products are allowed under this specification.

3.3.2 Metals. Metals shall be corrosion-resistant. Unless otherwise specified (see 3.1), metals shall be nonmagnetic, and all exposed corrosion-resistant steel parts shall have a passivated surface that is compatible with external coatings or platings of the type and color specified (see 3.1).

3.3.3 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless finished to prevent electrolytic corrosion. Selection and protection of dissimilar metal combinations shall be in accordance with MIL-STD-889.

3.3.4 Finish. The resultant finish on all cable splice closures (see 6.6.3) shall meet the requirements herein and be:

(a) Aluminum components - cadmium plate over electroless nickel for external parts.
(b) Stainless steel components, passivate in accordance with QQ-P-35.

3.3.5 Adhesives. Materials as specified (see 3.1) employed in the fiber to terminus securing or polishing processes shall not degrade from in-service use or during the installation process. When adhesives are used in the construction of splices, the adhesive shall not degrade during the intended lifetime of the splice (see 3.5.3.1).

3.3.6 Sealing compounds. Sealing compounds shall not flow at the maximum specified storage temperature or exhibit cracking at the minimum specified storage temperature specified in 3.5.3.

3.3.7 Nonmetallic materials. Nonmetallic materials used in the construction of splices shall not be affected by the use of solvents, adhesives, or cleaning agents, nor be degraded at the specified environmental conditions.

3.3.8 Index matching materials. If required, index matching materials shall not degrade the performance of the splice over the specified temperature ranges (see 3.5.3). Index matching materials that flow, migrate, or otherwise are positionally unstable in the completed splice shall not be used (see 6.8).

3.3.9 Toxic products. The materials 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.

3.3.10 Material safety data sheet (MSDS). The contracting activity shall be provided a material safety data sheet at the time of contract award. The MSDS shall be provided in accordance with the requirements of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.9).

3.4 Design and construction. The configuration and physical dimensions of the splice shall be as specified herein and as specified (see 3.1).

3.4.1 General. The splices shall operate with optical fibers and cables as specified in MIL-F-49291 and MIL-C-85045 (see 6.13). The fiber buffer diameter and cable diameter shall be as specified (see 6.2). The splices may be fusion or mechanical designs. Splice designs may be single fiber or multiple fiber. Figure 1 is an example of a typical splice assembly with all parts identified.

3.4.1.1 Fiber splice. The fiber splice shall include the waveguide splice (see 6.6.11) and the fiber splice housing (see 6.6.6).

3.4.1.1.1 Waveguide splice. The waveguide splice shall optically align the core and cladding of the optical fiber.

3.4.1.1.2 Fiber splice housing. The fiber splice housing shall restore the environmental and mechanical integrity of the coating or buffer of the optical fiber.

3.4.1.2 Cable splice. The cable splice shall include the cable splice closure and the fiber splices. The cable splices shall seal the cables to meet the environmental requirements specified herein.

3.4.1.2.1 Cable splice closure. The cable splice closure shall include the fiber splices and cable seals necessary to restore mechanical strength and environmental protection to the cable. The cable splice closure shall seal the fiber splice against moisture and contamination as specified herein.

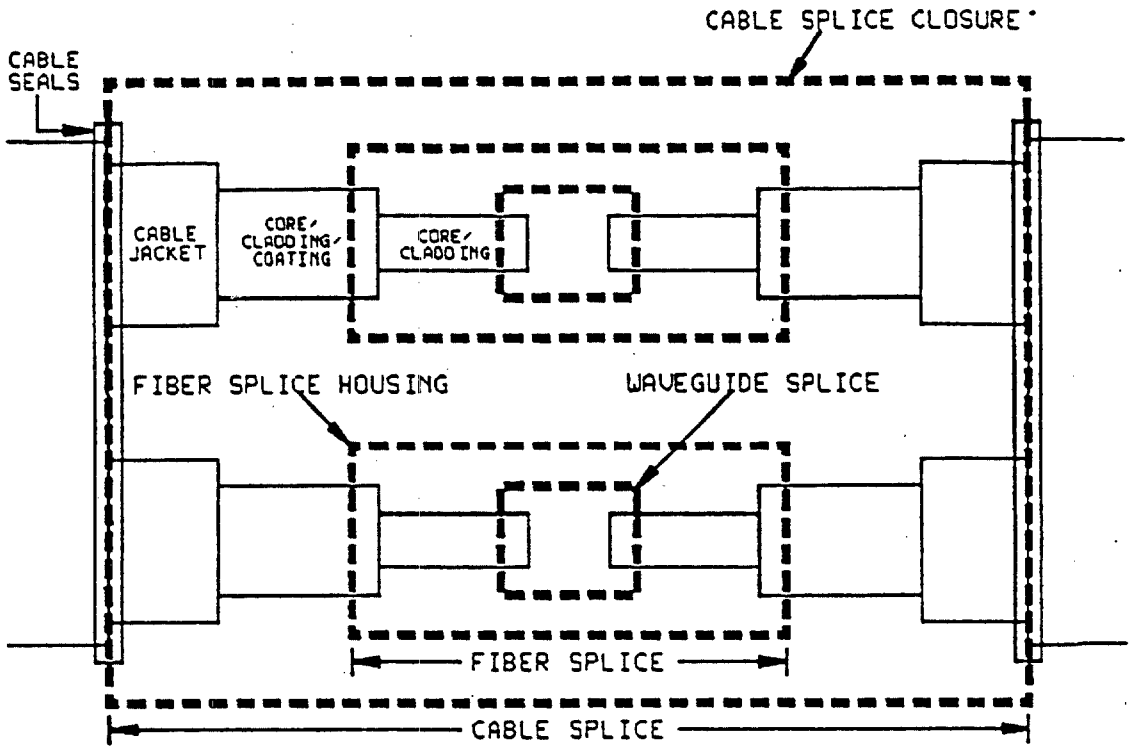


FIGURE 1. Typical splice assembly.

3.4.2 Strain relief. Cable splices shall accept and retain a cable support or cable relief to maintain tensile strength continuity from one cable to the next.

3.4.3 Interchangeability. All splices, assemblies, accessories, and replaceable parts having the same military part number shall be physically and functionally interchangeable without affecting operation or requiring modification.

