**METRIC**

**MIL-STD-2042-6C(SH)**
**18 October 2016**

**SUPERSEDING**
**MIL-STD-2042-6B(SH)**
**25 July 2002**

# DEPARTMENT OF DEFENSE
# STANDARD PRACTICE

## FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR SURFACE SHIPS AND SUBMARINES (TESTS)

## (PART 6 OF 7 PARTS)

# FOREWORD

1. This standard is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. This standard provides detailed information and guidance to personnel concerned with the installation of fiber optic cable topologies (optical fiber cabling and associated components) on naval surface ships and submarines. The methods specified herein are not identifiable to any specific ship class or type except as noted. They are intended to standardize and minimize variations in installation methods to enhance the compatibility of the installations on all naval ships.

3. In order to provide flexibility in the use and update of the installation methods, this standard is issued in eight parts; the base standard and seven numbered parts as follows:

Part 1: Cables

Part 2: Equipment

Part 3: Cable Penetrations

Part 4: Cableways

Part 5: Connectors and Interconnections

Part 6: Tests

Part 7: Pierside Connectivity Cable Assemblies and Interconnection Hardware

4. Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy mil (copy DLGR_NSWC_FO_ENG@navy.mil), with the subject line “Document Comment”. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

CONTENTS

CONTENTS

CONTENTS

LIST OF FIGURES

CONTENTS

LIST OF TABLES

# 1. SCOPE

1.1 Scope. This standard provides detailed methods for testing optical fiber cable installations.

1.2 Applicability. The installation methods in this document are intended to be used by all installing activities. These methods establish standards for installations in all naval ships and are not identifiable to any specific ship class or type, except as noted. The methods in this document are for new construction as well as for conversions, alterations, and repairs.

# 2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-64266 | - | Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-1678-1 | - | Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts) |
| MIL-STD-1678-5 | - | Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements) |
| MIL-STD-2042 | - | Fiber Optic Cable Topology Installation Standard Methods for Surface Ships and Submarines |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

| | | |
|---|---|---|
| 499-6877804 | - | Jumpers, Test Equipment, Fiber Optic |

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z136.2 - Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources

(Copies of this document are available from http://webstore.ansi.org/.)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-440 - Fiber Optic Terminology

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. DEFINITIONS

3.1 General fiber optics terms. Definitions for general fiber optics terms used in this standard are in accordance with TIA-440.

3.2 Other fiber optics terms. Definitions for other terms as they are used in this standard are given in the general standard MIL-STD-2042.

3.3 Acronyms. The following acronyms are used in this standard:

a. BB: Ball Bearing
b. BOF: Blown Optical Fiber
c. FOCT: Fiber Optic Cable Topology
d. LED: Light Emitting Diode
e. MQJ: Measurement Quality Jumper
f. OFCS: Optical Fiber Communication System
g. ORLM: Optical Return Loss Meter
h. OLTS: Optical Loss Test Set

## 4. GENERAL REQUIREMENTS

4.1 Test methods. The test methods identified in this standard shall be used to verify the proper operation and performance of the components that make up the fiber optic cable topology (FOCT). These tests shall be performed during various phases of installation of the FOCT, as described in this section. Details on which test procedures are mandatory at each phase of installation are provided in section 5.

4.1.1 Acceptance tests. Conventional optical fiber cable, blown optical fiber (BOF) cable, and associated components should undergo visual inspection and testing upon receipt at the shipyard. The conventional optical fiber cable should be tested while still on the shipping reel to ensure that it is mechanically and optically sound. Similarly, BOF cable should be tested while still on the shipping reel to ensure that it is mechanically sound. The associated fiber optic components should be subjected to visual examination only.

4.1.2 Pre-installation tests. Visual inspection and testing of the conventional optical fiber cable and BOF cable shall be conducted just prior to installation in the cableways to verify that the cables are still mechanically and optically sound.

4.1.3 Installation tests. After conventional optical fiber cable is installed in the cableways, the pre-installation tests should be repeated to verify that fibers were not broken or damaged when the cable was pulled through the cableways. After BOF cable is installed in the cableways, the pre-installation tests should be repeated to verify that the cables were not damaged when the cable was pulled through the cableways. Additional testing shall be conducted after installation of connectors or splices to ensure that the optical losses induced by these components are within acceptable limits and that the continuity of each fiber between interconnection devices has been maintained.

4.1.4 Post-installation tests. After all FOCT links have been installed, tests shall be conducted to verify that the end-to-end attenuation of the FOCT is within specified limits.

4.2 Test equipment. The following paragraphs discuss optical test equipment in general terms only. The specific equipment to be used for each test is identified in the individual test methods referenced in section 5.

4.2.1 Optical time domain reflectometer (OTDR). The OTDR is used for:

a. Estimating the attenuation rate of a fiber.

b. Identifying the nature and location of defects in an optical link.

c. Estimating the length of an installed optical link.

4.2.2 Optical power meter and stabilized light source. The optical power meter and stabilized light source (e.g., portable light emitting diode [LED] or laser diode) are used together to make accurate optical transmission loss measurements. Measurement quality jumpers (MQJs) are used to couple light from the stabilized source to the optical link under test, and from the optical link under test to the power meter.

4.2.3 Optical loss test set (OLTS). The OLTS combines the optical power meter and stabilized light source (see 4.2.2) into a single item (in some cases the OLTS may still consist of two units). The OLTS may display the transmission loss directly by comparing the optical power level of the source with the optical power level transmitted through the optical link under test.

4.2.4 Optical return loss meter (ORLM). The ORLM is used to measure the optical return loss of the optical fiber cable assembly or link. Test equipment for single mode applications which includes both ORLM and OLTS functionality is available.

4.2.5 MQJs. MQJs are required for connecting optical fiber cable assemblies or links to test equipment. Typical MQJ configurations shall be in accordance with 499-6877804. Special MQJ configurations may be used with authorized approval (see 6.4). MQJs used with optical power meters, stabilized light sources, OLTS, and ORLM shall have a minimum length of 1 meter (3 feet). MQJs used with an OTDR should be long enough (typically 50 meters [165 feet]) to compensate for the inability of the OTDR to make accurate measurements on short lengths (less than 50 meters [165 feet]) of fiber.

4.2.6 Bare fiber adapters. Bare fiber adapters are required for connecting cables that do not have connectors installed to test equipment. Bare fiber adapters may be of various constructions including:

a. A device with a compatible connector on one end and a holding mechanism for stripped fiber on the other end.

b. A single fiber cable with a compatible connector on one end and a temporary splice which mates to the stripped fiber on the other end.

c. An unused compatible connector in which the stripped optical fiber is placed.

4.3 Test procedures. The following paragraphs discuss test procedures in general terms only. Detailed, step-by-step procedures are presented in the methods referenced in section 5.

4.3.1 Visual inspections. Visual inspections for mechanical damage are accomplished with the naked eye without using a magnifier.

4.3.2 Cable continuity test. The optical fiber cable continuity test is a simple test to verify that there is no major damage to or breakage of a fiber. For multimode fiber, this test can be accomplished using any portable light source, such as a flashlight. For single mode fiber, a high intensity light source intended for optical fiber continuity measurements should be used.

4.3.3 BOF ball bearing (BB) test. The BB test is a simple test to verify that there are no major obstructions within the BOF tubes in a BOF cable. This test is performed using a BB with diameter of 3, 4, or 4.5 millimeters (0.118, 0.157, or 0.177 inch) depending on the installation, and a source of pressurized air.

4.3.4 BOF pressurization test. The BOF pressurization test is a simple test to verify that there are no major tears or holes in the BOF tubes and that concatenated BOF tubes are properly coupled together. This test is performed using a source of pressurized air and a pressure gauge.

4.3.5 BOF tube seal verification test. The BOF tube seal verification test is used to verify that each unused BOF tube path is properly end sealed and that each used BOF path is properly terminated. This test is performed using a source of pressurized air and a pressure gauge. The BOF tube seal verification test may be omitted for tube paths that are installed entirely above the ship's V-line and waterline.

4.3.6 Cable attenuation test. The cable attenuation test quantifies the attenuation of an optical signal over a particular cable length. The attenuation test is intended to be used for testing cables that have no terminations installed, or cables with terminations on only one end, and is performed using an OTDR.

4.3.7 Cable assembly link loss test. The cable assembly link loss test is used to measure the optical losses associated with connectors and splices in an optical link; and to demonstrate that the end-to-end attenuation of an optical fiber cable assembly is within acceptable limits. The link loss test shall be performed using an optical power meter and stabilized light source, or an OLTS.

4.3.8 Cable topology end-to-end attenuation test. The cable topology end-to-end attenuation test is used to measure the optical loss over a series of concatenated optical links. Typically, this test is performed after interconnection of the FOCT local and trunk cables, and measures the optical loss from one local cable equipment interface to the other. The end-to-end attenuation test shall be performed using an optical power meter and stabilized light source, or an OLTS.

4.3.9 Optical return loss test. The optical return loss test is used to measure the relative amount of optical power that would be reflected back into a link transmitter by the optical fiber cable under test. The optical return loss test shall be performed using an ORLM. Pass/fail criteria utilized for the optical return loss test shall be consistent with the polishing method requirements. Standard dome polish return loss levels shall be not less than 30 decibels (dB). Enhanced dome polish return loss levels shall be not less than 40 dB.

4.4 Safety precautions. The following safety precautions shall apply:

a. Observe all written safety precautions given in the test procedures of this standard.

b. Observe all warning signs on equipment and all written safety precautions included in the equipment instruction manual.

c. The classification of a laser is based on the ability of the optical beam to cause damage to the eye. Under normal operating conditions, an optical fiber communication system (OFCS) is inherently an eye safe system; but, when an optical fiber connection is broken and optical viewing instruments are used, it is possible that hazardous energy can enter the eye. For this reason four classes of laser have been devised to indicate the degree of hazard and required hazard control measures. Refer to ANSI Z136.2 for complete information.

d. Ensure personnel are familiar with the laser degree of hazard and the required control measures.

e. Light generated by LEDs and laser diodes may not be visible but may still be hazardous to the unprotected eye. Do not stare into the end of an optical fiber connected to an LED or laser diode and do not stare into broken, severed, or disconnected optical cables.

f. Do not view the primary beam or a specular reflection from an OFCS with an optical microscope, eye loupe, or other viewing instrument. The instrument may create a hazard due to its light gathering capability.

g. Wear safety glasses when handling bare fibers. Always handle optical fiber cable carefully to avoid personal injury. The ends of optical fibers may be extremely sharp and can lacerate or penetrate the skin or cause permanent eye damage if touched to the eye. If the fiber penetrates the skin, it most likely will break off, in which case the extraction of the fiber should be performed by trained medical personnel to prevent further complications.

h. Do not look into the end of a BOF tube. Always wear approved safety glasses when handling BOF tubes that may be connected to a pressure source.

f. Wash your hands after handling bare fibers or performing fiber terminations.

g. Observe all warning signs when handling solvents and epoxies. Become familiar with the first aid instructions for these agents.

h. Do not eat or drink in the vicinity of bare optical fibers. Ingested optical fibers may cause serious internal damage

4.5 Method improvement. Where the methods herein cannot be implemented, users shall submit proposed new methods or proposed modifications of existing methods, as specified (see 6.4).

4.6 Personnel qualifications. Fiber optic installers, supervisors, and Quality Assurance (QA) personnel shall meet Navy shipboard personnel proficiency requirements identified in MIL-STD-1678-1, Requirement 1306, for all fiber optic installations, modifications, and repairs.

4.7 Or equal. MIL-STD-2042 uses the term “or equal” to permit the use of parts, components, or tools that are equivalent and can perform the same function as the specified products. The use of the equivalent product is allowed as long as the same functional characteristics, performance, equipment safety, personnel safety, suitability for marine service, life cycle cost, maintenance cost, and supportability are attained, and agreement is obtained from NAVSEA (see 6.4). The request for agreement for the use of “equal” products shall include data that supports that functional and performance equivalence is retained.

## 5. DETAILED REQUIREMENTS

5.1 Acceptance tests. The acceptance tests should be conducted on all components.

5.1.1 Blown fibers and bundles. Blown fibers and bundles should be subjected to the visual inspection of Method 6A1 and the cable attenuation test of Method 6B1.

5.1.2 Cable. The tests to be performed on cables are determined by the optical fiber cable configuration as follows:

a. The visual inspection of Method 6A1 should be performed on all cables.

b. The cable attenuation test of Method 6B1 should be performed on conventional cables greater than 50 meters (165 feet) in length, either without connectors installed or with connectors installed on only one end.

c. The cable assembly link loss test of Method 6C1 should be performed on conventional cables with connectors installed on both ends. For cable assembly links with MIL-PRF-64266 connectors on both ends, Method 6C2 should be performed in lieu of Method 6C1.

d. The cable continuity test of Method 6D1 should be performed on conventional cables less than 50 meters (165 feet) in length without connectors installed on both ends.

e. The BOF cable BB test of Method 6H1should be performed on BOF cables.

5.1.3 Connectors, splices, and interconnection boxes. All components should be subjected to the visual inspection of Method 6A1.

5.2 Pre-installation tests. The pre-installation tests shall be performed just prior to installation of the components on the ship.

5.2.1 Cable. The tests to be performed are determined by the optical fiber cable configuration as follows:

a. The visual inspection of Method 6A1 shall be performed on all cables.

b. The cable continuity test of Method 6D1 should be performed on conventional cable.

c. The BOF cable BB test of Method 6H1 should be performed on BOF tube cable.

5.2.2 Connectors, splices, and interconnection boxes. All components shall be subjected to the visual inspection of Method 6A1.

5.3 Installation tests. The installation tests shall be performed as components are installed on the ship.

5.3.1 Conventional cable. The installation tests shall be performed in two phases, as follows:

a. Phase 1: Immediately after the conventional optical fiber cable is installed in the cableways, the visual inspection of Method 6A1 and the cable continuity test of Method 6D1 should be repeated on all cables (terminated and unterminated).

b. Phase 2.a: After installation of connectors on the optical fiber cable, such that fibers are terminated on both ends, the cable assembly link loss test of Method 6C1 shall be performed on all fibers terminated on both ends. For single mode fibers terminated on both ends, the cable assembly return loss test of Method 6K1 shall be performed. For cable assembly links with MIL-PRF-64266 connectors on both ends, Method 6C2 shall be performed in lieu of Method 6C1.

c. Phase 2.b: For cables with fibers that are not terminated on both ends, the cable continuity test of Method 6D1shall be performed on those fibers that are not terminated on both ends.

5.3.2 BOF cable. The installation tests are performed in four phases, as follows:

a. Phase 1: Immediately after the BOF cable is installed in the cableways, the visual inspection of Method 6A1 and the BOF cable BB test of Method 6H1 should be performed on all tube cables.

b. Phase 2: After connection of the full tube path and immediately before installation of the blown fiber into the BOF tubes, the BOF pressurization test of Method 6I1 and BOF cable BB test of Method 6H1 should be performed on all tubes identified for blown fiber installation. For tubes with paths entirely above the V-line and waterline or utilizing polyacrylamide crystals at both endpoints, the BOF cable pressurization test of Method 6I1 shall be performed and Phase 4a is not required.

c. Phase 3: After installation of fiber into the BOF cable, and the installation of tube furcation units, the cable continuity test of Method 6D1 should be performed.

d. Phase 4.a: After installation of connectors on the optical fiber cable such that the optical fiber cable is terminated on both ends, the cable assembly link loss test of Method 6C1 shall be performed. For cable assembly links with MIL-PRF-64266 connectors on both ends, Method 6C2 shall be performed in lieu of Method 6C1. Additional testing is based on the method used at the endpoint of blown fiber tube paths, as follows:

(1) For tubes with paths entirely above the V-line and waterline or utilizing polyacrylamide crystals at both endpoints, only the BOF cable pressurization test of Method 6I1 shall be performed in Phase 2. No additional pressure or seal verification testing is required.

(2) For tubes without polyacrylamide crystals and with portions of the path below the V-line or waterline, the BOF tube seal verification test of Method 6J1 shall be performed.

e. Phase 4.b: After final installation, including final saddle banding, and MCT packing, for unused BOF tubes, the BOF cable BB test of Method 6H1 and the BOF tube seal verification test of Method 6J1 shall be performed.

5.3.3 Connectors, splices, and interconnection boxes. All components shall be subjected to the visual inspection of Method 6A1. All connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors.

a. After installation of MIL-PRF-28876 or MIL-PRF-64266 connectors on the cable, the cable assembly link loss test of Method 6C1 shall be performed. For cable assembly links with MIL-PRF-64266 connectors on both ends, Method 6C2 shall be performed in lieu of Method 6C1. Additionally, the heavy-duty connector mechanical pull test of Method 6G1 should be performed.

b. For fusion spliced links, the cable topology end-to-end attenuation test of Method 6E1 or Method 6E2 shall be performed. For single mode cable, the cable topology end-to-end return loss of Method 6L1 shall be performed.

c. For BOF cable splices, the requirements of 5.3.2.b and 5.3.2.e shall be performed before installation of BOF.

5.4 Post-installation tests. The post-installation tests shall be performed on each link of the FOCT after the link is configured, and shall consist of the visual inspection of Method 6A1 and the cable topology end-to-end attenuation test of Method 6E1 or Method 6E2 for cables and associated components. For single mode cable, the cable topology end-to-end return loss test of Method 6L1 shall also be performed.

5.5 MQJ selection tests. MQJs shall be tested in accordance with Method 6F1. The cables shall be marked such that each cable can be readily identified as being an MQJ in accordance with 499-6877804. MQJ verification in accordance with Method 6F1 should be performed if measurement results are in question. MQJ verification in accordance with Method 6F1 should be performed with a frequency that reflects usage during test. Where MQJ usage is high, MQJ verification should be performed more regularly to ensure repeatable measurement results. Organizations should institute an MQJ verification program in which quality of MQJs is regularly validated.

5.5.1 Measurement quality jumper re-polish. If an MQJ is re-polished to meet the requirements of Method 6F1, the MQJ shall also meet the endface geometry requirements of MIL-STD-1678-5; measurement 5201.1.

TABLE 6-I. Endface geometry values.

| Geometry | Range |
|---|---|
| Radius of curvature | 7 to 25mm (0.275 to 0.984 inches) |
| Apex offset | <50 microns |
| Fiber height for PC polish | <50 nanometers |

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 methods for testing depicted in this standard have been developed, tested, and approved so that the shipboard fiber optic installations described can withstand the environmental and operational conditions aboard U.S. Navy vessels. They are intended to ensure the FOCT is properly installed during and after each phase of installation procedures.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this standard.

b. Delivery of the test data obtained in the conduct of these procedures.

6.3 Standard method designation. To simplify the usage of this standard, an alphanumeric designation system was developed to identify and locate a given method. The methods were grouped together by function as follows:

Group A: Visual inspection

Group B: Cable attenuation test

Group C: Cable assembly link loss test

Group D: Cable continuity test

Group E: Cable topology end-to-end attenuation test

Group F: Measurement quality jumper selection test

Group G: Heavy-duty connector mechanical pull test

Group H: BOF cable BB test

Group I: BOF cable pressurization test

Group J: BOF tube seal verification test

Group K: Cable assembly return loss test

Group L: Cable topology end-to-end return loss test

Group M: Connector cleaning and inspection

Then the designation system was completed as follows:

| | | | | |
|---|---|---|---|---|
| 6 | B | 1 | - | |
| MIL-STD-2042 part number | Functional group | Method number within group | - | Alternate procedure within method |

Thus, Method 6B1 indicates there is no alternate procedure for Method 1 of Group B in Part 6 (MIL-STD-2042-6) of MIL-STD-2042.