3.4.4 Size. The size shall be as specified (see 3.1 and 4.6.2.1).

3.4.5 Weight. The weight shall be as specified (see 3.1 and 4.6.2.2).

3.4.6 Design considerations. The splices shall have the following characteristics:

(a) Installable with standard splicing tools; installation time shall be as specified (see 3.1)
(b) Require minimal parts (see 3.1).

3.4.7 Maintainability. The splices shall require no preventive maintenance.

3.5 Performance requirements. The performance requirements are defined in terms of optical, mechanical, environmental, and chemical properties. Unless otherwise specified herein, the performance requirements apply to both fiber splices and cable splices.

3.5.1 Optical properties.

3.5.1.1 Insertion loss. The insertion loss (see 6.6.7) per fiber path shall meet the requirements of table I (see 4.6.3.1).

TABLE I. Insertion loss (dB).

Splice type	Single-mode	Multimode
Fusion		
Single fiber	≤ 0.30	≤ 0.20
Multiple fibers	≤ 0.30	≤ 0.20
Mechanical		
Single fiber	≤ 0.30	≤ 0.20
Multiple fibers	≤ 0.55	≤ 0.25

3.5.1.2 Change in optical transmittance. The change in optical transmittance during or after any specified environmental or mechanical requirement shall be not greater than 0.30 dB (see 4.6.3.2).

3.5.1.3 Return loss. The return loss (see 6.6.8) shall be not greater than minus 30 dB (see 4.6.3.3).

3.5.1.4 Crosstalk. The sum of signal power levels of passive channels for splices with two or more optical paths shall be below the level of the active channel by at least 40 dB (see 4.6.3.4 and 6.6.4).

3.5.1.5 Ambient light susceptibility. The optical power from any one port or sum of ports shall be not greater than minus 50 dBm (see 4.6.3.5 and 6.6.1).

3.5.2 Mechanical properties. The following mechanical properties shall be met without physical damage to the splice or fiber-to-splice interface.

3.5.2.1 Fiber dynamic strength (for class A splices only). The minimum fiber dynamic strength shall be 50 percent of the specified proof strength of the attached fiber (see 4.6.4.1). There shall be no fiber-to-splice seal damage, or distortion or bending of splice parts. The splice shall meet the optical requirements specified in 3.5.1.2.

3.5.2.2 Impact. The splices shall not exhibit any change in dimensions or deformation and meet the requirements of 3.4.4 (see 4.6.4.2). The splice shall meet the optical requirements of 3.5.1.2.

3.5.2.3 Twist (for class B splices only). Splice seals shall not exhibit any change in dimension or deformation and meet the requirements of 3.4.4 (see 4.6.4.3). The splice shall meet the optical requirements of 3.5.1.2.

3.5.2.4 Cable seal flexing (for class B splices only). Splice strain relief mechanisms shall prevent loss of environmental sealing or any damage which may impair the splice operation (see 4.6.4.4).

3.5.2.5 Crush resistance (for class B splices only). The splices shall show no evidence of broken parts, loss of optical continuity, or damage to seals (see 4.6.4.5). The splice shall meet the optical requirements of 3.5.1.2.

3.5.2.6 Cable pull-out force. The minimum cable-to-splice pull-out strength shall be 50 percent of the cable strength not to exceed 73.5kg for splices attaching to the strength members of the cable or 9kg for splices attaching directly to fiber cable components (see 4.6.4.6). The splices shall show no evidence of cable jacket damage, cable clamp failure, cable-to-splice seal damage, distortion of bending of splice parts or cable disengagement from the clamp. The splice shall meet the optical requirements specified in 3.5.1.2.

3.5.3 Environmental properties. The splice shall meet all requirements specified (see 3.1), during the specified operating environments and after the specified storage environment. The operating temperature range and storage temperature range shall be as specified in table II, as specified (see 3.1).

TABLE II. Temperature ranges.

Range	Operating (°C)	Storage (°C)
1	-54 to +65	-62 to +71
2	-54 to +85	-62 to +85
3	-28 to +65	-62 to +71
4	-28 to +85	-62 to +85

3.5.3.1 Temperature life. The splices shall not exhibit any evidence of dimensional change, opening of seals, cracking or crazing of components, fusion or seizure of mating components, or any form of physical damage that will impair function (see 4.6.5.1). The splices shall meet the optical requirements of 3.5.1.2.

3.5.3.2 Thermal shock. The splices shall exhibit no evidence of physical damage (see 4.6.5.2). The splices shall meet the optical requirements of 3.5.1.2.

3.5.3.3 Temperature-humidity cycling. The splices shall exhibit no evidence of deterioration of component parts or constituent materials, loosening of finishes, physical distortion, corrosion of metals, entrapment of moisture, separation of bonded surfaces, or other damages (see 4.6.5.3). The splices shall meet the optical requirements of 3.5.1.2.

3.5.3.4 Salt spray (corrosion). The splices shall exhibit no evidence of salt penetration into the splice seals or peeling, flaking or color change in materials as evidence of corrosive effects (see 4.6.5.4).

3.5.3.5 Water pressure (for class B splices only). The splices shall exhibit no penetration of indicator dye into the sealed region of the assembled splice (see 4.6.5.5). The splices shall meet the optical requirements of 3.5.1.2.

3.5.3.6 Freezing water (for class B splices only). The splices shall not be damaged during exposure (see 4.6.5.6). The splices shall meet the optical requirements of 3.5.1.2.

3.5.3.7 Fluid immersion. Splices shall show no swelling or softening of material, no loss of sealing capability, or other effects detrimental to its operation (see 4.6.5.7).

3.5.3.8 Sand and dust. The splices shall meet the optical requirements of 3.5.1.2 (see 4.6.5.8).

3.5.3.9 Vibration. The splices shall not exhibit cracks, splits, or show deformation that impairs its specified function (see 4.6.5.9). The splice shall meet the optical requirements of 3.5.1.2.

3.5.3.10 Shock. The splices shall exhibit no evidence of physical damage that impairs its specified function (see 4.6.5.10). The splice shall meet the optical requirements specified in 3.5.1.2.