6.4 Proposed new methods or method modifications. As specified (see 4.5), proposed new methods or proposed modifications of existing methods should be submitted to DLGR_NSWC_FO_ENG@navy.mil or Department of the Navy, Naval Surface Warfare Center, Dahlgren Division, ATTN: Fiber Optic Engineering Manager, 17214 Avenue B, Suite 126, Dahlgren, VA 22448-5147.

6.5 Dahlgren shipboard fiber optics website. The Naval Surface Warfare Center, Dahlgren Division (NSWCDD) fiber optic website houses additional shipboard fiber optic information and policy letters that may be applicable to the requirements in this standard. Due to the dynamic nature of web addresses, the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.

6.6 Subject term (key word) listing.

Acceptance tests

Assembly link loss test

Attenuation test

Continuity test

End-to-end attenuation test

Installation tests

Measurement quality jumpers

Post-installation tests

Safety procedures

Visual inspections

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

# METHOD 6A1
# VISUAL INSPECTION OF FIBER OPTIC COMPONENTS

## 1. SCOPE

1.1 Scope. This method describes a procedure for a visual inspection of conventional fiber optic cables, BOF tube cables, and associated FOCT components.

## 2. DOCUMENTS APPLICABLE TO METHOD 6A1

2.1 General. The documents listed in this section are specified in Method 6A1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6A1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-85045 - Cable, Fiber Optic, (Metric) General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-2042-1 - Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Cables) (Part 1 of 7 Parts)

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. Safety glasses shall be worn if bare fibers are present.

## 4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the ends of fibers as they may be razor sharp. Wash your hands after handling bare fiber.

4.2 Procedure I: Cable inspection. The following steps shall be performed:

NOTE: During handling, conventional optical fiber cable and BOF cable shall be protected from kinks, twists, crushing, and sharp bends. (Detailed handling procedures are given in MIL-STD-2042-1.)

Step 1. Examine the cable documentation to ensure that the optical fiber cable is in accordance with MIL-PRF-85045. Record all of the optical fiber cable information (including the manufacturer's cable identification number and any optical performance information) from the cable documentation (acceptance test only).

Step 2. Examine the conventional optical fiber cable and BOF tube cable for the following:

a. Damage: cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, kinks, or wrinkles.

b. Marking: at a minimum, the part number, JAN marking, manufacturer's identification, CAGE code, the words "fiber optic cable", and a four-digit date code (acceptance test only).

c. Color code: OFCC jacket colorations should be easily discernable (conventional optical fiber cable only).

NOTE: For optical fiber cable on a reel, examine that portion of the optical fiber cable that can be seen without removing the cable from the reel.

Step 3. Examine the blown fiber and BOF bundles for the following:

a. Damage: cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, kinks, or wrinkles.

b. Marking: at a minimum, the part number and manufacturer's identification.

c. Color code: blown fiber colorations should be easily discernable.

NOTE: For optical fiber cable on a reel, examine that portion of the optical fiber cable that can be seen without removing the cable from the reel.

4.3 Procedure II: Connector, splice, and interconnection box inspection. The following steps shall be performed:

Step 1. Examine the documentation to ensure that the components conform to the requirements of the applicable Defense Specifications.

Step 2. Examine the components for the following:

a. Damage: missing or loose parts, dents, cracks, chips, burrs, peeling, or chipping of the plating or finish.

b. Marking: at a minimum, the part number and manufacturer's identification (acceptance test only).

# METHOD 6B1
# CABLE ATTENUATION TEST

## 1. SCOPE

1.1 Scope. This method describes procedures for performing the cable attenuation test on conventional optical fiber cables, BOF bundles, or blown fibers 50 meters (165 feet) or greater in length, and either without connectors or terminations of any type, or with connectors or other terminations installed on only one end.

## 2. DOCUMENTS APPLICABLE TO METHOD 6B1

2.1 General. The documents listed in this section are specified in Method 6B1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6B1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-64266 | - | Connectors, Fiber Optic Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |
| MIL-PRF-85045 | - | Cable, Fiber Optic, (Metric) General Specification for |

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-2042-1 | - | Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Cables) (Part 1 of 7 Parts) |
| MIL-STD-2042-5 | - | Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Connectors and Interconnections) (Part 5 of 7 Parts) |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-455-78 - Measurement Methods and Test Procedures - Attenuation

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials specified in the tables of this method shall be used to perform these procedures, as applicable.

## 4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the ends of the fibers as they may be razor sharp. Wash your hands after handling fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Test conditions.

4.2.1 Laser light source. For single mode testing, a laser light source shall be used.

4.2.3 Calibration. Ensure all test equipment calibrations are current.

4.2.4 Test wavelength. If attempting to match manufacturer supplied attenuation data, the test shall be performed at the same wavelength as the manufacturer's test. If verifying attenuation against MIL-PRF-85045 requirements, this test shall be performed at the 850- or 1300-nanometer wavelength for multimode fibers or this test shall be performed at the 1310- or 1550-nanometer wavelength for single mode fibers.

4.3 Procedure I: Cable and fiber preparation for test. The following steps shall be performed.

4.3.1 Applicability. This procedure shall be performed when the optical fiber cable is not terminated with connectors or splices on either end. The procedure provided below is an example for commonly used ST style bare fiber adapters. If a different style bare fiber adapter is used, follow the manufacturer's fiber preparation instructions. If permanent connectors are being installed, appropriate methods in MIL-STD-2042-5 shall be used.

4.3.2 Equipment and materials. The equipment and materials in table 6B1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6B1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0012 | Cable jacket stripping tool | 1 |
| TL-0045 | Aramid yarn shears | 1 |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| TL-0069 | Ruler | 1 |
| TL-0078 | OFCC strip tool | 1 |
| TL-0071 | Safety glasses | 1 |
| TL-0079 | Buffer strip tool | 1 |
| | Bare fiber adapters | As required |
| TL-0014 | Scribe tool | 1 |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

NOTE: During handling, the optical fiber cable shall be protected from kinks, twists, crushing, and sharp bends. (See MIL-STD-2042-1 for more detailed optical fiber cable handling procedures.)

Step 1. Select one end of the optical fiber cable.

Step 2. Using the cable stripper, remove approximately 300 millimeters (12 inches) of the outer jacket from the unterminated end of the optical fiber cable. Using the aramid yarn shears, carefully cut off the aramid yarn strength members, the exposed central member, and any fillers.

CAUTION: Do not cut or nick OFCC jackets.

Step 3. Remove any water blocking material, clean the OFCCs with a wipe dampened with alcohol and blow them dry with air.

Step 4. Measure and mark the OFCC cable jacket approximately 70 millimeters (2.75 inches) from the end of the fiber. Using the OFCC stripper, remove the OFCC jacket back to the mark (see figure 6B1-1).


FIGURE 6B1-1. OFCC stripping dimension.

Step 5. Separate the aramid yarn strands from the buffered fiber and trim the strands back to the OFCC jacket end using the aramid yarn shears.

WARNING: Wear safety glasses when removing the buffer and coating to avoid possible eye injury.

Step 6. Measure and mark the buffer approximately 19 millimeters (0.75 inch) from the end of the fiber. Using the buffer stripper, remove the buffer and coating back to the mark. Remove the buffer and coating in small sections (approximately 6 millimeters [0.25 inch]) at a time (see figure 6B1-2).

NOTE: Normally, the buffer and coating are tightly adhered to one another and come off of the fiber at the same time.


FIGURE 6B1-2. Buffer stripping dimension.

Step 7. Remove any residual fiber coating from the bare fiber with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

Step 8. Push in and hold down the clamp button on the side of the bare fiber adapter. Install the bare fiber adapter onto the optical glass until the buffer bottoms out inside the adapter and then release the clamp button (see figure 6B1-3).

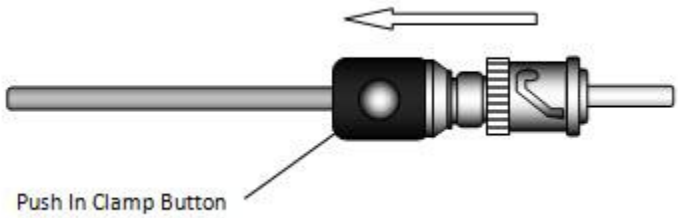


FIGURE 6B1-3. Installing bare fiber adapter.

Step 9. Using the fiber optic scribe tool, scribe the optical glass with one light stroke on top of the ferrule of the bare fiber adapter (see figure 6B1-4).

NOTE: Do not break the fiber with the tool.

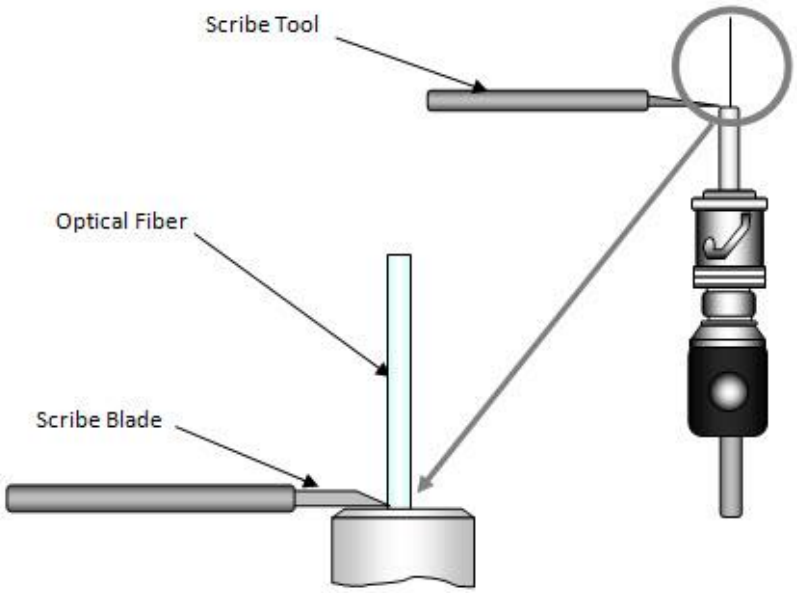


FIGURE 6B1-4. Scribing the optical fiber.

Step 10. Repeat steps 4 through 9 above for all of the OFCCs in the optical fiber cable.

4.4 Procedure II: Cable attenuation test for cables 50 meters (165 feet) or greater in length.

4.4.1 Equipment and materials. The equipment and materials in table 6B1-II shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6B1-II. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0071 | Safety glasses | 1 |
| | MQJ cables (499-6877804) | As required |
| TS-0003 | Optical time domain reflectometer (OTDR) | 1 |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

NOTE: These procedures were developed from TIA-455-78.

NOTE: Ensure the test equipment calibration is current.

NOTE: Use a wipe dampened with alcohol to clean all adapters and blow them dry with air before making connections.

NOTE: During execution of this method, all connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

Step 1. Following the OTDR manufacturer's instructions, energize the OTDR.

WARNING: When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED. Light may not be visible but can still damage the eye.

Step 2. Enter the required parameters, except the optical fiber cable group index, in accordance with the OTDR manufacturer's instructions.

Step 3. Refer to table 6B1-III below and choose the cable that most closely matches the cable under test and enter the shown Index of Refraction value for the optical fiber cable group index.

TABLE 6B1-III. Index of refraction values.

| MIL-PRF-49291 Fiber | Group Index of Refraction |
|---|---|
| Corning 62.5 micron Multimode | 1.496 (850 nanometers)<br>1.491 (1300 nanometers) |
| Corning 9 micron Single Mode | 1.467 (1310 nanometers)<br>1.468 (1550 nanometers) |

Step 4. Select one end of the optical fiber cable under test.

NOTE: If the optical fiber cable is terminated on one end, select the terminated end.

NOTE: If both ends of the optical fiber are unterminated, install the bare fiber adapter on the prepared end of the fiber.

Step 5. Select the applicable MQJ from table 6B1-IV. Connect the optical fiber cable under test to the OTDR using the MQJ as shown on figure 6B1-5.

NOTE: Connecting a fiber utilizing a bare fiber adapter with an MQJ may result in damage to the MQJ. Clean and inspect any MQJs per Method 6M1 for damage after use.

NOTE: For optical fiber cables under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the MQJ to the optical fiber cable under test. For optical fiber cables under test terminated with COTS SC, a hybrid adapter is required to connect the MQJ to the optical fiber cable under test.

TABLE 6B1-IV. MQJ selection for OTDR measurements.

| Termination on cable under test | Fiber polish type | Select MQJ part number |
|---|---|---|
| Bare fibers 1/ | MM<br>SM (enhanced) | 6877804-1<br>6877804-1SME |
| M83522 | MM<br>SM (enhanced) | 6877804-1<br>6877804-1SME |
| COTS ST (A-A-59940/3) | MM<br>SM (enhanced) | 6877804-1<br>6877804-1SME |
| COTS SC (A-A-59940/2) 2/ | MM<br>SM (enhanced) | 6877804-1<br>6877804-1SME |
| COTS LC (A-A-59940/1) | MM<br>SM (enhanced) | 6877804-14<br>6877804-14SME |
| MIL-PRF-28876 4 CH plug | MM<br>SM (enhanced) | 6877804-4<br>6877804-4SME |
| MIL-PRF-28876 4 CH receptacle | MM<br>SM (enhanced) | 6877804-3<br>6877804-3SME |
| MIL-PRF-28876 8 CH plug | MM<br>SM (enhanced) | 6877804-4<br>6877804-4SME |
| MIL-PRF-28876 8 CH receptacle | MM<br>SM (enhanced) | 6877804-3<br>6877804-3SME |
| MIL-PRF-28876 31 CH plug | MM<br>SM (enhanced) | 6877804-4<br>6877804-4SME |
| MIL-PRF-28876 31 CH receptacle | MM<br>SM (enhanced) | 6877804-3<br>6877804-3SME |
| MIL-PRF-64266 | MM<br>SM<br>SM (enhanced) | 50 meter MQJ with MIL-PRF-64266 Test Terminus |
| Other 3/ | MM<br>SM (enhanced) | |

NOTES:

1/ Use the ST-to-ST adapter to connect the ST-to-ST MQJ to the bare fiber adapter for unterminated optical fiber cable ends.

2/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

3/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

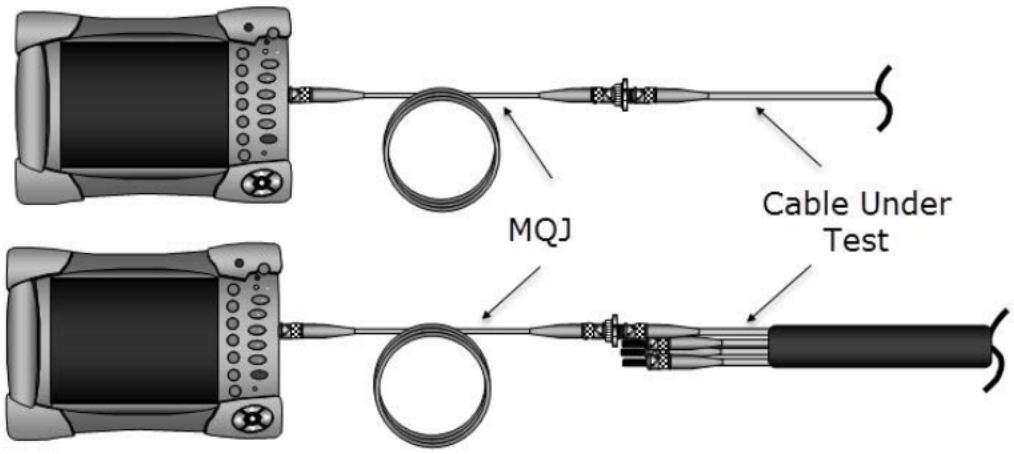


FIGURE 6B1-5. Test setup.

Step 6. Start the OTDR and capture a trace of the cable under test in accordance with the OTDR manufacturer's instructions.

Step 7. Adjust and place the cursor at the beginning ($Z_1$) and the end ($Z_2$) of the trace for the optical fiber cable under test (see figure 6B1-6). Record the optical fiber cable length ($Z_2$ - $Z_1$) and confirm that the measured length matches the length of the optical fiber cable under test.

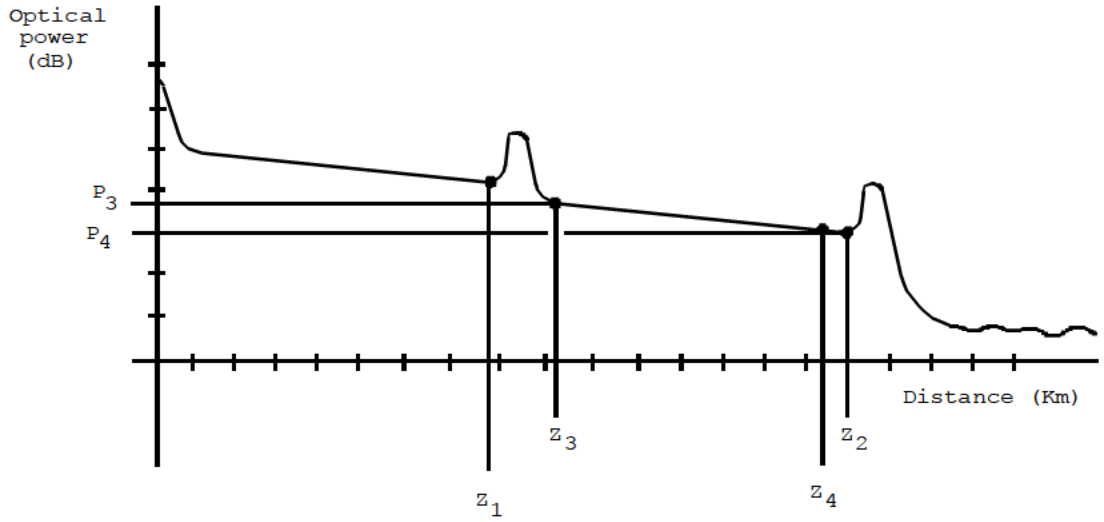


FIGURE 6B1-6. OTDR display (typical).

Step 8. Adjust and place the cursor at the beginning ($Z_3$) and end ($Z_4$) of the linear portion of the trace for the optical fiber cable under test (see figure 6B1-6). Record the optical fiber cable attenuation in dB. The OTDR may automatically calculate the optical fiber cable attenuation. If it does not, calculate the attenuation (B) in decibels per kilometer (dB/km) using the following equation:

$$B = \frac{P_3 - P_4}{Z_4 - Z_3}$$

Step 9. Repeat steps 6 through 8 above for all the fibers in the optical fiber cable.

Step 10. The optical fiber cable is considered acceptable if the maximum measured attenuation for each fiber does not exceed the vendor's attenuation data by greater than 1 dB/km, or the maximum allowable attenuation specified in MIL-PRF-85045.

NOTE: If the maximum measured attenuation for a fiber exceeds the above values, the optical fiber cable may have been damaged.

Step 11. If the optical fiber cable is not going to be installed in a cableway within 14 days, end seal the optical fiber cable in accordance with MIL-STD-2042-1, Method 1A1.

METHOD 6C1
CABLE ASSEMBLY LINK LOSS TEST

1. SCOPE

1.1 Scope. This method describes procedures for performing a cable assembly link loss test on optical fiber cables that have connectors or other terminations installed on both ends.