3.5.3.11 Nuclear radiation resistance. The performance requirements of 3.5.1.2 shall be met (see 4.6.5.11).

3.5.4 Chemical properties.

3.5.4.1 Fungus resistance. The splice shall be in accordance with MIL-STD-454, requirement 4, for fungus-inert materials or meet grade I classification of MIL-STD-810, method 508 (see 4.6.6.1).

3.5.4.2 Flame survivability. The splice shall meet the burning resistance criteria of condition B for flame extinguishing time after removal of applied flame, and there shall be no violent burning or explosive type fire (see 4.6.6.2). The splice shall meet the optical requirements of 3.5.1.2.

3.6 Transportability. The splice operational performance specified herein shall not be affected following storage or shipment under environmental conditions for shipment and storage specified herein, and as required for packaging for shipment (see 5.1).

3.7 Identification marking. Fiber splice housings and cable splice closures shall be permanently and legibly marked with the part number (see 6.6) and the manufacturer's federal supply code in accordance with the general marking requirements of MIL-STD-130. The marking location is optional, but should not be covered by the splice assembly or by the installation (see 4.6.1.1).

3.8 Workmanship. Splices and associated fittings shall be processed for uniform quality and shall be free from sharp edges, burrs, and other defects that will affect life, serviceability, appearance, or performance (see 4.6.1.1).

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.

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 the 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.

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

(a) First article inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.2.1 Toxicological product formulations. The contractor shall have the toxicological product formulations and associated information available for review by the contracting activity to evaluate the safety of the material for the proposed use.

4.3 Inspection conditions. Unless otherwise specified (see 3.1), all inspections shall be performed in accordance with the test conditions specified in applicable portions of EIA 455.

4.4 First article inspection. First article inspection shall consist of all the tests listed in table III and as specified (see 3.1).

TABLE III. First article inspection.

Inspection	Requirement	Test method	Sample size
Group I			
Visual and mechanical	3.4, 3.8	4.6.1.1	9
Size	3.4.4	4.6.2.1	1/
Weight	3.4.5	4.6.2.2	1/
Identification marking	3.7	4.6.1.1	1/
Insertion loss	3.5.1.1	4.6.3.1	1/
Return loss	3.5.1.3	4.6.3.3	1/
Crosstalk	3.5.1.4	4.6.3.4	1/
Ambient light susceptibility	3.5.1.5	4.6.3.5	1/
Group II			
Fungus resistance	3.5.4.1	4.6.6.1	1
Flame survivability	3.5.4.2	4.6.6.2	1
Water pressure	3.5.3.5	4.6.5.5	1
Group III			
Temperature life	3.5.3.1	4.6.5.1	1
Thermal shock	3.5.3.2	4.6.5.2	2/
Temperature-humidity cycling	3.5.3.3	4.6.5.3	2/
Salt spray (corrosion)	3.5.3.4	4.6.5.4	2/
Freezing water	3.5.3.6	4.6.5.6	2/

TABLE III. First article inspection - Continued.

Inspection	Requirement	Test method	Sample size
Fluid immersion	3.5.3.7	4.6.5.7	2/
Sand and dust	3.5.3.8	4.6.5.8	1
Vibration	3.5.3.9	4.6.5.9	3/
Shock	3.5.3.10	4.6.5.10	3/
Nuclear radiation resistance	3.5.3.11	4.6.5.11	3
Group IV			
Fiber dynamic strength	3.5.2.1	4.6.4.1	1
Impact	3.5.2.2	4.6.4.2	4/
Twist	3.5.2.3	4.6.4.3	4/
Cable seal flexing	3.5.2.4	4.6.4.4	4/
Crush resistance	3.5.2.5	4.6.4.5	4/
Cable pull-out force	3.5.2.6	4.6.4.6	4/

1/ The same sample shall be used as in the visual and mechanical inspection.
2/ The same sample shall be used as in the temperature life inspection.
3/ The same sample shall be used as in the sand and dust inspection.
4/ The same sample shall be used as in the fiber dynamic strength inspection.

4.4.1 Sample. A splice sample shall be submitted for each splice construction for which first article approval is desired. The sample submitted shall be nine splices of the same part number.

4.4.2 Inspection routine. The sample shall be subjected to the inspections specified in table III in the order shown. All sample units shall be subjected to the inspection of group I. The sample shall then be divided into three groups. The sample units shall then be subjected to the inspection for their particular group. After completion of sample testing, all units shall be resubjected to group I testing. Any splice failing any inspection shall not be subjected to further inspection.

4.4.3 Failures. One or more failures shall be sufficient cause for refusal to grant first article approval.

4.5 Quality conformance inspection. Quality conformance inspection shall consist of the examinations and tests specified for group A inspection (table IV) and group B inspection (table V) (see 6.3).

4.5.1 Group A inspection. Group A inspections shall follow the order shown in table IV.

TABLE IV. Group A inspection.

Inspection	Requirement	Test method
Visual and mechanical	3.4, 3.8	4.6.1.1
Size	3.4.4	4.6.2.1
Weight	3.4.5	4.6.2.2
Identification marking	3.7	4.6.1.1

4.5.2 Group B inspection. Group B inspection shall consist of the inspections specified in table V. Group B inspections shall be made on units that have passed the group A inspection. After completion of group C inspections, the samples shall be resubjected to group A inspection.

TABLE V. Group B inspection.

Inspection	Requirement	Test method
Shock	3.5.3.10	4.6.5.10
Thermal shock	3.5.3.2	4.6.5.2
Fiber dynamic strength	3.5.2.1	4.6.4.1
Twist	3.5.2.3	4.6.4.3
Cable pull-out force	3.5.2.6	4.6.4.6
Insertion loss	3.5.1.1	4.6.3.1
Return loss	3.5.1.3	4.6.3.3
Crosstalk	3.5.1.4	4.6.3.4
Ambient light susceptibility	3.5.1.5	4.6.3.5
Fungus resistance	3.5.4.1	4.6.6.1
Flame survivability	3.5.4.2	4.6.6.2

TABLE V. Group B inspection - Continued.