2. DOCUMENTS APPLICABLE TO METHOD 6C1

2.1 General. The documents listed in this section are specified in Method 6C1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6C1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940 | - | Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for |
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-29504/14 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/15 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/18 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-29504/20 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-49291/6 | - | Fiber, Optical, Type I, Class I, Size IV, Composition A, Wavelength B, Radiation Resistant (Metric) |
| MIL-PRF-49291/7 | - | Fiber, Optical, Type II, Class 5, Size II, Composition A, Wavelength D, Radiation Resistant (Metric) |
| MIL-PRF-64266 | - | Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |

MIL-DTL-83522 - Connectors, Fiber Optic, Single Ferrule, General Specification for

MIL-PRF-85045/16 - Cable, Fiber Optic, Single (One) Fiber, Cable Configuration Type 2 (OFCC), Tight Buffer, Cable Class SM and MM

MIL-PRF-85045/17 - Cable, Fiber Optic, Eight Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/18 - Cable, Fiber Optic, Four Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/20 - Cable, Fiber Optic, Thirty-Six Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/22 - Cable, Fiber Optic, Eighteen Fibers, Standard and Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/24 - Cable, Fiber Optic, Ninety Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/27 - Cable, Fiber Optic, Six-Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/29 - Cable, Fiber Optic, Twelve/Eighteen Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM, (Metric)

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6C1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6C1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | MQJ cables (499-6877804) | As required |
| TS-0009 | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) | As required |
| TS-0001 | LED or laser light source | As required |
| TS-0002 | Power meter | 1 |
| | Dust covers (plastic) | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the end of the fibers as they may be razor sharp. Wash your hands after handling fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Test conditions.

4.2.1 Laser light source. For single mode testing, a laser light source shall be used.

4.2.2 Calibration. Ensure all test equipment calibrations are current.

4.2.3 Test wavelength. This test shall be performed at the 1300 nanometer wavelength for multimode fibers. This test shall be performed at the 1310- and 1550-nanometer wavelength for single mode fibers.

4.3 Procedure. The following steps shall be performed:

NOTE: Use a wipe dampened with alcohol to clean the adapters and optical source and power meter ports and blow them dry with air before making the connections.

NOTE: During execution of this method, all connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

NOTE: Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

NOTE: This procedure involves the use of MQJs. Dirty or defective MQJs will lead to high or unacceptable cable assembly loss values. MQJs used in these procedures should be clean and should be of known quality. Test organizations are encouraged to institute an MQJ verification program in which the quality of MQJs is regularly validated (see Method 6F1). Additional guidance on establishing an MQJ verification program can be obtained from NSWCDD (see 6.4).

Step 1. Record the length of the optical fiber cable from the vendor's data or as measured. If the optical fiber cable length is unknown, a value of "0/unknown" may be recorded.

Step 2. Connect the appropriate reference MQJ (see table 6C1-II) between the light source and the power meter.

WARNING: When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED. Light may not be visible but can still damage the eye.

NOTE: For single mode optical fiber cable assembly loss measurements, the reference MQJ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

Step 3. Measure and record the reference power (in decibel-milliwatts [dBm]) at the meter (designated as $P_1$) (see figure 6C1-1).

NOTE: The time delay between the measurement of $P_1$ and $P_2$ shall be kept to a minimum to prevent inaccurate measurements.

NOTE: The value obtained for the reference power, $P_1$, should be consistent from test to test. Changes in the reference power greater than 0.5 dB indicates the condition of the MQJ has changed or the light source is drifting. If changes in the reference power greater than 0.5 dB occur, clean or replace the MQJ and repeat Step 3. If the value for $P_1$ continues to change from test to test, consider replacing the light source.

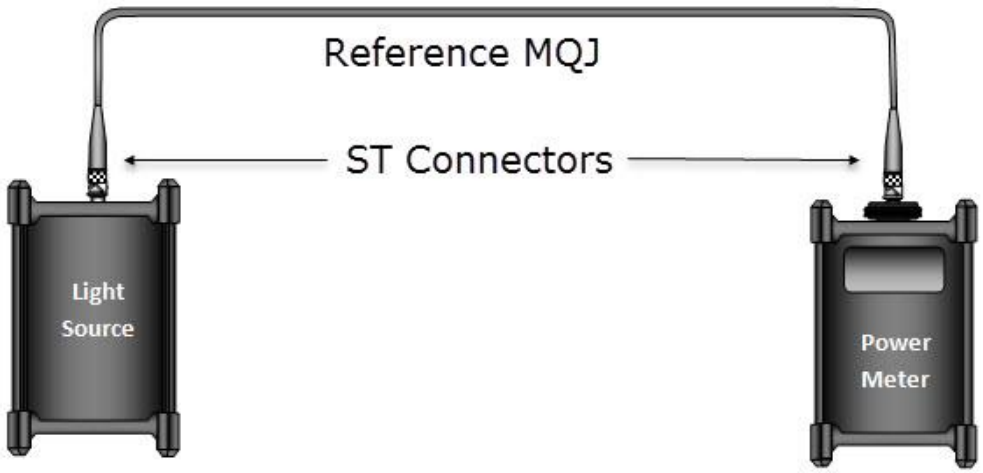


FIGURE 6C1-1. Reference measurement.

Step 4. Select the applicable MQJs from table 6C1-II and connect the optical fiber cable under test to the light source and the power meter as shown on figure 6C1-2.

CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For optical fiber cables with single terminus connectors, the reference MQJ shall be used as $MQJ_1$. For these tests the light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

NOTE: For optical fiber cables without single terminus connectors, a substitution method should be employed where the applicable MQJ from table 6C1-II is selected and replaces the reference MQJ as $MQJ_1$.

NOTE: For optical fiber cable assemblies under test terminated with M83522 or COTS ST connectors, an approved ST-to-ST adapter is required to connect the MQJs to the optical fiber cable assembly under test. For optical fiber cable assemblies under test terminated with COTS SC, a hybrid adapter is required to connect the MQJs to the optical fiber cable assembly under test.

NOTE: When testing a link within in the FOCP, it is recommended to connect the MQJ to the link under test through the existing ST-to-ST adapter on the FOCP patch panel.

NOTE: For single mode optical fiber cable assembly loss measurements, the $MQJ_1$ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

TABLE 6C1-II. MQJ selection for cable assembly loss measurements.

| Termination on cable under test | Fiber polish type | Select MQJ part number |
|---|---|---|
| M83522 | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS ST (A-A-59940/3) | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS SC (A-A-59940/2) 1/ | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS LC (A-A-59940/1) | MM<br>SM (enhanced) | 6877804-14<br>6877804-14SME |
| MIL-PRF-28876 4 CH plug | MM<br>SM (enhanced) | 6877804-8<br>6877804-8SME |
| MIL-PRF-28876 4 CH receptacle | MM<br>SM (enhanced) | 6877804-7<br>6877804-7SME |
| MIL-PRF-28876 8 CH plug | MM<br>SM (enhanced) | 6877804-10<br>6877804-10SME |
| MIL-PRF-28876 8 CH receptacle | MM<br>SM (enhanced) | 6877804-9<br>6877804-9SME |
| MIL-PRF-28876 31 CH plug | MM<br>SM (enhanced) | 6877804-13<br>6877804-13SME |
| MIL-PRF-28876 31 CH receptacle | MM<br>SM (enhanced) | 6877804-12<br>6877804-12SME |
| Other 2/ | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |

NOTES:

1/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

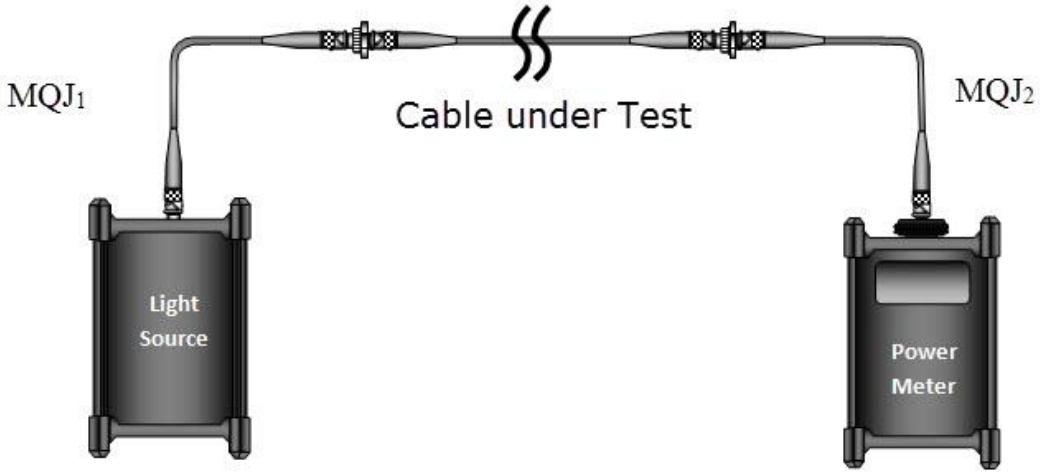


FIGURE 6C1-2. Test measurement (typical).

Step 5. Measure and record the test power (in dBm) at the meter (designated as $P_2$).

NOTE: The value obtained for the test power, $P_2$, should be less than the value obtained for the reference power. A value of the test power greater than the value of the reference power indicates that either a defective or dirty MQJ was used for the reference measurement. If a value for the test power greater than the value of the reference power is obtained, clean or replace the reference MQJ and repeat steps 2 through 5.

Step 6. Calculate the cable assembly link loss using the following formula and record the results:

$$B_{CA} = ( P_1 - P_2 )$$

Where: $B_{CA}$ = Total cable assembly link loss in dB
$P_1$ = Reference power in dBm
$P_2$ = Test power in dBm

NOTE: Some optical power meters will automatically calculate the cable assembly loss when the meter is referenced or zeroed after the reference power measurement. The reference and test optical powers may be measured and the loss calculated using the formula above or the calculation capability of the optical power meter may be used. In either case, the value of the optical reference power shall be recorded.

NOTE: The cable assembly link loss value should be a positive number.

Step 7. Repeat steps 2 through 6 for each fiber in the optical fiber cable.

NOTE: If the optical light source is stable over the period of time required to measure all of the fibers in the optical fiber cable, steps 2 and 3 do not have to be repeated for each fiber.

NOTE: Cleaning of connector ferrules and mating instrument adapters immediately before each mating and after each de-mating is imperative to ensure accurate and reproducible results.

Step 8. For multimode optical fiber cable assemblies, measure the cable assembly link loss in the opposite direction, repeating steps 2 through 7.

Step 9. Identify the connectors and splices by type and proceed to 4.4.

4.4 Maximum acceptable loss calculations. The following steps shall be performed:

NOTE: If this test is part of an acceptance test, proceed to step 1. If this test is part of a pre-installation or installation test, proceed to step 2.

Step 1. The optical fiber cable assembly is considered acceptable if the measured loss (in each direction for multimode optical fiber cable assemblies) does not exceed the loss specified by the vendor for the optical fiber cable assembly. If the measured loss (in each direction for multimode optical fiber cable assemblies) is greater than the vendor specified loss, proceed to step 2.

Step 2. Compare the measured loss (in each direction for multimode optical fiber cable assemblies) to the maximum allowable loss. The maximum allowable loss is calculated from the maximum component loss values shown in table 6C1-III using the following formula:

$$MAL = A_{ca}L + N_{co}L_{co} + N_sL_s$$

Where: MAL = Maximum acceptable loss
$A_{ca}$ = Maximum attenuation of the cable
L = Length of the cable
$N_s$ = Number of splices
$L_s$ = Maximum loss of a splice
$N_{co}$ = Number of connectors
$L_{co}$ = Maximum loss of a connector

The optical fiber cable assembly is considered acceptable if the measured loss (in each direction for multimode optical fiber cable assemblies) is equal to or less than the maximum acceptable loss. If the measured loss (in both directions for multimode optical fiber cable assemblies) is acceptable, proceed to step 4. If measured loss (in either direction for multimode optical fiber cable assemblies) is greater than the maximum acceptable loss, proceed to step 3.

NOTE: If the length of the optical fiber cable is not known, a value of zero shall be used for the cable length.

NOTE: If a MIL-PRF-85045 optical fiber cable type does not appear in in table 6C1-II, refer to the applicable MIL-PRF-85045 specification sheet for that cable type to determine the maximum allowable component loss for the cable.

NOTE: If the automated pass/fail criteria on the test equipment being used cannot be setup to properly represent the topology being tested, the MAL and determination of acceptability of each link shall be done manually.

TABLE 6C1-III. Maximum component loss values.

| Component | Single mode | Multimode |
|---|---|---|
| MIL-PRF-85045/16 | 1.0 dB/km at 1,310 nm<br>1.0 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/17, /18, /20, and /22 | 1.5 dB/km at 1310 nm<br>1.5 dB/km at 1550 nm | 2.0 dB/km at 1300 nm |
| MIL-PRF-85045/24 | 2.0 dB/km at 1310 nm<br>2.0 dB/km at 1550 nm | 2.0 dB/km at 1300 nm |
| MIL-PRF-85045/27 and /29 | 0.75 dB/km at 1310 nm<br>0.75 dB/km at 1550 nm | 1.25 dB/km at 1300 nm |
| MIL-PRF-49291/6 and /7 | 0.4 dB/km at 1310 nm<br>0.3 dB/km at 1550 nm | 1.00 dB/km at 1300 nm |
| MIL-DTL-83522 single terminus light duty connectors (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-28876 (MIL-PRF-29504/14, /15, and quick connect termini) (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-64266 (MIL-PRF-29504/18 and /20) (mated pair) | 0.50 dB | 0.50 dB |
| COTS connectors A-A-59940 light duty (mated pair) | 0.75 dB | 0.75 dB |
| Fusion splice | 0.2 dB | 0.2 dB |

NOTE: If components other than those listed in table 6C1-III are used, the loss value of these components must be included in the maximum acceptable loss. If the loss value for a component is not known, contact NSWCDD (see 6.4) for assistance in determining the appropriate loss value.

Step 3. If the measured loss (in either direction for multimode optical fiber cable assemblies) is 0.5 dB or more above the maximum acceptable loss, reject the optical fiber cable assembly. If the measured loss (in either direction for multimode optical fiber cable assemblies) is less than 0.5 dB above the maximum acceptable loss, disconnect and clean all the connections and retest. If the loss (in either direction for multimode optical fiber cable assemblies) is still unacceptable, re-terminate or replace the defective components.

Step 4. If the optical fiber cable is not going to be immediately connected to its mating connectors, install dust covers over the optical fiber cable connectors.

METHOD 6C2
CABLE ASSEMBLY LINK LOSS TEST UTILIZING TEST TERMINUS

1. SCOPE

1.1 Scope. This method describes procedures for performing a cable assembly link loss test on optical fiber cables that have a MIL-PRF-64266 connector on one or both ends. Utilization of MIL-PRF-64266 connectors allows for the use of specially designed test terminus probes and test terminus adapters that eliminate the need for MQJs with matching multi-terminus connectors.

NOTE: This method only applies when using test terminus probes. If standard MQJs are being used, refer to Method 6C1.

2. DOCUMENTS APPLICABLE TO METHOD 6C2

2.1 General. The documents listed in this section are specified in Method 6C2 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6C2 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59940 - Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for

MIL-PRF-29504/14 - Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)

MIL-PRF-29504/15 - Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)

MIL-PRF-29504/18 - Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors)

MIL-PRF-29504/20 - Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors)

MIL-PRF-49291/6 - Fiber, Optical, Type I, Class I, Size IV, Composition A, Wavelength B, Radiation Resistant (Metric)

MIL-PRF-49291/7 - Fiber, Optical, Type II, Class 5, Size II, Composition A, Wavelength D, Radiation Resistant (Metric)

MIL-PRF-64266 - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for

MIL-PRF-64266/32 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Plug Style, for use with a Connector Receptacle

MIL-PRF-64266/33 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Receptacle Style, for use with a Connector Plug

MIL-DTL-83522 - Connectors, Fiber Optic, Single Ferrule, General Specification for

MIL-PRF-85045 - Cable, Fiber Optic, (Metric) General Specification for

MIL-PRF-85045/16 - Cable, Fiber Optic, Single (One) Fiber, Cable Configuration Type 2 (OFCC), Tight Buffer, Cable Class SM and MM

MIL-PRF-85045/17 - Cable, Fiber Optic, Eight Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/18 - Cable, Fiber Optic, Four Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/20 - Cable, Fiber Optic, Thirty-Six Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/22 - Cable, Fiber Optic, Eighteen Fibers, Standard and Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/24 - Cable, Fiber Optic, Ninety Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/27 - Cable, Fiber Optic, Six-Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/29 - Cable, Fiber Optic, Twelve/Eighteen Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM, (Metric)

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6C2-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6C2-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | MQJ with test terminus (P/N TBD) | As required |
| | Test terminus adapter (MIL-PRF-64266/32 or MIL-PRF-64266/33) | As required |
| TS-0001 | LED or laser light source | As required |
| TS-0004 | Optical Loss Test Set | 2 |
| | Test terminus adapter for Tempo OLTS (P/N TBD) | 1 |

NOTES:

1. Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4).
2. Values for items listed as “TBD” were not available at time of publication; contact NSWCDD (see 6.4) or the manufacturer.

## 4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the end of the fibers as they may be razor sharp. Wash your hands after handling fiber.

c. Observe warnings and cautions on equipment and materials.

e. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Test conditions.

4.2.1 Laser light source. For single mode testing, a laser light source shall be used.

4.2.2 Calibration. Ensure all test equipment calibrations are current.

4.2.3 Test wavelength. This test shall be performed at the 1300-nanometer wavelength for multimode fibers. This test shall be performed at the 1310- and 1550-nanometer wavelength for single mode fibers.

4.3 Procedure. The following steps shall be performed:

NOTE: This method requires an adapter for the receive port on the OLTS that will only work with Tempo OLTS. If Tempo OLTS are not available, Method 6C1 with a substitution method for the reference MQJ shall be used.

NOTE: During handling, the cable shall be protected from kinks, twists, crushing, and sharp bends.

NOTE: Ensure the test equipment calibration is current.

NOTE: Ensure that the power meter is set to the proper wavelength and to units of dBm.

NOTE: Make sure that both the light source and the power meter have been energized long enough to have stable performance before making measurements.

NOTE: A laser light source is recommended for use with single mode optical fiber cable assembly, link loss measurements.

NOTE: This method may be generalized to apply to other connector configurations such as SC-to-Test-Probe MQJs by replacing the word “ST” with “SC”, or other connector type and performing the steps listed below.

NOTE: Measurements $P_1$ and $P_2$ of this test are for the optical loss measurement on the entire cable assembly (calculation $P_1 - P_2$). This method conforms to the optical power loss measurement of TIA/EIA-526-14, Method B.

NOTE: Cleaning of connector/test terminus ferrules and mating instrument adapters immediately before each mating is imperative to ensure accurate and reproducible results (see Method 6M1).

4.3.1 First power measurement ($P_1$). The following steps shall be performed:

Step 1. Designate one of the ST-to-Test Terminus MQJs as $MQJ_1$ (see figure 6C2-1).

NOTE: For single mode fiber optical loss measurements, $MQJ_1$ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

NOTE: Types of MQJs: step 1 assumes that a MIL-PRF-64266 connector is on each end of the cable harness. General guidance for MQJ selection is provided as follows:

a. Use the ST-to-Test-Terminus MQJ for MIL-PRF-64266 connectors.

b. Use an ST-to-ST MQJ or an MQJ in accordance with 499-6877804 for the end of the cable assembly with the ST connector pigtail for ST connectors.

c. Use an ST-to-applicable-single-ferrule-connector MQJ for the end of the cable assembly with the applicable single ferrule connector pigtail for other single ferrule connector types.

Step 2. Designate the ST end of the ST-to-Test Terminus MQJ as “A” and the Test Terminus end as “B”.

Step 3. Clean the adapter ports on both optical source and power meter.

Step 4. Place an ST adapter on the optical source and a test terminus adapter on the power meter.

Step 5. Clean end “A” of $MQJ_1$ and immediately place into the optical source adapter.

Step 6. Clean end "B" of $MQJ_1$ and immediately place end "B" into the Test Terminus Adapter on the power meter.

Step 7. Record the optical power as $P_1$ and, if possible, reference (zero-out) the power meter.

NOTE: The reference cable to light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

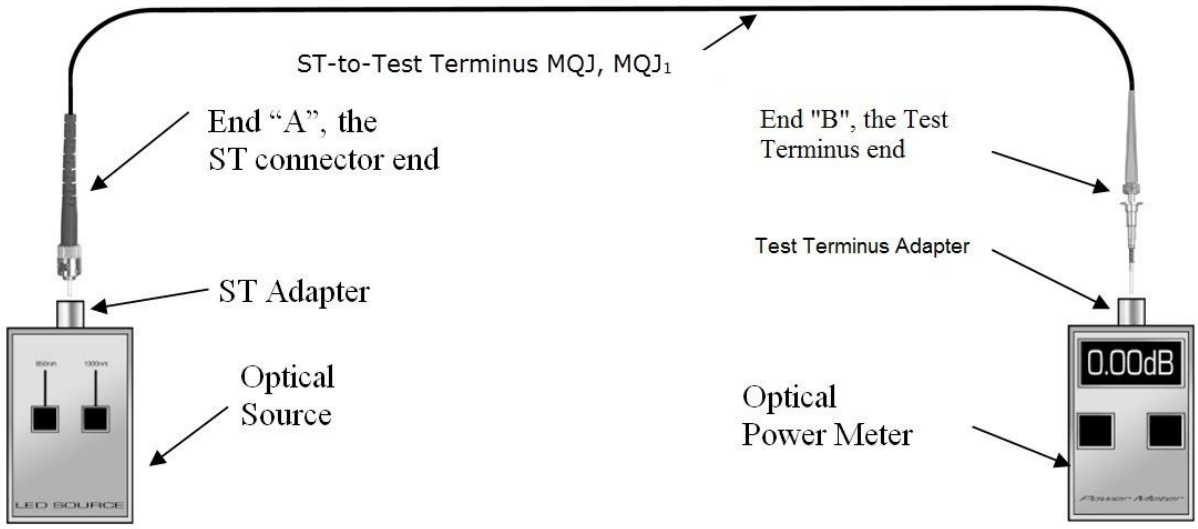


FIGURE 6C2-1. First power measurement ($P_1$) setup.

4.3.2. Test measurement ($P_2$). The following steps shall be performed:

Step 1. Identify mating connector probe adapters for each end of the cable assembly/harness under test.

NOTE: Use the adapter that matches the connectors on the cable harness to be tested:

a. For MIL-PRF-64266 connectors, use the test terminus adapter.

b. ST connectors: For cable harnesses under test terminated with ST connector pigtails at one end, use an ST-to-ST adapter to connect the MQJ to the ST connector pigtail end of the cable harness under test.

c. SC connectors: For cable harnesses under test terminated with SC connector pigtails at one end, use an ST—to-SC hybrid adapter to connect the MQJ to the pigtail end of the cable harness under test.

d. LC connectors: For cable harnesses under test terminated with LC connector pigtails at one end, use an LC to LC adapter and an LC to ST MQJ to connect to the pigtail end of the cable harness under test.

Step 2. Designate the other ST-to-test-terminus MQJ as $MQJ_2$ (see figure 6C2-2).

NOTE: End "A" will refer to the ST end of the MQJ that will attach to the Optical Power Meter. End "B" of $MQJ_2$ will refer to the end of the MQJ that will attach to the cable assembly under test (i.e., the test terminus end if MIL-PRF-64266 connectors are in use).

NOTE: Types of MQJs: Step 2 assumes that a MIL-PRF-64266 connector is on each end of the cable harness. General guidance for MQJ selection is provided as follows:

a. For MIL-PRF-64266 connectors, use the ST-to-test-terminus MQJ.

b. For ST connectors, use an ST-to-ST MQJ for the end of the cable assembly with the ST connector pigtail.

c. For other single ferrule connector types, use an ST-to-applicable-single-ferrule-connector MQJ for the end of the cable assembly with the applicable single ferrule connector pigtail.

Step 3. Clean the connectors and termini on the cable assembly and $MQJ_2$.

Step 4. Clean the test terminus adapters and insert into the connector on each end of the cable harness under test.

Step 5. Remove end "B" of $MQJ_1$ from the Optical Power Meter, clean end "B" of $MQJ_1$ and immediately place end "B" of $MQJ_1$ into the proper position of the connector test terminus adapter.

Step 6. Connect end "A" of $MQJ_2$ into the optical power meter.

Step 7. Connect end "B" of $MQJ_2$ into proper position in the test terminus adapter on the other end of the cable assembly under test (see figure 6C2-2).

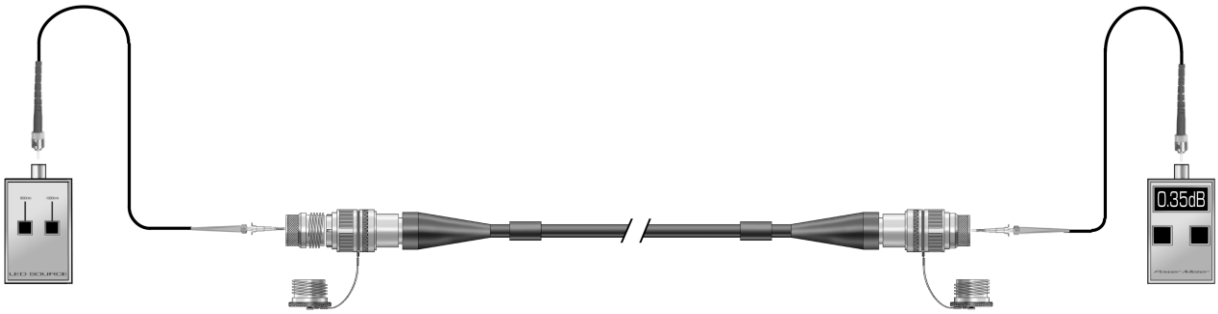


FIGURE 6C2-2. Second power measurement ($P_2$) setup.

Step 8. Record optical power measurement $P_2$. If the optical power meter was zeroed out in step 7 of the first power measurement ($P_1$), then the total cable harness loss value (BCA) = $P_2$. Skip to step 10.

Step 9. If the power meter was not zeroed out in step 7 for the first power measurement ($P_1$), then the total cable harness loss value (BCA) = ($P_1$ - $P_2$).

Step 10. Optical loss is acceptable if BCA is less than or equal to the specified optical loss for the cable harness. If BCA is greater than the specified optical loss or no optical loss has been specified, refer to 4.4.

Step 11. Repeat steps 7 through 10 for the remaining connector positions to be tested.

NOTE: Clean end "B" of $MQJ_2$ and the terminus to be tested before every measurement.

Step 12. For multimode optical fiber cable assemblies, measure the cable assembly link loss in the opposite direction, repeating all steps in section 4.3.1 and 4.3.2.

4.4 Maximum allowable loss calculations.

NOTE: If this test is part of an Acceptance Test, proceed to step 1. If this test is part of a Pre-Installation or Installation Test, proceed to step 2.

Step 1. The optical fiber cable assembly is considered acceptable if the measured loss (in each direction for multimode optical fiber cable assemblies) does not exceed the loss specified by the vendor for the optical fiber cable assembly. If the measured loss (in each direction for multimode optical fiber cable assemblies) is greater than the vendor specified loss, proceed to step 2.

Step 2. Compare the measured loss (in each direction for multimode optical fiber cable assemblies) to the maximum allowable loss. The maximum allowable loss is calculated from the maximum component loss values shown in table 6C1-III using the following formula:

$$MAL = A_{ca}L + N_{co}L_{co} + N_sL_s$$

Where: MAL = Maximum acceptable loss
$A_{ca}$ = Maximum attenuation of the cable
L = Length of the cable
$N_s$ = Number of splices
$L_s$ = Maximum loss of a splice
$N_{co}$ = Number of connectors
$L_{co}$ = Maximum loss of a connector

The optical fiber cable assembly is considered acceptable if the measured loss (in each direction for multimode optical fiber cable assemblies) is equal to or less than the maximum acceptable loss. If the measured loss (in both directions for multimode optical fiber cable assemblies) is acceptable, proceed to step 4. If measured loss (in either direction for multimode optical fiber cable assemblies) is greater than the maximum acceptable loss, proceed to step 3.

NOTE: If the length of the optical fiber cable is not known, a value of zero shall be used for the cable length.

NOTE: If a MIL-PRF-85045 optical fiber cable type does not appear in table 6C2-II, refer to the applicable MIL-PRF-85045 specification sheet for that cable type to determine the maximum allowable component loss for the cable.

NOTE: If the automated pass/fail criteria on the test equipment being used cannot be setup to properly represent the topology being tested, the MAL and determination of acceptability of each link shall be done manually.

TABLE 6C2-II. Maximum component loss values.

| Component | Single mode | Multimode |
|---|---|---|
| MIL-PRF-85045/16 | 1.0 dB/km at 1,310 nm<br>1.0 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/17, /18, /20, and /22 | 1.5 dB/km at 1,310 nm<br>1.5 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/24 | 2.0 dB/km at 1310 nm<br>2.0 dB/km at 1550 nm | 2.0 dB/km at 1300 nm |
| MIL-PRF-85045/27 and /29 | 0.75 dB/km at 1310 nm<br>0.75 dB/km at 1550 nm | 1.25 dB/km at 1300 nm |
| MIL-PRF-49291/6 and /7 | 0.4 dB/km at 1310 nm<br>0.3 dB/km at 1550 nm | 1.00 dB/km at 1300 nm |
| MIL-DTL-83522 single terminus light duty connectors (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-28876 (MIL-PRF-29504/14, /15, and quick connect termini) (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-64266 (MIL-PRF-29504/18 and /20) (mated pair) | 0.50 dB | 0.50 dB |
| COTS A-A-59940 light duty connectors (mated pair) | 0.75 dB | 0.75 dB |
| Fusion splice | 0.2 dB | 0.2 dB |

NOTE: If components other than those listed in table 6C2-II are used, the loss value of these components must be included in the maximum acceptable loss. If the loss value for a component is not known, contact NSWCDD (see 6.4) for assistance in determining the appropriate loss value.

Step 3. If the measured loss (in either direction for multimode optical fiber cable assemblies) is 0.5 dB or more above the maximum acceptable loss, reject the optical fiber cable assembly. If the measured loss (in either direction for multimode optical fiber cable assemblies) is less than 0.5 dB above the maximum acceptable loss, disconnect and clean all the connections and retest. If the loss (in either direction for multimode optical fiber cable assemblies) is still unacceptable, re-terminate or replace the defective components.

Step 4. If the optical fiber cable is not going to be immediately connected to its mating connectors, install dust covers over the optical fiber cable connectors.

# METHOD 6D1
# CABLE CONTINUITY TEST

## 1. SCOPE

1.1 Scope. This method describes a procedure for performing an optical fiber cable continuity test on conventional or BOF cables with or without connectors or terminations of any type.

## 2. REQUIRED EQUIPMENT AND MATERIALS

2.1 Equipment and materials. The equipment and materials in table 6D1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6D1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0071 | Safety glasses | 1 |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | Flashlight or high intensity light source | 1 |
| | Bare fiber adapter | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

## 3. PROCEDURE

3.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the ends of the fibers as they may be razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure. The following steps shall be performed:

Step 1. Establish communications, if required, using available communication equipment.

Step 2. Inspect and clean connectors on both ends of the fiber in accordance with Method 6M1.

Step 3. Using a flashlight or equivalent, shine light in each fiber and verify that light is present at the opposite end.

NOTE: For continuity testing of single mode fiber, a high intensity light source specifically for single mode continuity testing should be used.

NOTE: A bare fiber adapter may be used to optimize the connection between the flashlight and unterminated optical fibers.

# METHOD 6E1
# CABLE TOPOLOGY END-TO-END ATTENUATION TEST

## 1. SCOPE

1.1 Scope. This method describes a procedure for performing a cable topology end-to-end attenuation test to ensure that the FOCT losses are within acceptable limits.

## 2. DOCUMENTS APPLICABLE TO METHOD 6E1

2.1 General. The documents listed in this section are specified in Method 6E1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6E1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940 | - | Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for |
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-29504/14 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/15 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/18 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-29504/20 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-49291/6 | - | Fiber, Optical, Type I, Class I, Size IV, Composition A, Wavelength B, Radiation Resistant (Metric) |
| MIL-PRF-49291/7 | - | Fiber, Optical, Type II, Class 5, Size II, Composition A, Wavelength D, Radiation Resistant (Metric) |

MIL-PRF-64266 - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for

MIL-PRF-64266/32 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Plug Style, for use with a Connector Receptacle

MIL-PRF-64266/33 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Receptacle Style, for use with a Connector Plug

MIL-DTL-83522 - Connectors, Fiber Optic, Single Ferrule, General Specification for

MIL-PRF-85045 - Cable, Fiber Optic, (Metric) General Specification for

MIL-PRF-85045/16 - Cable, Fiber Optic, Single (One) Fiber, Cable Configuration Type 2 (OFCC), Tight Buffer, Cable Class SM and MM

MIL-PRF-85045/17 - Cable, Fiber Optic, Eight Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/18 - Cable, Fiber Optic, Four Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/20 - Cable, Fiber Optic, Thirty-Six Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/22 - Cable, Fiber Optic, Eighteen Fibers, Standard and Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/24 - Cable, Fiber Optic, Ninety Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/27 - Cable, Fiber Optic, Six-Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/29 - Cable, Fiber Optic, Twelve/Eighteen Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM, (Metric)

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6E1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6E1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0016 | Wipes | As required |
| TL-0002 or TL-0044 | Alcohol bottle with alcohol/2-propanol (sealable type) | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | MQJ cables (499-6877804) | As required |
| TS-0009 | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) 1/ | As required |
| | Test terminus adapter (MIL-PRF-64266/32 or MIL-PRF-64266/33) | As required |
| | Test terminus adapter for Tempo OLTS (P/N TBD) | As required |
| TS-0001 or TS-0004 | LED or laser light source | 1 |
| TS-0002 | Power meter | 1 |
| | Dust covers | As required |

FOOTNOTE:

1/ Hybrid adapters are only permitted where the connectors being mated have the same ferrule size. Examples of hybrid adapters not permitted due to dissimilar ferrule sizes include: ST-to-LC and SC-to-LC.

NOTES:

1. Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4).
2. Values for items listed as “TBD” were not available at time of publication; contact NSWCDD (see 6.4) or the manufacturer.

4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the end of the fibers as they are razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Test conditions.

4.2.1 Laser light source. For single mode testing, a laser light source shall be used.

4.2.2 Calibration. Ensure all test equipment calibrations are current.

4.2.3 Test wavelength. This test shall be performed at the 1300-nanometer wavelength for multimode fibers. This test shall be performed at the 1310- and 1550-nanometer wavelengths for single mode fibers.

4.3 Procedure. The following steps shall be performed:

NOTE: Use a wipe dampened with alcohol to clean the adapters and blow them dry with air before making the connections.

NOTE: During execution of this method, all connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

NOTE: Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

NOTE: This procedure involves the use of MQJs. Dirty or defective MQJs will lead to high or unacceptable end-to-end attenuation values. MQJs used in these procedures should be clean and should be of known quality. Test organizations are encouraged to institute an MQJ verification program in which the quality of MQJs is regularly validated (see Method 6F1). Additional guidance on establishing an MQJ verification program can be obtained from NSWCDD (see 6.4).

Step 1. Connect the reference MQJ (see table 6E1-II) between the light source and the power meter and record the power (in dBm) at the meter ($P_1$) (see figure 6E1-1), and, if possible, reference (zero-out) the power meter.

WARNING: When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED. Light may not be visible but can still damage the eye.

NOTE: The time delay between the measurement of $P_1$ and $P_2$ shall be kept to a minimum to prevent inaccurate measurements.

NOTE: For single mode fiber FOCT end-to-end attenuation measurements, the reference MQJ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

NOTE: The value obtained for the reference power, $P_1$, should be consistent from test to test. Changes in the reference power greater than 0.5 dB indicates the condition of the MQJ has changed or the light source is drifting. If changes in the reference power greater than 0.5 dB occur, clean or replace the MQJ and repeat step 3. If the value for $P_1$ continues to change from test to test, consider replacing the light source.

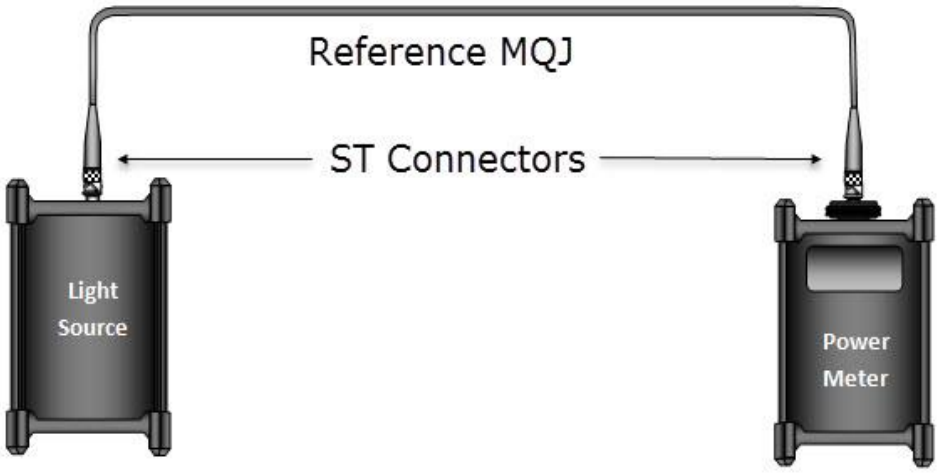


FIGURE 6E1-1. Connecting the reference MQJ.

Step 2. Select the applicable MQJs from table 6E1-II, and connect the optical fiber cable under test to the light source and the power meter as shown on figure 6E1-2.

CAUTION: Ensure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For FOCT links with single terminus connectors, the reference MQJ shall be used as $MQJ_1$. For these tests, the light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

NOTE: For FOCT links under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the MQJs to the FOCT link under test. For FOCT links under test terminated with COTS SC connectors, a hybrid adapter is required to connect the MQJs to the FOCT link under test.

NOTE: For FOCT end-to-end attenuation measurements with MIL-PRF-64266 connectors, use of test terminus adapters in accordance with table 6E1-I are necessary.