Inspection	Requirement	Test method
Water pressure	3.5.3.5	4.6.5.5
Impact	3.5.2.2	4.6.4.2
Cable seal flexing	3.5.2.4	4.6.4.4
Crush resistance	3.5.2.5	4.6.4.5
Temperature life	3.5.3.1	4.6.5.1
Temperature-humidity cycling	3.5.3.3	4.6.5.3
Salt spray	3.5.3.4	4.6.5.4
Freezing water	3.5.3.6	4.6.5.6
Fluid immersion	3.5.3.7	4.6.5.7
Sand and dust	3.5.3.8	4.6.5.8
Vibration	3.5.3.9	4.6.5.9
Nuclear radiation resistance	3.5.3.11	4.6.5.11

4.6 Methods of inspection.

4.6.1 General testing practice.

4.6.1.1 Visual and mechanical examinations. Unless otherwise specified (see 3.1), visual and mechanical examinations shall be performed in accordance with EIA 455-13 to verify that the design, construction, physical characteristics, dimensions, marking, and workmanship are in accordance with the applicable requirements. Visual inspection for splice color may be accomplished without magnification.

4.6.1.2 Optical test methods. The use of optical test methods to assess the influence of test exposures on performance of splices requires that they be connected to lengths of fiber. Unless otherwise specified (see 3.1), the optical properties inspections shall be performed at a wavelength of 1.310 ± 0.020 μm. The fiber should be cabled, that is, the splices should be attached to lengths of cable of the type specified in MIL-C-85045 (see 6.13). The cable lengths shall be not greater than 30 meters. The optical fiber components exposed at the test set (source, detector, or coupler) may be connectorized for access to the test set. For multimode fiber, the source used shall be noncoherent. Light launch conditions shall be in accordance with table VI.

TABLE VI. Light launch conditions.

Fiber type	Launch condition
single-mode	30-mm diameter mandrel
multimode	70/100 restricted, or 70/70 restricted (see 6.6.9 and 6.6.10)

Any optical power detection method may be used if the method is sufficiently sensitive to measure the differential optical power levels as specified (see 3.5.1.1), and if the method provides repeatable readings (less than 3 percent variation).

4.6.2 Design and construction inspection.

4.6.2.1 Size. Splice components shall be measured using instruments with accuracies sufficient such that systematic errors are within the tolerances defined (see 3.4.4).

4.6.2.2 Weight. Splice components shall be weighed using scales with an accuracy of 5 percent (see 3.4.5). Splice components shall not be assembled to cables for this test.

4.6.3 Optical properties inspection.

4.6.3.1 Insertion loss. The insertion loss shall be measured in accordance with EIA 455-34 (see 3.5.1.1).

4.6.3.2 Change in optical transmittance. The change in optical transmittance shall be measured in accordance with EIA 455-20 or by an equivalent test method (see 3.5.1.2 and 6.2).

4.6.3.3 Return loss. The return loss shall be measured in accordance with appendix A (see 3.5.1.3).

4.6.3.4 Crosstalk. The splice crosstalk shall be measured in accordance with EIA 455-42 (see 3.5.1.4). The test temperature shall be 25°C.

4.6.3.5 Ambient light susceptibility. The ambient light susceptibility shall be measured in accordance with EIA 455-22, with the exception that the output power in the "on" state shall be referenced to 1 milliwatt (see 3.5.1.5). The test temperature shall be 25°C.

4.6.4 Mechanical properties inspection.

4.6.4.1 Fiber dynamic strength. The fiber pigtail dynamic strength (see 3.5.2.1) shall be tested as follows: The fiber pigtail shall have an axial tensile load applied up to the load specified at an angle of 45 degrees to the

normal (see figure 2). With the load applied, the pigtail shall be rotated through one rotation (360 degrees). The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

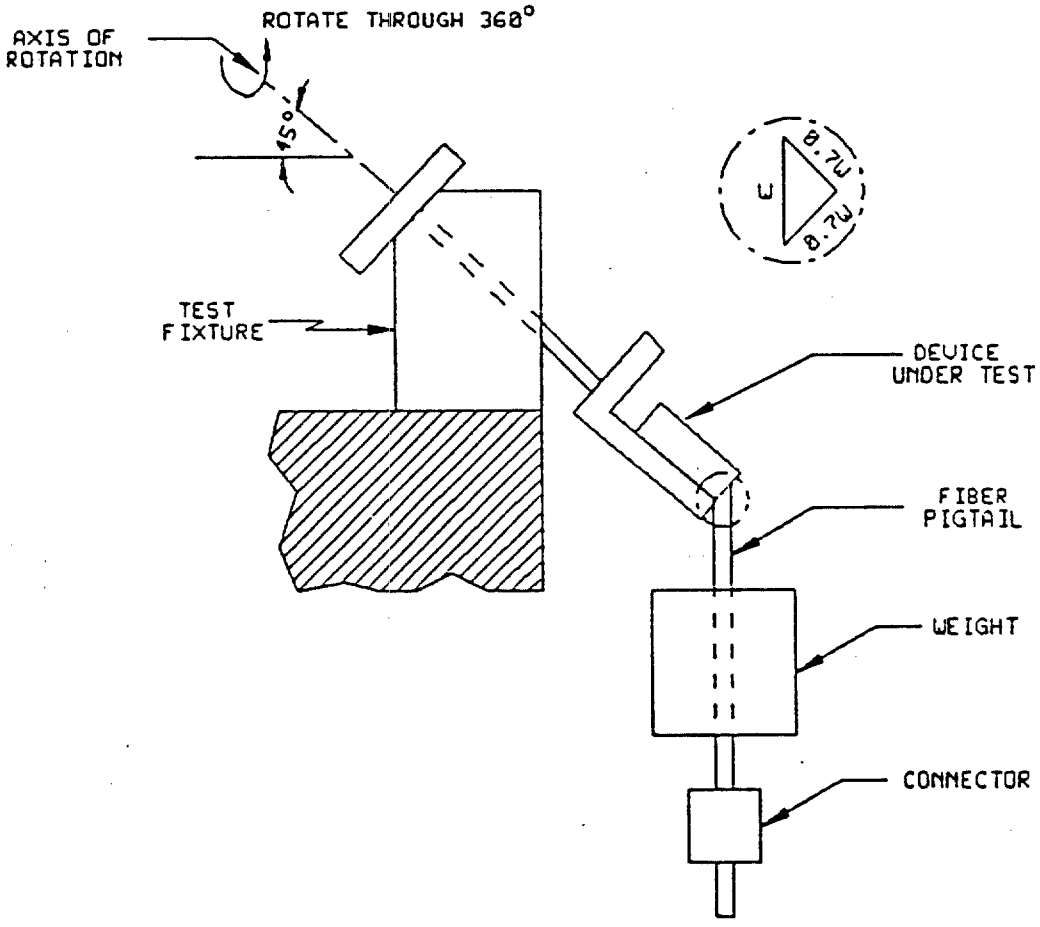


FIGURE 2. Fiber dynamic strength test set up.

4.6.4.2 Impact. Splices shall be tested in accordance with EIA 455-2 (see 3.5.2.2). Cable splices shall be classified as "moderate service class" and fiber splices shall be classified as "light service class". The change in optical transmittance shall be measured after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.4.3 Twist. The splice shall be tested in accordance with EIA 455-36, for 50 cycles (see 3.5.2.3). The tensile load shall be 5 newtons and the number of loads to be applied shall be one. The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.4.4 Cable seal flexing. Cable splices shall be tested in accordance with MIL-STD-1344, method 2017, with the exception that the test sample shall be a splice (see 3.5.2.4). References to discontinuity, dielectric withstanding voltage, and insulation resistance in the test method are not applicable. At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.4.5 Crush resistance. Cable splices shall be tested in accordance with MIL-STD-1344, method 2008, with the exception that the test sample shall be a splice (see 3.5.2.5). The test load shall be 1250 newtons, and the number of loads shall be one. The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.4.6 Cable pull-out force. Cable splices shall be tested in accordance with EIA 455-6 (see 3.5.2.6). The axial tensile load shall be applied up to the load specified and shall be maintained for 10 minutes. The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5 Environmental properties inspection.

4.6.5.1 Temperature life. Splices shall be tested in accordance with EIA 455-4, with the exception that the test sample shall be a splice instead of a connector (see 3.5.3.1). The exposure time shall be 96 hours. The exposure temperature shall be 85°C for splices conforming to ranges 1 and 3 and 105°C for splices conforming to temperature ranges 2 and 4. The change in optical transmittance shall be measured after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.2 Thermal shock. Splices shall be tested in accordance with EIA 455-71, schedule C (see 3.5.3.2). The high and low temperatures shall correspond to the specified storage temperature extremes. The transition time shall be 5 minutes maximum. The change in optical transmittance shall be measured after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.3 Temperature-humidity cycling. Splices shall be tested in accordance with EIA 455-5, test type 3 (see 3.5.3.3). The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.4 Salt spray. Splices shall be tested in accordance with EIA 455-16 (see 3.5.3.4). The cable splices shall be exposed for 500 hours at 35°C. At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.5 Water pressure. Cable splices shall be immersed in an aqueous dye penetrant solution at an applied pressure of 0.1 megapascals (equivalent to a depth of 10.4 meters) for 48 hours at a temperature of 10 to 35°C (see 3.5.3.5). The splices shall be externally cleaned, examined for dye penetration into the splice and the change in optical transmittance shall be measured (see 4.6.3.2).

4.6.5.6 Freezing water. Cable splices shall be tested in accordance with DOD-STD-1678, method 4050, with the exception that the splices shall be completely immersed in water for 6 hours at the specified minimum operating temperature (see 3.5.3.6). The vessel containing the water need not be sealed. The size of the vessel shall be such that, when the cable splice is placed in the center of the vessel, the cable splice is within 150 mm of the sides, top and bottom. The change in optical transmittance shall be measured during and after the test (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.7 Fluid immersion. Splices shall be tested in accordance with EIA 455-12 (see 3.5.3.7). The splices shall be immersed in each of the fluids in table VII at the temperature specified for 24 hours. The splice shall be completely dried after each immersion. At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

TABLE VII. Immersion test fluids.

Fluids	Specification	Test temperature (°C)
Fuel Oil	MIL-F-16884	33 - 37
Turbine fuel (JP-5)	MIL-T-5624	20 - 25
Isopropyl alcohol	TT-I-735	20 - 25
Hydraulic fluids	MIL-H-5606	48 - 50
Lubricating oils	MIL-L-17331 MIL-L-23699	73 - 77
Coolant 1/	-	20 - 25
Seawater	-	20 - 25

1/ Monsanto Coolanol 25 or equivalent

4.6.5.8 Sand and dust. Cable splices shall be tested in accordance with EIA 455-35 (see 3.5.3.8). The change in optical transmittance shall be measured during and after the test (see 4.6.3.2).

4.6.5.9 Vibration. Splices shall be tested in accordance with MIL-STD-1344, method 2005, test condition II and VI (see 3.5.3.9). For test condition VI, test condition C shall apply. Test condition I shall be used during the low frequency portion of test condition II. The test sample shall be a splice instead of a connector. References to electrical load conditions and electrical discontinuity

in the test method are not applicable. Unless otherwise specified (see 3.1), the change in optical transmittance shall be monitored continuously during and after the test with equipment having a time resolution of at least 50 microseconds (μs) (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.10 Shock. Splices shall be tested in accordance with grade A, type A, class I of MIL-S-901 (see 3.5.3.10). Unless otherwise specified (see 3.1), the change in optical transmittance shall be monitored continuously during and after the test with equipment having a time resolution of at least 50 μs (see 4.6.3.2). At the completion of the test, the splice shall be visually examined in accordance with 4.6.1.1.

4.6.5.11 Nuclear radiation resistance. The splice shall be tested in accordance with EIA 455-49 (see 3.5.3.11). Unless otherwise specified (see 3.1), tests shall be performed at a wavelength of 1.310 ± 0.020 μm and at the low operating temperature, 20°C, and the high operating temperature. The dose rate shall be 30 rads/second. The total dose shall be as specified contractually, (see 6.2). The change in optical transmittance shall be measured during and after the test (see 4.6.3.2).

4.6.6 Chemical properties inspection.

4.6.6.1 Fungus resistance. Cable splices that do not meet the requirements of fungus-inert materials in accordance with MIL-STD-454, requirement 4 shall be tested for resistance to fungus in accordance with MIL-STD-810, method 508 (see 3.5.4.1).