NOTE: For single mode fiber FOCT end-to-end attenuation measurements, $MQJ_1$ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

TABLE 6E1-II. MQJ selection for cable topology end-to-end attenuation measurements.

| Termination on cable end under test | Fiber polish type | Select MQJ part number |
|---|---|---|
| M83522 | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS ST (A-A-59940/3) | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS SC (A-A-59940/2) 1/ | MM<br>SM (enhanced) | 6877804-5<br>6877804-5SME |
| COTS LC (A-A-59940/1) | MM<br>SM (enhanced) | 6877804-14<br>6877804-14SME |
| MIL-PRF-28876 4 CH plug | MM<br>SM (enhanced) | 6877804-8<br>6877804-8SME |
| MIL-PRF-28876 4 CH receptacle | MM<br>SM (enhanced) | 6877804-7<br>6877804-7SME |
| MIL-PRF-28876 8 CH plug | MM<br>SM (enhanced) | 6877804-10<br>6877804-10SME |
| MIL-PRF-28876 8 CH receptacle | MM<br>SM (enhanced) | 6877804-9<br>6877804-9SME |
| MIL-PRF-28876 31 CH plug | MM<br>SM (enhanced) | 6877804-13<br>6877804-13SME |
| MIL-PRF-28876 31 CH receptacle | MM<br>SM (enhanced) | 6877804-12<br>6877804-12SME |
| MIL-PRF-64266 | MM<br>SM (enhanced) | ST to MIL-PRF-64266 test terminus MQJ |
| Other 2/ | MM<br>SM (enhanced) | |

NOTES:

1/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

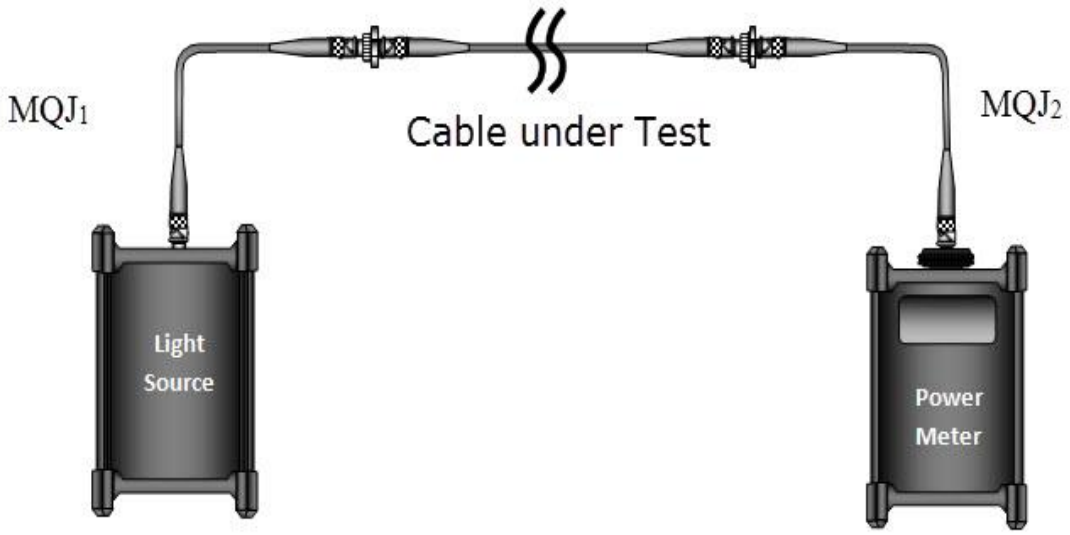


FIGURE 6E1-2. Test setup (typical).

Step 3. Record the power (in dBm) at the meter ($P_2$).

NOTE: The value obtained for the test power ($P_2$) should be less than the value obtained for the reference power. A value of the test power greater than the value of the reference power indicates that either a defective or dirty MQJ was used for the reference measurement. If a value for the test power greater than the value of the reference power is obtained, clean or replace the reference MQJ and repeat steps 2 and 3.

Step 4. Calculate the FOCT end-to-end attenuation using the following formula and record the results:

$$B_{TL} = ( P_1 - P_2 )$$

Where: $B_{TL}$ = Total FOCT end-to-end attenuation in dB
$P_1$ = Reference power in dBm
$P_2$ = Test power in dBm

NOTE: Some optical power meters will automatically calculate the end-to-end attenuation when the meter is referenced or zeroed after the reference power measurement. The reference and test optical powers may be measured and the loss calculated using the formula above or the calculation capability of the optical power meter may be used. In either case, the value of the optical reference power shall be recorded.

NOTE: The end-to-end attenuation value should be a positive number. If the value is not positive, return to step 1 to re-reference the meter and repeat the measurement.

Step 5. Repeat steps 1, 2, 3, and 4 for each fiber in the FOCT link.

Step 6. Identify all of the connectors or splices contained in the FOCT links by type and proceed to 4.4.

4.4 Calculations. The following calculations shall be performed:

Step 1. Compare the measured end-to-end attenuation to the specified maximum allowable link loss. If the maximum allowable link loss is not specified, compare the measured end-to-end attenuation to the maximum allowable loss calculated from the maximum component loss values shown in table 6E1-III using the following formula:

$$MAL = A_{ca}L + N_{co}L_{co} + N_sL_s$$

Where: MAL = Maximum acceptable loss
$A_{ca}$ = Maximum attenuation of the cable
L = Total length of the FOCT link
$N_s$ = Number of splices
$L_s$ = Maximum loss of a splice
$N_{co}$ = Number of connectors
$L_{co}$ = Maximum loss of a connector

The FOCT link is considered acceptable if the measured end-to-end attenuation is equal to or less than the maximum acceptable loss. If the measured end-to-end attenuation is acceptable, proceed to step 3. If measured end-to-end attenuation is greater than the maximum acceptable loss, proceed to step 2.

NOTE: If the length of the FOCT link is not known, a value of zero shall be used for the FOCT link length.

NOTE: If a MIL-PRF-85045 optical fiber cable type does not appear in in table 6E1-III, refer to the applicable MIL-PRF-85045 specification sheet for that cable type to determine the maximum allowable component loss for the cable.

NOTE: If the automated pass/fail criteria on the test equipment being used cannot be setup to properly represent the topology being tested, the MAL and determination of acceptability of each link shall be done manually.

TABLE 6E1-III. Maximum component loss values.

| Component | Single mode | Multimode |
|---|---|---|
| MIL-PRF-85045/16 | 1.0 dB/km at 1,310 nm<br>1.0 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/17, /18, /20, and /22 | 1.5 dB/km at 1,310 nm<br>1.5 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/24 | 2.0 dB/km at 1,310 nm<br>2.0 dB/km at 1,550 nm | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/27 and /29 | 0.75 dB/km at 1,310 nm<br>0.75 dB/km at 1,550 nm | 1.25 dB/km at 1,300 nm |
| MIL-PRF-49291/6 and /7 | 0.4 dB/km at 1,310 nm<br>0.3 dB/km at 1,550 nm | 1.00 dB/km at 1,300 nm |
| MIL-DTL-83522 single terminus light duty connectors (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-28876 (MIL-PRF-29504/14, /15, and quick connect termini) (mated pair) | 0.75 dB | 0.75 dB |
| MIL-PRF-64266 (MIL-PRF-29504/18 and /20) (mated pair) | 0.50 dB | 0.50 dB |
| COTS A-A-59940 light duty connectors (mated pair) | 0.75 dB | 0.75 dB |
| Fusion splice | 0.2 dB | 0.2 dB |

NOTE: If components other than those listed in table 6E1-III are used, the loss value of these components must be included in the maximum acceptable loss. If the loss value for a component is not known, contact NSWCDD (see 6.4) for assistance in determining the appropriate loss value.

Step 2. If the measured end-to-end attenuation is 1.0 dB or more above the maximum acceptable loss, reject the FOCT link. If the measured end-to-end attenuation is less than 1.0 dB above the maximum acceptable loss, disconnect and clean all the connections and retest. If the end-to-end attenuation is still unacceptable, reterminate or replace the defective components.

Step 3. If the ends of the FOCT link are not going to be immediately connected to their mating connectors, install dust covers over the FOCT link connectors.

METHOD 6E2
CABLE TOPOLOGY END-TO-END ATTENUATION TEST FOR MULTIMODE LINKS UTILIZING MODE-CONDITIONING PATCH CORDS

## 1. SCOPE

1.1 Scope. This method describes a procedure for performing a cable topology end-to-end attenuation test to ensure that the FOCT losses are within acceptable limits.

1.2 Applicability. This method applies to fiber optic links that utilize 62.5 micron multimode fiber with a single mode, mode-conditioning, patch cord at the transmitter (e.g., 1000 BASE-LX over multimode fiber).

## 2. DOCUMENTS APPLICABLE TO METHOD 6E2

2.1 General. The documents listed in this section are specified in Method 6E2 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6E2 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940 | - | Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for |
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-29504/14 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/15 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/18 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-29504/20 | - | Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors) |
| MIL-PRF-49291/6 | - | Fiber, Optical, Type I, Class I, Size IV, Composition A, Wavelength B, Radiation Resistant (Metric) |

MIL-PRF-49291/7 - Fiber, Optical, Type II, Class 5, Size II, Composition A, Wavelength D, Radiation Resistant (Metric)

MIL-PRF-64266 - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for

MIL-DTL-83522 - Connectors, Fiber Optic, Single Ferrule, General Specification for

MIL-PRF-85045 - Cable, Fiber Optic, (Metric) General Specification for

MIL-PRF-85045/16 - Cable, Fiber Optic, Single (One) Fiber, Cable Configuration Type 2 (OFCC), Tight Buffer, Cable Class SM and MM

MIL-PRF-85045/17 - Cable, Fiber Optic, Eight Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/18 - Cable, Fiber Optic, Four Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/20 - Cable, Fiber Optic, Thirty-Six Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/22 - Cable, Fiber Optic, Eighteen Fibers, Standard and Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/24 - Cable, Fiber Optic, Ninety Fibers, Enhanced Performance, Cable Configuration Type 2 (OFCC), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/27 - Cable, Fiber Optic, Six-Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM

MIL-PRF-85045/29 - Cable, Fiber Optic, Twelve/Eighteen Fiber Bundle, Blown Optical Fiber, Cable Configuration Type 3 (Cable Bundle), Application B (Shipboard), Cable Class SM and MM, (Metric)

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy.mil.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant

(Copies of this document are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6E2-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found at the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear on is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6E2-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0016 | Wipes | As required |
| TL-0002 or TL-0044 | Alcohol bottle with alcohol ½-propanol (sealable type) | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | MQJ cables (499-6877804) | As required |
| TS-0009 | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) 1/ | As required |
| TS-0001 | Laser single mode light source | 1 |
| TS-0002 | Multimode power meter | 1 |
| | Dust covers | As required |

FOOTNOTE:

1/ Hybrid adapters are only permitted where the connectors being mated have the same ferrule size. Examples of hybrid adapters not permitted due to dissimilar ferrule sizes include: ST-to-LC and SC-to-LC.

NOTE:

1. Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4).

## 4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the end of the fibers as they are razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Test conditions.

4.2.1 Test direction. Testing can only be conducted from the transmitter side of the link. Testing in the opposite direction will result in high optical loss.

4.2.3 Laser light source. A laser light source shall be used.

4.2.4 Calibration. Ensure all test equipment calibrations are current.

4.2.5 Test wavelength. This test shall be performed at the 1310-nanometer wavelength.

4.3 Procedure. The following steps shall be performed:

Step 1. Inspect and clean the all connectors in accordance with Method 6M1.

NOTE: Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

NOTE: This procedure involves the use of MQJs. Dirty or defective MQJs will lead to high or unacceptable end-to-end attenuation values. MQJs used in these procedures should be clean and should be of known quality. Test organizations are encouraged to institute an MQJ verification program in which the quality of MQJs is regularly validated. Additional guidance on establishing an MQJ verification program can be obtained from NSWCDD (see 6.4).

Step 2. Connect a single mode reference $MQJ_1$ (see table 6E2-II) between the light source and the power meter and record the power (in dBm) at the meter ($P_1$) (see figure 6E2-1).

WARNING: When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED. Light may not be visible but can still damage the eye.

NOTE: The time delay between the measurement of $P_1$ and $P_2$ shall be kept to a minimum to prevent inaccurate measurements.

NOTE: The single mode reference $MQJ_1$ may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power. If a loop is used for the $P_1$ measurement it shall be used on $MQJ_1$ for other measurements in this method (e.g., $P_2$ measurement).

NOTE: The value obtained for the reference power, $P_1$, should be consistent from test to test. Changes in the reference power greater than 0.5 dB indicates the condition of the MQJ has changed or the light source is drifting. If changes in the reference power greater than 0.5 dB occur, clean or replace the MQJ and repeat step 2. If the value for $P_1$ continues to change from test to test, consider replacing the light source.

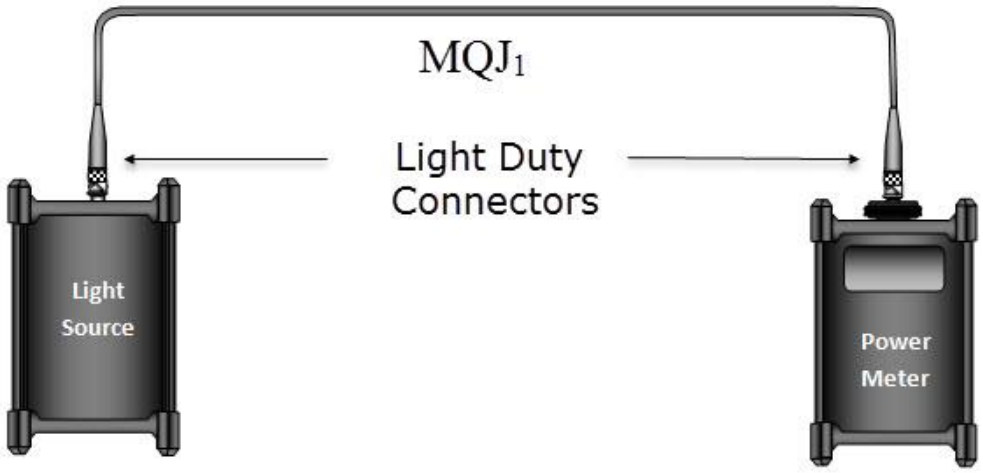


FIGURE 6E2-1. Connecting the reference MQJ ($MQJ_1$).

TABLE 6E2-II. $MQJ_1$ selection for cable topology end-to-end attenuation measurements.

| Termination on cable end under test | Fiber polish type | Select MQJ part number |
|---|---|---|
| M83522 | SM (enhanced) | 6877804-5SME |
| COTS ST (A-A-59940/3) | SM (enhanced) | 6877804-5SME |
| COTS SC (A-A-59940/2) 1/ | SM (enhanced) | 6877804-5SME |
| COTS LC (A-A-59940/1) | SM (enhanced) | 6877804-14SME |
| Other 2/ | SM (enhanced) | |

NOTES:

1/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

NOTE: The reference $MQJ_1$ is shown on figure 6E2-2. If a different connector is required to connect to the link under test, a separate MQJ that meets the loss requirements in Method 6F1 may be substituted as $MQJ_1$. If no substitution is required, the light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

Step 3. Select the applicable MQJ for $MQJ_2$ from table 6E2-III, and connect the optical fiber cable under test to the light source and the power meter as shown on figure 6E2-2.

NOTE: For FOCT links under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the MQJs to the FOCT link under test. For FOCT links under test terminated with COTS SC connectors, a hybrid adapter is required to connect the MQJs with ST connectors to the FOCT link under test. Hybrid adapters are only permitted where the connectors being mated have the same ferrule size. Examples of hybrid adapters not permitted due to different ferrule sizes include: ST-to-LC and SC-to-LC.

NOTE: For FOCT links under test terminated with connectors having ferrule sizes other than 2.5 millimeters (ST/SC connector), a separate MQJ that meets the loss requirements in Method 6F1 may be substituted as $MQJ_1$. When the optical power meter interface permits direct measurement of this separate MQJ, the MQJ shall be denoted as $MQJ_1$ and used directly for the reference measurement $P_1$ obtained in step 1.

NOTE: $MQJ_1$ shall include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power if a loop was utilized in step 2.

TABLE 6E2-III. $MQJ_2$ selection for cable topology end-to-end attenuation measurements.

| **Termination on cable end under test** | **Fiber polish type** | **Select MQJ part number** |
|---|---|---|
| M83522 | MM | 6877804-5 |
| COTS ST (A-A-59940/3) | MM | 6877804-5 |
| COTS SC (A-A-59940/2) 1/ | MM | 6877804-5 |
| COTS LC (A-A-59940/1) | MM | 6877804-14 |
| MIL-PRF-28876 4 CH plug | MM | 6877804-8 |
| MIL-PRF-28876 4 CH receptacle | MM | 6877804-7 |
| MIL-PRF-28876 8 CH plug | MM | 6877804-10 |
| MIL-PRF-28876 8 CH receptacle | MM | 6877804-9 |
| MIL-PRF-28876 31 CH plug | MM | 6877804-13 |
| MIL-PRF-28876 31 CH receptacle | MM | 6877804-12 |
| Other 2/ | MM | |

NOTES:

1/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

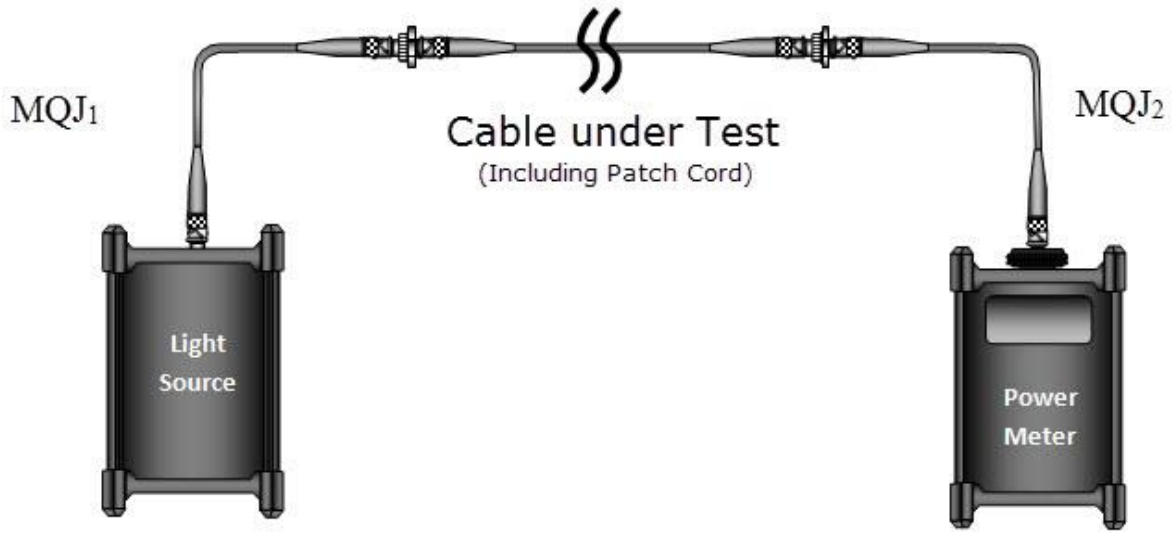


FIGURE 6E2-2. Test setup (typical).

Step 4. Record the power (in dBm) at the meter ($P_2$).

NOTE: The value obtained for the test power ($P_2$) should be less than the value obtained for the reference power. A value of the test power greater than the value of the reference power indicates that either a defective or dirty MQJ was used for the reference measurement. If a value for the test power greater than the value of the reference power is obtained, clean or replace the reference MQJ and repeat steps 2 and 3.

Step 5. Calculate the FOCT end-to-end attenuation using the following formula and record the results:

$$B_{TL} = ( P_1 - P_2 )$$

Where: $B_{TL}$ = Total FOCT end-to-end attenuation in dB
$P_1$ = Reference power in dBm
$P_2$ = Test power in dBm

NOTE: Some optical power meters will automatically calculate the end-to-end attenuation when the meter is referenced or zeroed after the reference power measurement. The reference and test optical powers may be measured and the loss calculated using the formula above or the calculation capability of the optical power meter may be used. In either case, the value of the optical reference power shall be recorded.

NOTE: The cable assembly link loss value should be a positive number.

Step 6. Repeat steps 1 through 5 for each fiber in the FOCT link.

Step 7. Identify the total number of the connectors or splices contained in the FOCT links by type and proceed to 4.4.

4.4 Calculations.

Step 1. Compare the measured end-to-end attenuation to the specified maximum allowable link loss. If the maximum allowable link loss is not specified, compare the measured end-to-end attenuation to the maximum allowable loss calculated from the maximum component loss values shown in table 6E2-IV using the following formula:

$$MAL = A_{ca}L + N_{co}L_{co} + N_sL_s$$

Where: MAL = Maximum acceptable loss
$A_{ca}$ = Maximum attenuation of the cable
L = Total length of the FOCT link
$N_s$ = Number of splices
$L_s$ = Maximum loss of a splice
$N_{co}$ = Number of connectors
$L_{co}$ = Maximum loss of a connector

The FOCT link is considered acceptable if the measured end-to-end attenuation is equal to or less than the maximum acceptable loss. If the measured end-to-end attenuation is acceptable, proceed to step 3. If measured end-to-end attenuation is greater than the maximum acceptable loss, proceed to step 2.

NOTE: If the length of the FOCT link is not known, a value of zero shall be used for the FOCT link length.

NOTE: If a MIL-PRF-85045 optical fiber cable type does not appear in table 6E2-IV, refer to the applicable MIL-PRF-85045 specification sheet for that cable type to determine the maximum allowable component loss for the cable.

NOTE: If the automated pass/fail criteria on the test equipment being used cannot be setup to properly represent the topology being tested, the MAL and determination of acceptability of each link shall be done manually.

TABLE 6E2-IV. Maximum component loss values.

| Component | Multimode |
|---|---|
| MIL-PRF-85045/16, /17, /18, /20, /22, and /24 | 2.0 dB/km at 1,300 nm |
| MIL-PRF-85045/27 and /29 | 1.25 dB/km at 1,300 nm |
| MIL-PRF-49291/6 and /7 | 1.00 dB/km at 1,300 nm |
| MIL-DTL-83522 single terminus light duty connectors (mated pair) | 0.75 dB |
| MIL-PRF-28876 (MIL-PRF-29504/14, /15, and quick connect termini) (mated pair) | 0.75 dB |
| MIL-PRF-64266 (MIL-PRF-29504/18 and /20) (mated pair) | 0.50 dB |
| COTS A-A-59940 light duty connectors (mated pair) | 0.75 dB |
| Fusion splice | 0.2 dB |

NOTE: If components other than those listed in table 6E2-IV are used, the loss value of these components must be included in the maximum acceptable loss. If the loss value for a component is not known, contact NSWCDD (see 6.4) for assistance in determining the appropriate loss value.

Step 2. If the measured end-to-end attenuation is 1.0 dB or more above the maximum acceptable loss, reject the FOCT link. If the measured end-to-end attenuation is less than 1.0 dB above the maximum acceptable loss, disconnect and clean all the connections and retest. If the end-to-end attenuation is still unacceptable, reterminate or replace the defective components.

Step 3. If the ends of the FOCT link are not going to be immediately connected to their mating connectors, install dust covers over the FOCT link connectors.

# METHOD 6F1
# MQJ CABLE SELECTION TEST

## 1. SCOPE

1.1 Scope. This method describes procedures for measuring the loss of MQJ cable end terminations.

## 2. DOCUMENTS APPLICABLE TO METHOD 6F1

2.1 General. The documents listed in this section are specified in Method 6F1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6F1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-29504/14 | - | Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/15 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-64266 | - | Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |
| MIL-PRF-64266/32 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Plug Style, for use with a Connector Receptacle |
| MIL-PRF-64266/33 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Receptacle Style, for use with a Connector Plug |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

| | | |
|---|---|---|
| TIA/EIA-455-171 | - | Attenuation by Substitution Measurement for Short-Length Multimode Graded-Index and Single-mode Optical Fiber Cable Assemblies |
| TIA-526-14 | - | Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant |

(Copies of these documents are available online at www.tiaonline.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6F1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6F1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | Reference cable (ST on both ends) | As required |
| | Reference cable (ST-to M29504/14 pin terminus) | As required |
| | Reference cable (ST-to-M29504/15 socket terminus) | As required |
| | Reference cable (ST-to-MIL-PRF-64266 test terminus) | As required |
| TS-0001 | Light source | 1 |
| TS-0002 | Power meter | 1 |
| | Dust covers | As required |
| TS-0009 | ST to ST adapter | 1 |
| | MIL-PRF-28876 plug connector | 1 |
| | MIL-PRF-28876 receptacle connector | 1 |
| | Test terminus adapter plug (MIL-PRF-64266/32) | As required |
| | Test terminus adapter receptacle (MIL-PRF-64266/33) | As required |
| | Test terminus adapter for Tempo OLTS (P/N TBD) | As required |
| | ST termination type power meter adapter | 1 |
| | Single socket terminus power meter adapter | 1 |
| | Single pin terminus power meter adapter | 1 |
| | Splice ferrule termination type power meter adapter | 1 |

NOTES:

1. Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4).
2. Values for items listed as “TBD” were not available at time of publication; contact NSWCDD (see 6.4) or the manufacturer.

4. PROCEDURES

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when handling bare fibers.

b. Do not touch the end of the fibers as they may be razor sharp. Wash your hands after handling bare fiber.

c. Observe warnings and cautions on equipment and materials.

d. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Procedure.

NOTE: Alternative methods shall be approved by NSWCDD (see 6.4).

NOTE: Ensure the test equipment calibration is current.

NOTE: Use a wipe dampened with alcohol to clean the adapters and blow them dry with air before making connections.

NOTE: During execution of this method, all connectors shall be inspected /cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

NOTE: Identify and label all of the MQJ cables to be evaluated. Labelling terminated ends “A” and “B” respectively will aide in accurately completing the entire method.

NOTE: Reference cables are cables constructed using fibers and connectors with tightened geometrical specifications (for example, diameter, concentricity). For more information on reference cables, refer to TIA/EIA-455-171.

NOTE: Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

NOTE: A laser light source shall be used for single mode optical fiber MQJs.

4.2.1 ST connector measurement. The following steps shall be performed:

Step 1. Select an MQJ.

NOTE: The loss of the MQJ end with an ST connector is measured first. If both ends of the MQJ are terminated with ST connectors, the ends shall be identified as “A” and “B” and the loss of “A” measured first.

Step 2. Connect the ST-to-ST reference cable between the light source and the power meter and record the optical power at the meter ($P_1$) and, if possible, reference (zero-out) the power meter (see figure 6F1-1). Disconnect the reference cable from the power meter.

WARNING: Do not look into the end of a fiber connected to an LED or laser diode. Light may not be visible but can still damage the eye.

NOTE: For single mode fiber measurements, the reference cable may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

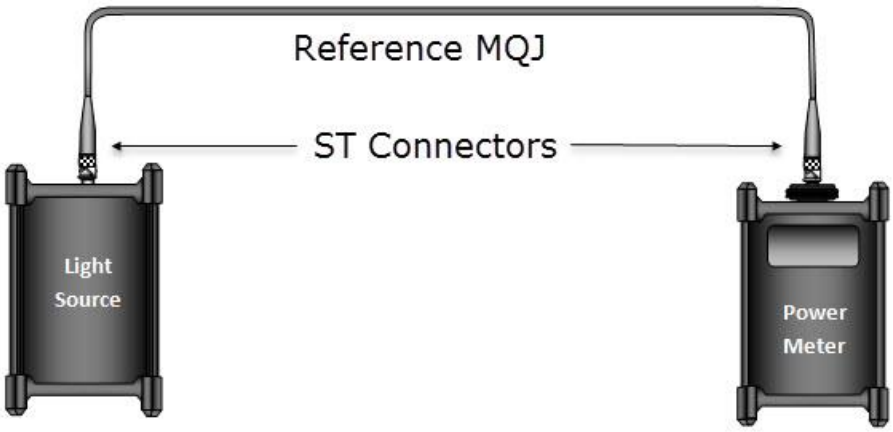


FIGURE 6F1-1. Connecting the reference cable.

NOTE: The time delay between the measurement of $P_1$ and $P_2$ shall be kept to a minimum to prevent inaccurate readings.

NOTE: The reference cable to light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

Step 3. Connect the MQJ to the reference cable using a single-mode ST-to-ST adapter and to the power meter using the applicable power meter adapter head (see figure 6F1-2).

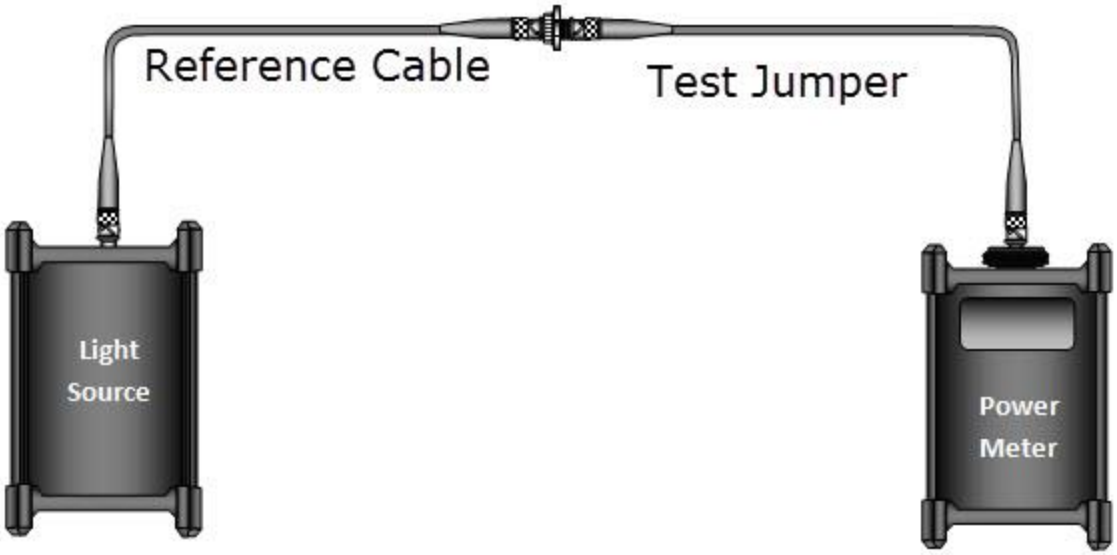


FIGURE 6F1-2. Connecting the test jumper.

Step 4. Record the power at the meter ($P_2$).

Step 5. Calculate the ST connector loss using the following formula:

$$B_{ST} = (P_1 - P_2)$$

Where: $B_{ST}$ = ST connector loss in dB
$P_1$ = Reference cable power in dBm
$P_2$ = Test power in dBm

Step 6. Record the ST connector loss along with the MQJ identification.

Step 7. Repeat steps 3 through 6 a minimum of 3 times (a maximum of 10 times) for the selected MQJ.

Step 8. Proceed to 4.2.2 to measure the connector loss on the other end of the MQJ.

4.2.2 ST connector measurement. The following steps shall be performed:

NOTE: A wipe dampened with alcohol may be used to clean the adapters and connectors and they may be blown dry with air before making each connection.

NOTE: The loss of the second MQJ end is measured next. If both ends of the MQJ have ST connectors on them, the loss of the "B" end is measured next.

Step 1. Connect the ST-to-ST, ST-to-pin terminus, ST-to-socket terminus, or ST-to-MIL-PRF-64266 test terminus reference cable between the light source and the power meter and record the power at the meter ($P_1$) (see figure 6F1-3). Disconnect the reference cable from the power meter.

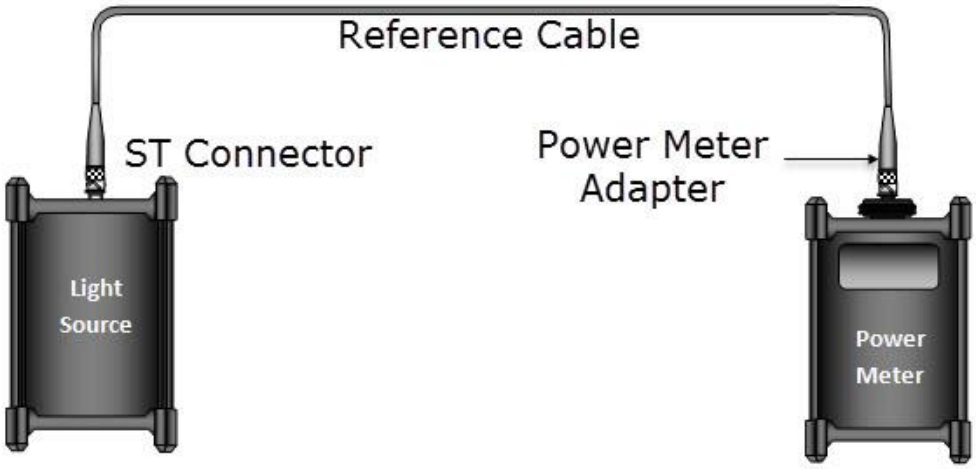


FIGURE 6F1-3. Connecting the reference cable.

NOTE: If testing ST-to-MIL-PRF-64266 test terminus MQJs, the adapter for the receive port on the OLTS will only work with Tempo OLTS. If Tempo OLTS are not available a substitution method must be used for step 1.

NOTE: The time delay between the measurement of $P_1$ and $P_2$ shall be kept to a minimum to prevent inaccurate readings.

NOTE: The reference cable to light source connection shall not be disturbed between measurement of $P_1$ and $P_2$ to prevent inaccurate readings.

NOTE: For single mode fiber measurements, the reference cable may include a single loop with a diameter of 30 millimeters (1 inch) to eliminate higher order mode power.

Step 2. Connect the MQJ to the reference cable and to the power meter using the ST adapter head (see figure 6F1-4).

NOTE: For either pin or socket termini, the termini shall be inserted into MIL-PRF-28876 plug or receptacle connectors and mated.

NOTE: For MIL-PRF-64266 test terminus MQJs, a test terminus adapter plug and test terminus adapter receptacle must be mated to connect the reference cable and test jumper.

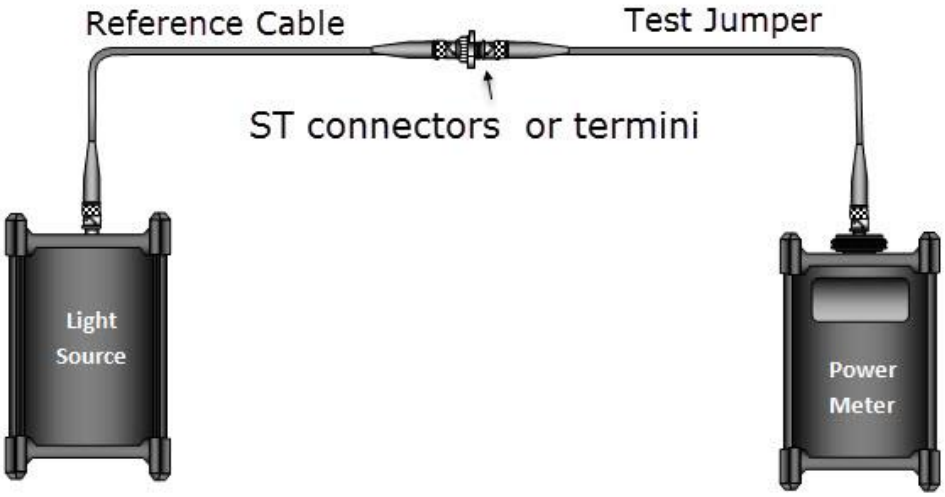


FIGURE 6F1-4. Connecting the test jumper.

Step 3. Record the power at the meter ($P_2$).

Step 4. Calculate the ST, terminus, or splice connection loss using following formula:

$$B_C = (P_1 - P_2)$$

Where: $B_C$ = ST, terminus, or splice connection loss in dB
$P_1$ = Reference cable power in dBm
$P_2$ = Test power in dBm

Step 5. Record the ST, terminus, or splice connection loss along with the test jumper identification.

Step 6. Repeat steps 9 through 12 a minimum of 3 times (a maximum of 10 times) for the selected MQJ.

NOTE: A wipe dampened with alcohol may be used to clean the adapters and connectors and they may be blown dry with air before making each connection.

4.3 Calculations. The following steps shall be performed:

Step 1. Calculate the mean loss for each end of the MQJ using the following formula and record the results:

$$\mu_C = \frac{1}{m} x \sum_{n=1}^{m} B_n$$

Where: $\mu_C$ = Mean connection loss in dB
$B_n$ = Connection loss for measurement n in dB
m = Number of loss measurements performed

Step 2. Calculate the standard deviation of the measured loss for each MQJ end using the following formula and record the results:

$$\sigma_C = \sqrt{\frac{\sum_{n=1}^{m}(B_n - \mu_C)^2}{m-1}}$$

Where: $\sigma_c$ = Standard deviation of the connection loss in dB
m = Number of loss measurements performed

Step 3. An MQJ is considered acceptable if the mean loss and the standard deviation of the loss of each end is in accordance with table 6F1-II.

NOTE: For jumper cables which are in excess of 1 meter (3.28 feet) in length, the loss of the fiber can be added to the following acceptable loss limits.

TABLE 6F1-II. MQJ loss acceptance criteria.

| End connection | Acceptable loss (dB) | Standard deviation (dB) |
|---|---|---|
| ST | $0.00 \leq \mu_c \leq 0.35$ | 0.05 max. (multimode)<br>0.10 max. (single mode) |
| M29504/14 pin terminus | $0.00 \leq \mu_c \leq 0.70$ | 0.05 max. (multimode)<br>0.10 max. (single mode) |
| M29504/15 socket terminus | $0.00 \leq \mu_c \leq 0.70$ | 0.05 max. (multimode)<br>0.10 max. (single mode) |

Step 4. If the mean loss or the standard deviation of either end is not in accordance with table 6F1-II, the MQJ is not acceptable for use.

# METHOD 6G1
# HEAVY-DUTY CONNECTOR MECHANICAL PULL TEST

## 1. SCOPE

1.1 Scope. This method describes procedures for performing a mechanical pull test on the cable strain relief of heavy-duty connectors.

## 2. REQUIRED EQUIPMENT AND MATERIALS

2.1 Equipment and materials. The equipment and materials in table 6G1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6G1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| | Connector clamp | 1 |
| | Cable pulling device | 1 |
| | Strain gauge (with accuracy of ±5 percent) | 1 |
| NOTE: The cable pulling device should not introduce any permanent deformation into the optical fiber cable jacket. | | |

## 3. PROCEDURES

3.1 Safety summary. The following safety precautions shall be observed:

a. Observe warnings and cautions on equipment and materials.

b. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure. The following steps shall be performed:

Step 1. Attach the strain gauge between a fixed object and the connector clamp.

Step 2. Attach the heavy-duty connector to the connector clamp.

Step 3. Attach the cable pulling device to the optical fiber cable.

Step 4. Pull on the optical fiber cable assembly with a force of 444 newtons (100 pounds-force) for 1 minute.

Step 5. Disconnect the cable pulling device and the connector clamp from the optical fiber cable assembly.

Step 6. Visually inspect the connector/cable interface for cable pullout and deformation of the optical fiber cable jacket. Optical fiber cable assemblies that show these defects shall be rejected.

# METHOD 6H1
# BOF CABLE BB TEST

## 1. SCOPE.

1.1 Scope. This method describes a procedure for performing a BB test on BOF cables. This method is performed to verify that the BOF tubes are free of obstructions that would inhibit blown fiber or BOF bundle installation.

## 2. DOCUMENTS APPLICABLE TO METHOD 6H1

2.1 General. The documents listed in this section are specified in Method 6H1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6H1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59731 - Fittings, Tube, Blown Optical Fiber

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-2042-2 - Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Equipment) (Part 2 of 7 Parts)

(Copies of these documents are available online at http://quicksearch.dla.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6H1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6H1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0071 | Safety glasses | 1 |
| | Projectile trap (Kitco 0745-2140, or equal [see 4.7]) | 1 |
| | Heat shrink label (Raychem P/N 5061850001, or equal [see 4.7]) | As required |
| | BOF tube coupler with plug (A-A-59731-U-8) or BOF tube end cap (A-A-59731-EC-8) | As required |
| | Dry air pressure source | As required |
| | BB with diameter of 2.5, 3.0, 4.5, or 5 mm (0.10, 0.12, 0.17, or 0.20 inch) | As required |

NOTES:

1. Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4).
2. Refer to table 6H1-II to determine the appropriate BB size.