4.6.6.2 Flame survivability. Cable splices shall be tested in accordance with MIL-STD-1344, method 1012, test condition A, with the exception that the test sample shall be a splice (see 3.5.4.2). The change in optical transmittance shall be measured after the test (see 4.6.3.2).

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.7.)

5.1 Packaging. The requirements for packaging shall be in accordance with MIL-C-55330. The levels of preservation and packaging shall be as specified (see 6.2).

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 splices covered by this specification are intended for use in any application where their performance characteristics are required. The splices are for installation in shipboard systems within the limitations of applicable performance requirements.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of the specification.
(b) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(c) Applicable specification sheet number, title, and date.
(d) Applicable part number (see 6.10).
(e) Quantity required.
(f) When first article inspection is required (see 3.2).
(g) Fiber buffer diameter (see 3.4.1).
(h) Cable diameter (see 3.4.1).
(i) When equivalent test method is specified (see 4.6.3.2).
(j) Total dose radiation requirement (see 4.6.5.11).
(k) Level of preservation and packaging required (see 5.1).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/ provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
4.5	DI-T-5329	Inspection and test reports	----
4.5 and appendix B	DI-MISC-80653	Test reports	----

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 First article. When first article inspection is required, the items should be a first article sample. The first article should consist of nine units. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been

previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.5 Quality conformance. Quality conformance inspections require contractual definition of the overall test program including sample sizes and lot sizes, if appropriate (see 4.5).

6.5.1 Disposition of group B inspection sample units. Sample units subjected to group B inspection are not to be delivered.

6.6 Definitions.

6.6.1 Ambient light susceptibility. Ambient light susceptibility is the optical power (dBm) that enters the splice from ambient illumination incident upon the splice.

6.6.2 Cable splice. A cable splice is a connection between two cables, consisting of one or more optical fiber splices within a cable splice closure. It provides optical continuity between cables, protection against environmental conditions, and mechanical strength to the cable joint. The cable splice is used primarily to complete a cable span or to repair a cable.

6.6.3 Closure. The closure is the portion of a cable splice that covers the fiber splice housings, seals against the outer jackets of the joined cables, provides protection against the environment, and provides mechanical strength for the joint.

6.6.4 Crosstalk. A measure of the optical power picked up by an optical fiber from an adjacent energized fiber. If the optical power at the receiving end of the energized fiber is P_o and the power in the disturbed fiber at the corresponding end is P_d then:

$$\text{Crosstalk} = 10\log_{10}(P_d/P_o) \quad \text{in dB}$$

Since P_d is always less than P_o, the crosstalk is always negative. The negative sign is commonly ignored.

6.6.5 Fiber splice. A connection between two optical fibers made by joining an end of one fiber to an end of another fiber. A fiber splice includes a housing and is contained within interconnection junction boxes or cable splice closures. The following types of fiber splices are included in this definition:

(a) Fusion
(b) Mechanical

(1) Ultraviolet cured or bonded
(2) Rotary mechanical
(3) Ribbon

6.6.6 Housing. A housing, such as tapes, jackets, coatings, and other components necessary for attaching, supporting, and aligning fibers, applied over a fiber optic splice and proximate fiber for their protection against the environment, for some mechanical strength, and for preservation of the integrity of the fiber coating, buffer, cladding, and core. The housing includes a means for mounting the aligned assembly in an interconnection box or cable splice closure.

6.6.7 Insertion loss. Insertion loss is the radiant power loss (dB) caused by absorption, scattering, diffusion, leaky waves, dispersion, microbends, macrobends, reflection, radiation, or other causes when a splice is inserted into the system.

6.6.8 Return loss. Return loss is the optical power (dB) that is reflected back toward the source of optical power by the splice.

6.6.9 70/70 restricted launch. A 70/70 restricted launch is a beam optics launch with a 70 percent spot size and source aperture equal to 70 percent of the fiber numerical aperture.

6.6.10 70/100 restricted launch. A 70/100 restricted launch is a beam optics launch with a 70 percent spot size and source aperture equal to or greater than the fiber numerical aperture.

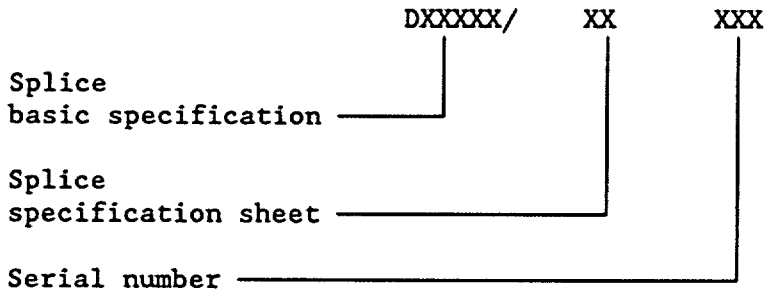
6.6.11 Waveguide splice. A waveguide splice is a permanent joint between the transmission elements of two waveguides so that signals may pass from one waveguide to the other with minimal loss, for example, a joint between the cores and claddings of two optical fibers.

6.7 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.8 Index matching materials. The splice manufacturer should certify their acceptability for not less than 20 years of use under the specified conditions without the need for replacement.

6.9 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in FED-STD-313.

6.10 Part or Identifying Number (PIN). Splices should contain only the following:



Examples:

DXXXXX/01-001
DXXXXX/02-002

6.11 Part designator. A part designator, if specified (see 3.1) should include classifications (see 1.2) as follows:

(1) Type (see 1.2.1).
(2) Fiber style (see 1.2.2).
(3) Class (see 1.2.3).

Example: MSMA.

6.12 Subject term (key word) listing.

Change in optical transmittance
Closure
Fiber optic communications
Fiber optic component
Fusion splice
Housing
Mechanical splice

6.13 Specification use. When MIL-F-49291 or MIL-C-85045 are referenced, the Navy version of these MIL-F-0049291 (Fiber, Optical, General Specification for) and MIL-C-0085045 (Cable, Optical, General Specification for) should be used, respectively, until cancelled.

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

Preparing activity:
Navy - SH
(Project 6060-N024)

APPENDIX A

TEST PROCEDURE TO MEASURE RETURN LOSS

10. SCOPE

10.1 Scope. The intent of this procedure is to determine the ratio of optical power reflected by a component or an assembly to the optical power incident on a component port when that component assembly is introduced into a link or system. This ratio is termed return loss. This appendix is a mandatory part of this specification. The information contained herein is intended for compliance.

10.2 Test. The test for return loss is based on two setups. The first test setup shown on figure 3 is designed to measure the insertion loss of a coupler along a particular through a path of that device. The coupler is an integral part of measuring the insertion loss of the test setup shown on figure 4.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST EQUIPMENT

30.1 Apparatus. The apparatus shall consist of the following primary items and those additional items identified on figures 3 and 4 and the specification sheet. The apparatus configuration shall be as shown on figures 3 and 4.

30.2 Optical power source. The optical power source shall consist of a light source emitting wavelengths suitable for the devices tested and can either be modulated or unmodulated. A light-emitting diode (LED) or injection laser with suitable radiation band is a suitable source and may be specified. The source shall be stable to plus or minus 1 percent (0.05 dB) over the measurement period. Wavelength selective filters may be used if necessary to limit optical spectral width.

30.3 Optical directional coupler. The directional coupler (or splitter) may be of any convenient coupling ratio. Its return path to forward path power ratio (directivity) when terminated in a nonreflecting termination shall be 10 dB greater than the maximum return loss ratio desired to be measured. The coupler shall be mode insensitive.

30.4 Test jumper assemblies. One pair of pigtails are required per device under test (DUT) measurement.

30.5 Termination. An optical load which is fully absorbent and nonreflective (at least 10 dB below the desired level of test sensitivity) when coupled to the connecting cable of the test system. Index matching gel or fluid is a suitable termination.

30.6 Optical power meter. A device that measures incident optical power which is linear to within 5 percent over the power levels to be measured and stable to plus or minus 1 percent (0.05 dB) over the measurement period. Relative power levels only are required so no absolute accuracy is necessary.

30.7 Interconnects/splices. Since all connectors used in the test will influence the test results, extremely low loss and repeatable units shall be used. Fusion splices are recommended if practical and are noted as such on the figures. Index matching materials at all interfaces not under test are highly recommended.

30.8 Mode filter. A 50-mm diameter loop of fiber/cable of the same type used in the coupler.

40. TEST SAMPLE

40.1 Test sample. The test sample or DUT shall be as specified (see 3.1).

50. TEST PROCEDURE

50.1 Determination of insertion loss of coupler. The test procedure shall be as follows:

(a) Referring to the test configuration shown in step A of figure 3, a meter of single-mode fiber is fusion-welded to the lead length of the fiber from port 3 of the coupler as a temporary joint. This fiber lead from port 2 is connected to a detector/power meter. Index matching material is applied to fiber leads from ports 1 and 4 to provide termination points. A power measurement is taken at the specified wavelength and a measurement P_2 is recorded.

(b) In step B, cut the fiber between the coupler and the fusion joint, just beyond the joint, allowing material for polishing of the cut end. The free end of the fiber shall be properly prepared so that it is smooth and perpendicular to the axis. Connect the prepared end of the fiber to the detector ensuring that the power level is repeatable. Measure and record this power measurement as P_3. The insertion loss of this particular path between port 2 and port 3 of the coupler is given by the formula:

$$L_c = -10\log_{10} (P_2/P_3)$$

50.2 Determination of DUT return loss. The test procedure shall be as follows:

(a) Using the setup shown on figure 4, connect the fiber lead of port 1 of the coupler to the light source. Connect the detector/power meter to the fiber lead from port 3. Terminate the fiber leads from port 2 and 4 with index matching gel. Measure and record the insertion loss between ports 1 and 3 as P_o.

(b) Switch the detector/power meter to the fiber lead from port 2 of the coupler and terminate the fiber from port 3 with index gel. Measure and record the insertion loss between ports 1 and 2 as P_i.

(c) The test jumper assemblies are cut in half to provide the necessary DUT pigtails required for the return loss measurements. Joint the DUT pigtail to the fiber from port 3 with a temporary joint (fusion). The DUT is then coupled to a second pigtail using an adapter. The end of the second pigtail is terminated with index gel. With the light source at the specified wavelength, measure and record the power reflection of the DUT as P'_i. Repeat steps A through C for the remaining DUT's to be measured.

(d) The return loss of each DUT is then calculated by the formula below:

$$R_L = -10\log_{10} (P'_i - P_i)/P_o + 10\log_{10} (P_2/P_3)$$

The DUT should have (as an objective) a return loss greater than 30 dB.

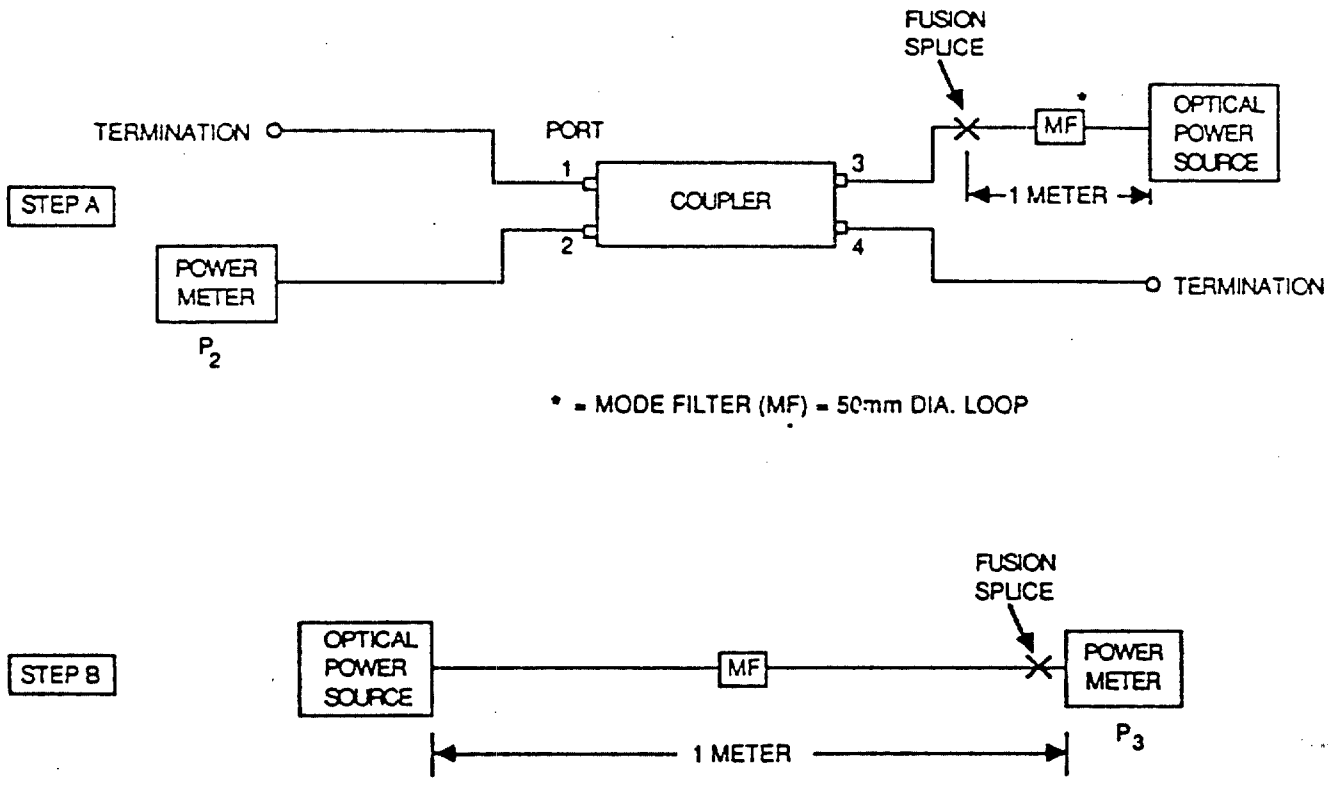


FIGURE 3. Coupler insertion loss test setup.

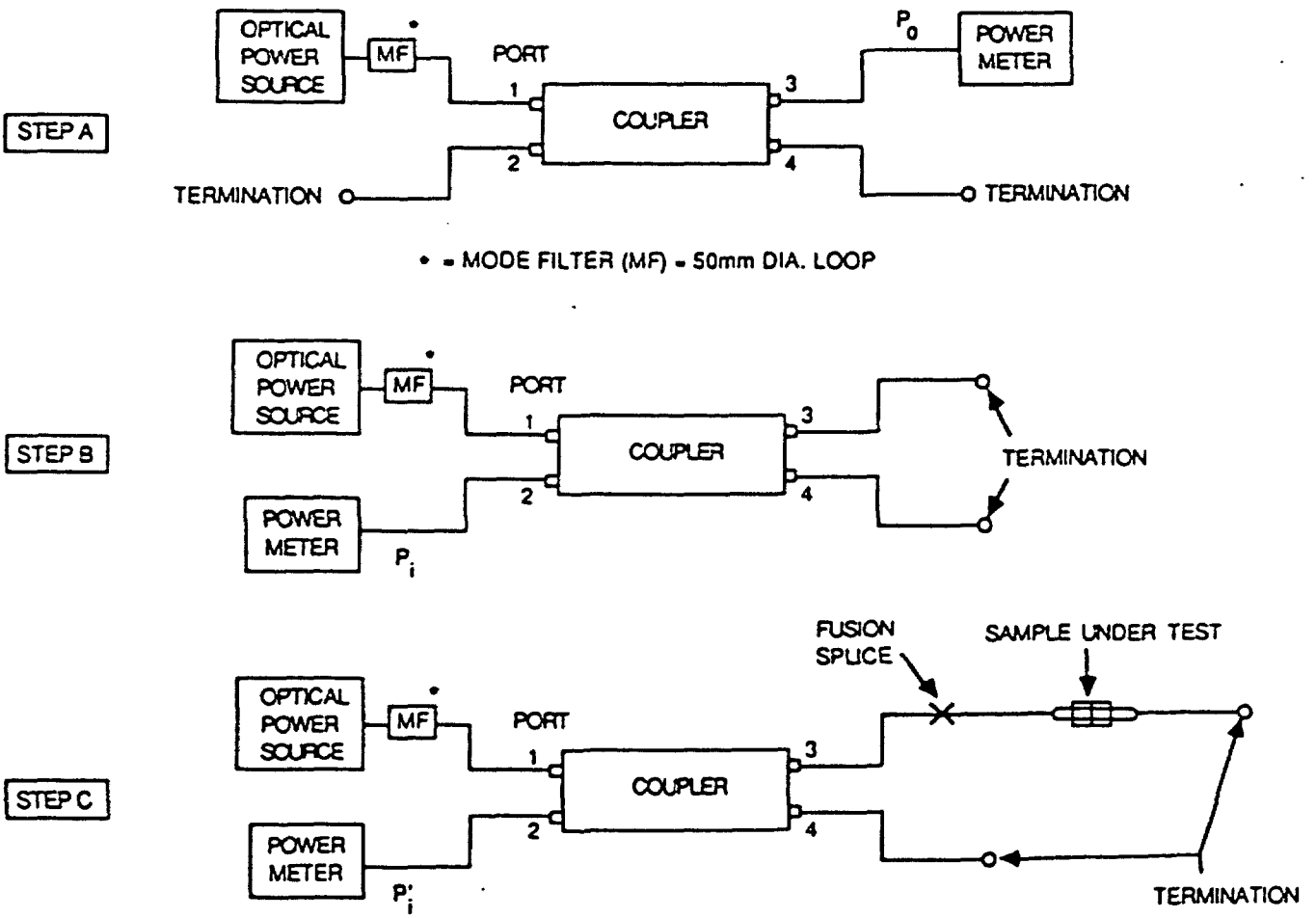


FIGURE 4. DUT return loss test setup.

APPENDIX B

TEST REPORT TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers information that should be included in the test reports when specified in the contract or order. This appendix is applicable only when data item description DI-MISC-80653 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DOCUMENTATION

30.1 Data recorded. When required by the contract or order, the following data shall be recorded:

(a) Title of the test.
(b) Test sample description.
(c) Test equipment used and calibration data.
(d) Launch conditions.
(e) Test values and results.
(f) Specification sheet reference.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-S-0024623A(NAVY)	SPLICE, FIBER OPTIC, SHIPBOARD, GENERAL SPECIFICATION FOR

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

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)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.