4. PROCEDURE

4.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when blowing a BB.

b. Observe warnings and cautions on equipment and materials.

c. Do not look into the end of a BOF tube. Always wear approved safety glasses when handling BOF tubes that may be connected to a pressure source.

d. Do not exceed 1,032 kilopascals (kPa) (150 pounds per square inch [psi]) within the BOF tube when attempting to dislodge a stuck BB. BOF tube damage can occur at pressures greater than 150 psi.

4.2 Procedure. The following steps shall be performed:

Step 1. Establish communications between the personnel at the two ends of the cable using available communication equipment.

Step 2. Install the projectile trap on the remote end of the first BOF tube to be tested.

Step 3. Verify that the projectile trap is installed on the correct tube.

NOTE: This can be accomplished by applying air flow to the near end of the BOF tube to be tested and observing air flow at the tube remote end. A source pressure of 344 to 688 kPa (50 to 100 psi) should be sufficient to allow tube verification.

Step 4. Place a BB into the BOF tube under test. Refer to table 6H1-II to determine the appropriate BB size depending on the testing scenario.

TABLE 6H1-II. BB size.

| Testing scenario | BB diameter (mm) |
|---|---|
| Cable acceptance testing | 4.5 |
| Post cable installation (see 5.3.2.a) | 4.5 |
| Pre-fiber installation testing, 6-fiber bundle (see 5.3.2.b) | 3.0 |
| Pre-fiber installation testing, 12 or 18-fiber bundle (see 5.3.2.b) | 4.0 |
| Pre-fiber installation testing, individual blown fibers (any count) (see 5.3.2.b) | 4.5 |
| Post final installation (see 5.3.2.e) | 4.5 |

Step 5. Using the pressure source, send the BB through the tube. Use the projectile trap to catch the BB as it exits the tube. Recommended minimum blowing times before declaring a failure appear in table 6H1-III.

TABLE 6H1-III. Recommended minimum blowing times.

| Tube path length range (meters) | Minimum blowing time (seconds) |
|---|---|
| 0 to 50 | 5 |
| 51 to 100 | 10 |
| 101 to 150 | 15 |
| 151 to 200 | 20 |
| > 200 | 25 |

NOTE: A source pressure of 482 to 688 kPa (70 to 100 psi) should be sufficient to send the BB through the BOF tube.

Step 6. If the BB exits the BOF tube, record the test result on the test data sheet and proceed to step 8. If the BB does not exit the BOF tube, proceed to step 7.

Step 7. The following actions can be taken in an attempt to free a lodged BB:

a. While maintaining air flow on the near end of the BOF tube being tested, close the valve on the projectile trap on the far end of the tube. Allow pressure to stabilize in the tube and then open the valve on the projectile trap and check for the BB.

b. Alternatively, the pressure source can be moved to the remote end of the tube under test and air flow can be applied in the reverse direction of the original test.

c. Insert a 2.5-millimeter (0.99-inch) BB in the remote end of the tube and apply air flow in the opposite direction of the original test to dislodge the original BB.

d. Record the test failure on the test data sheet.

e. Use the heat shrink label to mark both ends of the tested tube as a failed tube along with the testing date. Do not shrink the label.

f. If the tube was assigned for an installation, contact the appropriate planning yard for assignment of an alternate tube.

NOTE: Tube labels shall not be switched to another available tube as an alternative to a failing assigned tube path. Tube label numbers and the tube number printed on the tube shall match.

NOTE: Do not exceed 1034 kPa (150 psi) within the BOF tube when attempting to dislodge a stuck BB. BOF tube damage can occur at pressures greater than 1034 kPa (150 psi).

Step 8. Repeat steps 2 through 7 for all of the tubes to be tested.

Step 9. Ensure that both ends of all tubes tested have been properly end sealed in accordance with MIL-STD-2042-2, Method 2J1.

METHOD 6I1
BOF CABLE PRESSURIZATION TEST

1 SCOPE

1.1 Scope. This method describes a procedure for performing a pressurization test on BOF tubes in BOF cables. This method is performed to verify that the BOF tubes are free of tears or holes and that all tube coupler connections within the BOF tube path are properly connected.

2. REQUIRED EQUIPMENT AND MATERIALS

2.1 Equipment and materials. The equipment and materials in table 6I1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6I1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0071 | Safety glasses | 1 |
| | Dry air variable pressure source | As required |
| | Pressure gauge | 1 |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

3. PROCEDURE

3.1 Safety summary. The following safety precautions shall be observed:

a. Wear safety glasses when pressurizing the BOF cable.

b. Observe warnings and cautions on equipment and materials.

c. Do not look into the end of a BOF tube. Always wear approved safety glasses when handling BOF tubes that may be connected to a pressure source.

3.2 Procedure. The following steps shall be performed:

Step 1. Establish communications, if required, using available communication equipment.

Step 2. Select a BOF tube. Connect the pressure source onto one end of the BOF tube and the pressure gauge onto the other end of the BOF tube.

NOTE: When performing the pressurization test, the tube couplers must not be removed after the test is complete. If tube couplers are removed, the pressurization test shall be performed again.

NOTE: If the tube couplers used at either end are not new tube couplers, it is recommended to swab the inside of the couplers with a cotton swab to remove previous tube coating debris.

Step 3. Adjust the pressure at the pressure source to 688 kPa (100 psi). Allow the tube to stabilize and verify the pressure at the pressure gauge.

Step 4. After 1 minute, if the pressure at the pressure gauge is the same as that at the pressure source, proceed to step 5. If the pressure at the pressure gauge is not the same as that at the pressure source, check the BOF cable for damage, check the tube couplings for leaks, and repeat this test.

Step 5. Repeat steps 2, 3, and 4 for all tubes.

# METHOD 6J1
# TUBE SEAL VERIFICATION TEST

## 1 SCOPE

1.1 Scope. This method describes the procedures for verifying the integrity of BOF tube end seals.

## 2. DOCUMENTS APPLICABLE TO METHOD 6J1

2.1 General. The documents listed in this section are specified in Method 6J1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6J1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59731 | - | Fittings, Tube, Blown Optical Fiber |

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-2042-2 | - | Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Equipment) (Part 2 of 7 Parts) |

(Copies of these documents are available online at http://quicksearch.dla.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6J1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6J1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TL-0071 | Safety glasses | 1 |
| | Pressure source | 1 |
| | Isolation valve | 1 |
| | Pressure gauge | 1 |
| | Bleed valve | 1 |
| | BOF tube | As required |
| | BOF tube coupler (A-A-59731-U-8 or A-A-59731-U-8E) | As required |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

4. PROCEDURES

4.1 Safety summary. The following safety procedures shall be observed:

a. Wear safety glasses when pressurizing the BOF cable.

b. Observe warnings and cautions on equipment and materials.

c. Do not look into the end of a BOF tube. Always wear approved safety glasses when handling BOF tubes that may be connected to a pressure source.

4.2 Procedure. The following steps shall be performed:

CAUTION: Do not disengage mated BOF tube couplers. Disengaging utilized BOF tube couplers may damage or break the optical fibers contained within the BOF tubes.

Step 1. Assemble the pressure source, isolation valve, bleed valve, and pressure gauge using BOF tube as shown on figure 6J1-1. Visually verify that the ends of all BOF tubes are cut perpendicular to the tube length. Apply an axial load of approximately 22 newtons (5 pounds-force) to all BOF tube connections to verify that they are properly engaged.

NOTE: Alternate test configurations that provide the same functionality may be utilized.

NOTE: For BOF tubes containing no fibers, the pressure test equipment is connected to one end of the tube. The other end shall have been previously end sealed in accordance with MIL-STD-2042-2, Method 2J1.

NOTE: For BOF tubes containing fibers, the pressure test equipment is connected to a short BOF tube or pressure fitting extending from a tee connection previously installed between BOF tubes containing the fibers. The tube path ends shall have been previously end sealed in accordance with MIL-STD-2042-2, Method 2F1.

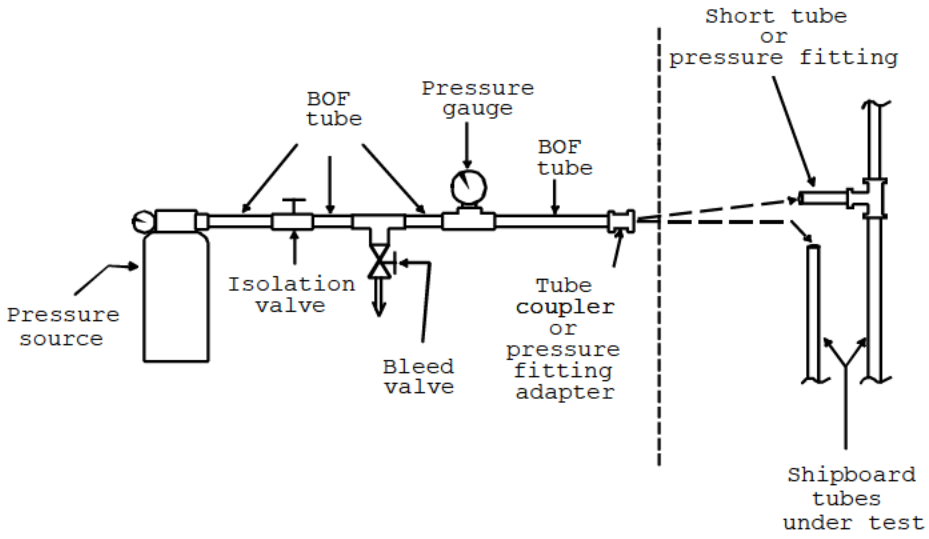


FIGURE 6J1-1. BOF tube seal verification test setup (typical).

Step 2. Adjust the pressure source to 234 kPa (34 psi) and apply this pressure to the BOF tube. Allow the pressure to stabilize.

Step 3. Shut the isolation valve so that the BOF tube is isolated from the pressure source. Read the initial pressure at the pressure gauge and record the value. Maintain this configuration for 5 minutes.

NOTE: If the connection to the BOF tube is a pressure valve assembly (Connective Solutions FC08B1, or equal [see 4.7]), the pressure test equipment may be disconnected from the BOF tube during the test.

Step 4. Read the final pressure at the pressure gauge and record the value.

NOTE: If the pressure test equipment was disconnected from the BOF tube after initial pressurization, the pressure test equipment must be reconnected to the BOF tube before making this measurement.

Step 5. Using the bleed valve, reduce the pressure in the BOF tube to 0 kPa (0 psi).

Step 6. Disconnect the pressure test equipment from the tube under test.

Step 7. Subtract the final pressure from the initial pressure. BOF tubes for which the difference between the two measurements is more than 10.3 kPa (1.5 psi) shall be end sealed again in accordance with MIL-STD-2042-2, Methods 2F1 or 2J1 and retested.

Step 8. If the testing was performed on a BOF tube end, end seal the BOF tube end in accordance with MIL-STD-2042-2, Method 2J1.

Step 9. If the testing was performed at a tee tube coupler without a pressure valve assembly, perform one of the following:

a. End seal the short BOF tube from the tee tube coupler in accordance with MIL-STD-2042-2, Method 2J1.

b. Clean a tube coupler plug with a wipe dampened with alcohol and blow dry as necessary. Insert the tube coupler plug in the tee tube coupler. Apply an axial load of approximately 22 newtons (5 pounds-force) between the BOF tube and the tube coupler plug to verify that they are properly engaged into the tube coupler.

Step 10. If the testing was performed at a tee tube coupler with a pressure valve assembly, install the pressure valve assembly cap on the pressure valve assembly.

# METHOD 6K1
# CABLE ASSEMBLY RETURN LOSS TEST

## 1 SCOPE

1.1 Scope. This method describes procedures for performing a cable assembly return loss test on optical fiber cables that have connectors or other terminations installed on both ends. Optical return loss testing is performed only on single mode optical fiber cable assemblies.

## 2. DOCUMENTS APPLICABLE TO METHOD 6K1

2.1 General. The documents listed in this section are specified in Method 6K1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6K1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940 | - | Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for |
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-64266 | - | Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |
| MIL-PRF-64266/32 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Plug Style, for use with a Connector Receptacle |
| MIL-PRF-64266/33 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Receptacle Style, for use with a Connector Plug |
| MIL-DTL-83522 | - | Connectors, Fiber Optic, Single Ferrule, General Specification for |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6K1-I shall be used to perform these procedures. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6K1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TS-0006 | ORLM | 1 |
| | ORLM interface cable | As required |
| TS-0009 | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) | As required |
| | MQJ cables (499-6877804) | As required |
| | Test terminus adapter (MIL-PRF-64266/32 or MIL-PRF-64266/33) | As required |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | Dust covers | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

4. PROCEDURE

4.1 Safety summary. The following safety precautions shall be observed:

a. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Procedure. The following steps shall be performed:

WARNING: Do not stare into the end of an optical fiber connected to an LED or laser diode. Light may not be visible, but can still damage the eye.

CAUTION: Throughout the testing process, cleanliness is critical to obtaining a correct optical measurement. Make sure that your hands and the work area are as clean as possible to minimize the ingress of dirt into the connector parts.

NOTE: Ensure the test equipment calibration is current.

NOTE: Use a wipe dampened with alcohol to clean the adapters and wipe them dry with a clean, lint-free, 100 percent cotton cloth before making the connections.

NOTE: During execution of this method, all connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

NOTE: This procedure involves the use of MQJs. Dirty or defective MQJs will lead to low or unacceptable cable assembly return loss values. MQJs used in these procedures should be clean and should be of known quality. Test organizations are encouraged to institute an MQJ verification program in which the quality of MQJs is regularly validated. Additional guidance on establishing an MQJ verification program can be obtained from NSWCDD (see 6.4).

NOTE: Make sure of the specified return loss for the cable assembly under test. Use standard dome polish MQJs for testing of cable assemblies with return loss requirements not less than 30 dB. Use enhanced dome polish MQJs for testing of cable assemblies with return loss requirements not less than 40 dB.

Step 1. Energize the ORLM.

NOTE: Make sure that the ORLM has been energized for at least 10 minutes to ensure stable performance before making measurements.

Step 2. Set the ORLM in optical return loss mode. Refer to the manufacturer's instructions for additional information.

Step 3. Select the 1310-nanometer wavelength (if the ORLM can perform return loss measurements at multiple wavelengths).

Step 4. If necessary, attach an ORLM interface cable to the optical receptacle of the ORLM. An interface cable is necessary if the connection to the ORLM does not match the connector type of the applicable MQJ.

Step 5. Select the applicable input MQJ from table 6K1-II, and, if necessary, connect the input MQJ to the ORLM interface cable using the hybrid adapter as shown on figure 6K1-1.

NOTE: If the ORLM input port accepts the applicable MQJ in accordance with 499-6877804, connect the input MQJ directly to the ORLM.

NOTE: Do not connect the input MQJ to the optical fiber cable assembly under test. This connection is not completed until step 10.

TABLE 6K1-II. MQJ selection for cable assembly return loss measurements.

| Termination on cable end under test | Fiber polish type | Select MQJ part number |
|---|---|---|
| M83522 | SM (enhanced) | 6877804-5SME |
| COTS ST (A-A-59940/3) | SM (enhanced) | 6877804-5SME |
| COTS SC (A-A-59940/2) 1/ | SM (enhanced) | 6877804-5SME |
| COTS LC (A-A-59940/1) | SM (enhanced) | 6877804-14SME |
| MIL-PRF-28876 4 CH plug | SM (enhanced) | 6877804-8SME |
| MIL-PRF-28876 4 CH receptacle | SM (enhanced) | 6877804-7SME |
| MIL-PRF-28876 8 CH plug | SM (enhanced) | 6877804-10SME |
| MIL-PRF-28876 8 CH receptacle | SM (enhanced) | 6877804-9SME |
| MIL-PRF-28876 31 CH plug | SM (enhanced) | 6877804-13SME |
| MIL-PRF-28876 31 CH receptacle | SM (enhanced) | 6877804-12SME |
| MIL-PRF-64266 | SM (enhanced) | ST to MIL-PRF-64266 Test Terminus MQJ |
| Other 2/ | SM (enhanced) | |

NOTES:

1/ Use the ST-to-ST MQJ with a ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

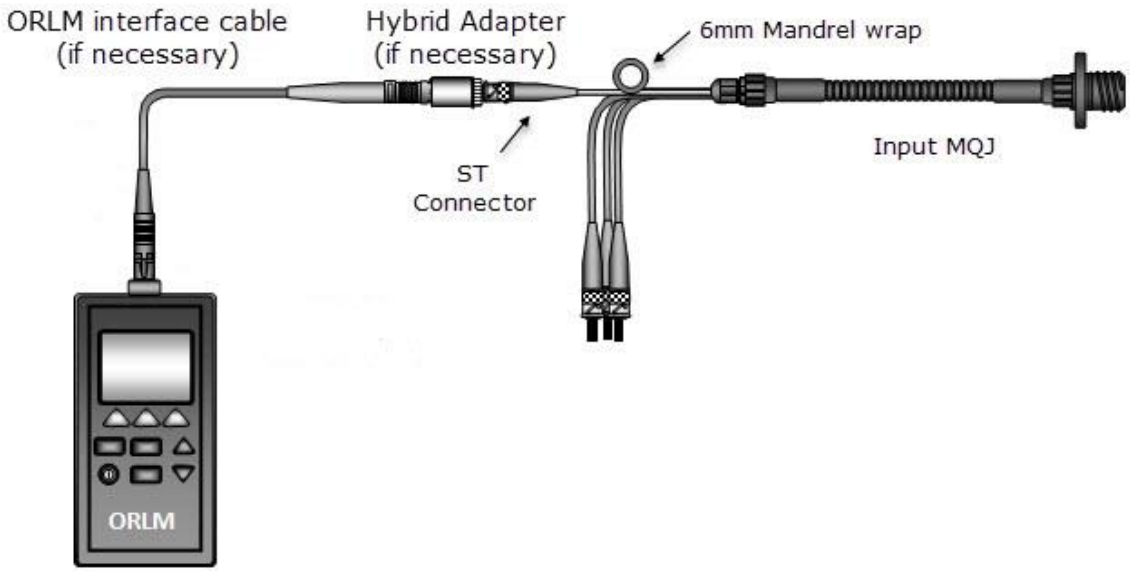


FIGURE 6K1-1. ORLM reference setup (typical).

Step 6. Wrap the input MQJ (or the appropriate single fiber cable of the input MQJ) around a 6-millimeter (0.25-inch) mandrel.

NOTE: The input MQJ (or the appropriate single fiber cable of the input MQJ) should be wrapped around the mandrel until a stable value greater than 30 dB is indicated on the ORLM display. Ten mandrel wraps are usually sufficient to obtain a stable value.

NOTE: When measuring enhanced polish products, a stable value greater than 40 dB should be indicated on the ORLM display.

Step 7. Reference the ORLM. Refer to the manufacturer's instructions for additional information.

Step 8. Unwrap the input MQJ from the mandrel.

NOTE: Do not unwrap the MQJ from the mandrel until the referencing process is complete.

Step 9. Verify that the ORLM is displaying a value between 14.3 dB and 15.9 dB.

NOTE: If a different value is displayed, reconnect the ORLM interface cable to the input MQJ and repeat steps 6, 7, 8, and 9. If this does not remedy the problem, clean the ORLM interface cable and the input MQJ connections, and repeat steps 4 through 9.

Step 10. Connect the appropriate end of the optical fiber cable assembly under test to the input MQJ.

CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For return loss measurements of assemblies with MIL-PRF-64266 connectors, use of test terminus adapters in accordance with table 6K1-I are necessary.

NOTE: For optical fiber cable assemblies under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the input MQJ to the optical fiber cable assembly under test. For optical fiber cable assemblies under test terminated with COTS SC, a hybrid adapter is required to connect the input MQJ to the optical fiber cable assembly under test.

Step 11. Select the applicable output MQJ from table 6K1-II, and connect the output MQJ to the other end of the optical fiber cable assembly under test as shown on figure 6K1-2.

CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For return loss measurements of assemblies with MIL-PRF-64266 connectors, use of test terminus adapters in accordance with table 6K1-I are necessary.

NOTE: For optical fiber cable assemblies under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the output MQJ to the optical fiber cable assembly under test. For optical fiber cable assemblies under test terminated with COTS SC, a hybrid adapter is required to connect the output MQJ to the optical fiber cable assembly under test.

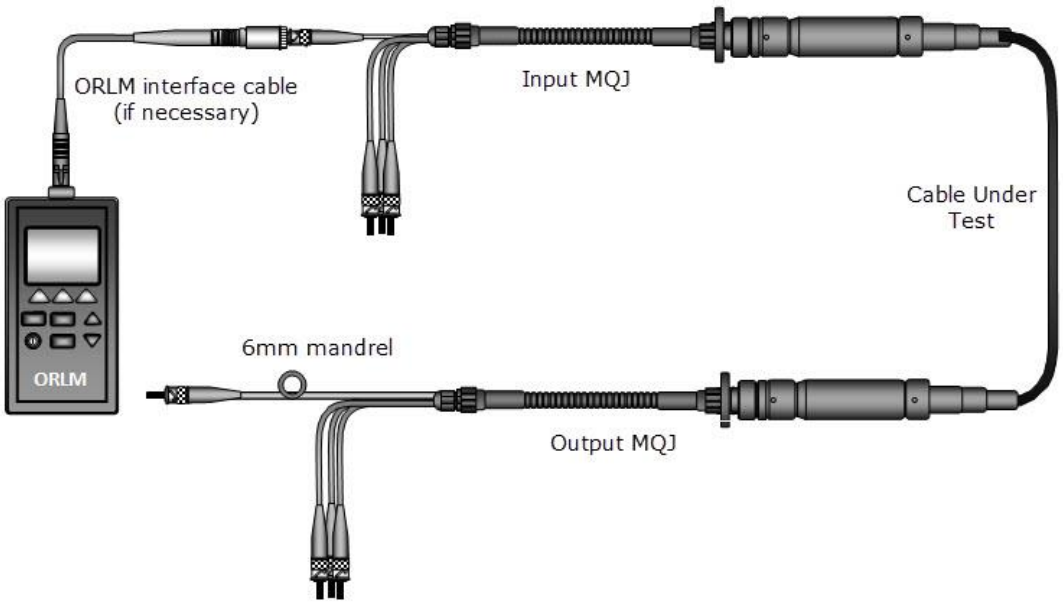


FIGURE 6K1-2. ORLM cable assembly measurement setup (typical).

Step 12. Wrap the output MQJ (or the appropriate single fiber cable of the output MQJ) around a 6-millimeter (0.25 inch) mandrel.

NOTE: The output MQJ (or the appropriate single fiber cable of the output MQJ) should be wrapped around the mandrel until a stable value is indicated on the ORLM display. Ten mandrel wraps are usually sufficient to obtain a stable value.

Step 13. Record the value displayed by the ORLM.

Step 14. Unwrap the output MQJ from the mandrel.

NOTE: Do not unwrap the MQJ from the mandrel until the return loss value has been recorded.

Step 15. Repeat the test for each fiber in the optical fiber cable assembly.

NOTE: If the optical fiber cable assembly under test is terminated with single fiber connectors on the input side, disconnect the input MQJ from the cable assembly under test. Repeat steps 9 through 15 for the other fibers in the optical fiber cable assembly under test.

NOTE: If the optical fiber cable assembly under test is terminated with multi-fiber connectors on the input side, disconnect the optical fiber cable assembly under test and the ORLM interface cable from the input MQJ. Repeat steps 5 through 15 for the other fibers in the optical fiber cable assembly under test.

Step 16. Proceed to 4.3.

4.3 Cable assembly return loss. The following steps shall be performed:

Step 1. Verify the measured return loss is not less than the value identified in table 6K1-III.

NOTE: The optical fiber cable assembly is considered acceptable if the measured return loss is greater than or equal to the minimum cable assembly return loss. If the measured return loss is acceptable, proceed to step 3. If the measured return loss is less than the minimum cable assembly return loss, proceed to step 2.

TABLE 6K1-III. Minimum cable assembly return loss.

| Termination process | Minimum cable assembly return loss |
|---|---|
| Domed polish, standard | 30 dB |
| Domed polish, enhanced | 40 dB |

Step 2. Disconnect and clean all the connections and retest. If the measured cable assembly return loss is still unacceptable, re-polish the optical fiber cable assembly terminations or replace the defective components and retest. Where the cable assembly has already passed cable assembly loss testing, use of ultrafine paper for re-polish operation is recommended.

Step 3. If the optical fiber cable assembly is not going to be immediately connected to its mating connectors, install dust covers over the optical fiber cable assembly connectors.

METHOD 6L1
CABLE TOPOLOGY END-TO-END RETURN LOSS TEST

1 SCOPE

1.1 Scope. This method describes procedures for performing a cable topology return loss test on FOCT links. Optical return loss testing of FOCT links is performed only on single mode optical fiber cable.

2. DOCUMENTS APPLICABLE TO METHOD 6L1

2.1 General. The documents listed in this section are specified in Method 6L1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6L1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

| | | |
|---|---|---|
| A-A-59940 | - | Connectors, Fiber Optic, Single or Multiple Fiber, General Specification for |
| A-A-59940/1 | - | Connectors, Fiber Optic, Single Fiber, Small Form Factor, LC Type |
| A-A-59940/2 | - | Connectors, Fiber Optic, Single Fiber, SC Type |
| A-A-59940/3 | - | Connectors, Fiber Optic, Single Fiber, ST Type |

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-64266 | - | Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for |
| MIL-PRF-64266/32 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Plug Style, for use with a Connector Receptacle |
| MIL-PRF-64266/33 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Test Terminus Adapter, Receptacle Style, for use with a Connector Plug |
| MIL-DTL-83522 | - | Connectors, Fiber Optic, Single Ferrule, General Specification for |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) DRAWINGS

499-6877804 - Jumpers, Test Equipment, Fiber Optic

(Copies of this document are available online at https://199.208.213.105/webjedmics/index.jsp. To request an NSEDR account for drawing access, send an email to NNSY_JEDMICS_NSEDR_HELP_DESK@navy mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6L1-I shall be used to perform these procedures. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6L1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TS-0006 | ORLM | 1 |
| | ORLM interface cable | As required |
| TS-0009 | ST-to-ST adapter | As required |
| | Hybrid adapter, ST-to-SC (AMP 503638-2, or equal [see 4.7]) | As required |
| | Test terminus adapter (MIL-PRF-64266/32 or MIL-PRF-64266/33) | As required |
| | MQJ cables (499-6877804) | As required |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| TL-0013 | Canned air or compressed air | As required |
| | Dust covers | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

## 4. PROCEDURE

4.1 Safety summary. The following safety precautions shall be observed:

a. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

4.2 Procedure. The following steps shall be performed:

CAUTION: Throughout the testing process, cleanliness is critical to obtaining a correct optical measurement. Make sure that your hands and the work area are as clean as possible to minimize the ingress of dirt into the connector parts.

WARNING: When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED. Light may not be visible but can still damage the eye.

NOTE: Ensure the test equipment calibration is current.

NOTE: Use a wipe dampened with alcohol to clean the adapters and wipe them dry with a clean, lint-free, 100 percent cotton cloth before making the connections.

NOTE: During execution of this method, all connectors shall be inspected/cleaned in accordance with Method 6M1 before being mated to other connectors or test equipment.

NOTE: This procedure involves the use of MQJs. Dirty or defective MQJs will lead to high or unacceptable end-to-end return loss values. MQJs used in these procedures should be clean and should be of known quality. Test organizations are encouraged to institute an MQJ verification program in which the quality of MQJs is regularly validated (see Method 6F1). Additional guidance on establishing an MQJ verification program can be obtained from NSWCDD (see 6.4).

NOTE: Make sure of the specified return loss for the link under test. Use standard dome polish MQJs for testing of links with return loss requirements not less than 30 dB. Use enhanced dome polish MQJs for testing of links with return loss requirements not less than 40 dB.

Step 1. Energize the ORLM.

NOTE: Make sure that the ORLM has been energized for at least 10 minutes, to ensure stable performance, before making measurements.

Step 2. Set the ORLM in optical return loss mode. Refer to the manufacturer's instructions for additional information.

Step 3. Select the 1310-nanometer wavelength (if the ORLM can perform return loss measurements at multiple wavelengths).

Step 4. If necessary, attach an ORLM interface cable to the optical receptacle of the ORLM. An interface cable is necessary if the connection to the ORLM does not match the connector type of the applicable MQJ.

Step 5. Connect one end of the MQJ to the end of the cable assembly under test in the direction from the network equipment transmitter (optical source) to the network equipment receiver (detector).

Step 6. Select the applicable input MQJ from table 6L1-II, and, if necessary, connect the input MQJ to the ORLM interface cable using the hybrid adapter as shown on figure 6L1-1.

NOTE: If the ORLM input port accepts the applicable MQJ in accordance with 499-6877804, connect the input MQJ directly to the ORLM.

NOTE: Do not connect the input MQJ to the FOCT link under test. This connection is not completed until step 11.

TABLE 6L1-II. MQJ selection for cable topology end-to-end return loss measurements.

| Termination on FOCT link end | Fiber polish type | Select MQJ part number |
|---|---|---|
| M83522 | SM (enhanced) | 6877804-5SME |
| COTS ST (A-A-59940/3) | SM (enhanced) | 6877804-5SME |
| COTS SC (A-A-59940/2) 1/ | SM (enhanced) | 6877804-5SME |
| COTS LC (A-A-59940/1) | SM (enhanced) | 6877804-14SME |
| MIL-PRF-28876 4 CH plug | SM (enhanced) | 6877804-8SME |
| MIL-PRF-28876 4 CH receptacle | SM (enhanced) | 6877804-7SME |
| MIL-PRF-28876 8 CH plug | SM (enhanced) | 6877804-10SME |
| MIL-PRF-28876 8 CH receptacle | SM (enhanced) | 6877804-9SME |
| MIL-PRF-28876 31 CH plug | SM (enhanced) | 6877804-13SME |
| MIL-PRF-28876 31 CH receptacle | SM (enhanced) | 6877804-12SME |
| MIL-PRF-64266 | SM (enhanced) | ST to MIL-PRF-64266 test terminus MQJ |
| Other 2/ | SM (enhanced) | |

NOTES:

1/ Use the ST-to-ST MQJ with an ST-to-SC hybrid adapter to connect to optical fiber cable ends terminated with SC connectors.

2/ For COTS connectors that cannot be mated to an ST-to-ST MQJ using an ST-to-SC hybrid adapter, non-standard MQJs may be used.

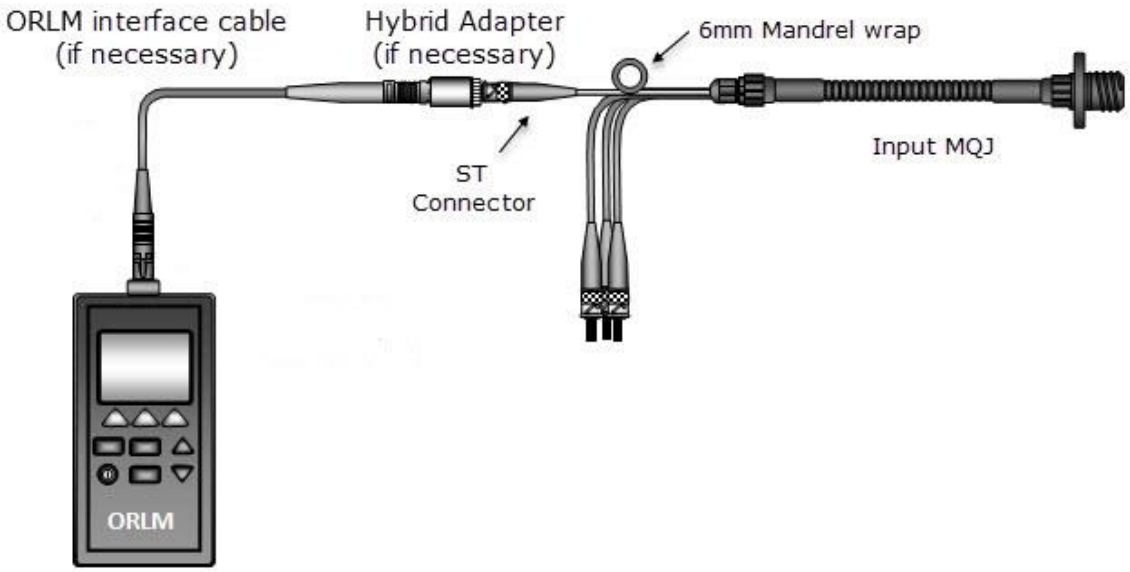


FIGURE 6L1-1. ORLM reference setup (typical).

Step 7. Wrap the input MQJ (or the appropriate single fiber cable of the input MQJ) around a 6-millimeter (0.25-inch) mandrel.

NOTE: The input MQJ (or the appropriate single fiber cable of the input MQJ) should be wrapped around the mandrel until a stable value greater than 30 dB is indicated on the ORLM display. Ten mandrel wraps are usually sufficient to obtain a stable value.

NOTE: When measuring enhanced polish products, a stable value greater than 40 dB should be indicated on the ORLM display.

Step 8. Reference the ORLM. Refer to the manufacturer's instructions for additional information.

Step 9. Unwrap the input MQJ from the mandrel.

NOTE: Do not unwrap the MQJ from the mandrel until the referencing process is complete.

Step 10. Verify that the ORLM is displaying a value between 14.3 dB and 15.9 dB.

NOTE: If a different value is displayed, reconnect the ORLM interface cable to the input MQJ and repeat steps 7, 8, 9, and 10. If this does not remedy the problem, clean the ORLM interface cable and the input MQJ connections, and repeat steps 5 through 10.

Step 11. Connect the appropriate end of the FOCT link under test to the input MQJ.

CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For return loss measurements of assemblies with MIL-PRF-64266 connectors, use of test terminus adapters in accordance with table 6L1-I are necessary.

NOTE: For FOCT links under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the input MQJ to the FOCT link under test. For FOCT links under test terminated with COTS SC, a hybrid adapter is required to connect the input MQJ to the FOCT link under test.

Step 12. Select the applicable output MQJ from table 6L1-II, and connect the output MQJ to the other end of the FOCT link under test as shown on figure 6L1-2.

CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-PRF-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

NOTE: For return loss measurements of assemblies with MIL-PRF-64266 connectors, use of test terminus adapters in accordance with table 6L1-I is necessary.

NOTE: For optical fiber cable assemblies under test terminated with M83522 or COTS ST connectors, an ST-to-ST adapter is required to connect the output MQJ to the optical fiber cable assembly under test. For optical fiber cable assemblies under test terminated with COTS SC, a hybrid adapter is required to connect the output MQJ to the optical fiber cable assembly under test.

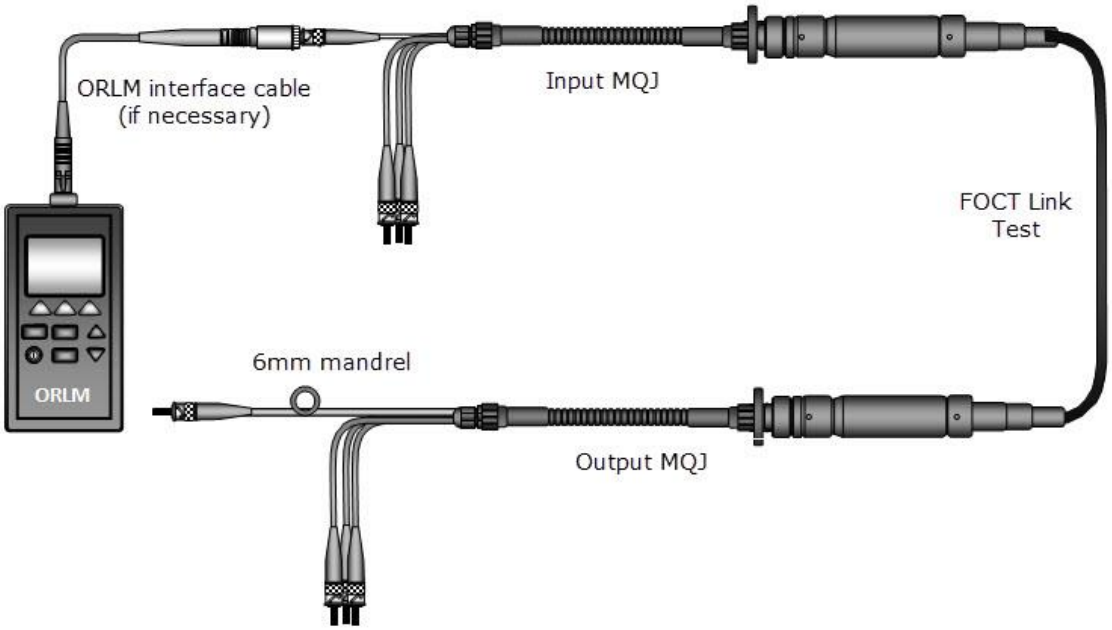


FIGURE 6L1-2. ORLM cable topology end-to-end measurement setup (typical).

Step 13. Wrap the output MQJ (or the appropriate single fiber cable of the output MQJ) around a 6-millimeter (0.25-inch) mandrel.

NOTE: The output MQJ (or the appropriate single fiber cable of the output MQJ) should be wrapped around the mandrel until a stable value is indicated on the ORLM display. Ten mandrel wraps are usually sufficient to obtain a stable value.

Step 14. Record the value displayed by the ORLM.

Step 15. Unwrap the output MQJ from the mandrel.

NOTE: Do not unwrap the MQJ from the mandrel until the return loss value has been recorded.

Step 16. Repeat the test for each fiber in the FOCT link under test.

NOTE: For each FOCT link, perform the return loss test on the source end of the cable assembly (i.e., the end on the cable assembly in the direction from the equipment transmitter [optical source] to the network equipment receiver [detector]).

NOTE: If the FOCT link under test is terminated with single fiber connectors on the input side, disconnect the input MQJ from the FOCT link under test. Repeat steps 10 through 16 for the other fibers in the FOCT link under test.

NOTE: If the FOCT link under test is terminated with multi-fiber connectors on the input side, disconnect the FOCT link under test and the ORLM interface cable from the input MQJ. Repeat steps 6 through 16 for the other fibers in the FOCT link under test.

Step 17. Proceed to 4.3.

4.3 Cable topology end-to-end return loss. The following steps shall be performed:

Step 1. Verify the measured return loss is less than the value identified in installation drawings.

NOTE: The FOCT link is considered acceptable if the measured return loss is greater than or equal to the specified FOCT link return loss. If the measured return loss is acceptable, proceed to step 3. If the measured return loss is less than the specified FOCT link return loss, proceed to step 2.

Step 2. Disconnect and clean all the connections and retest. If the measured FOCT link return loss is still unacceptable, re-polish the FOCT link terminations or replace the defective components and retest. Where the FOCT link has already passed end-to-end loss testing, use of ultrafine paper for re-polish operation is recommended.

Step 3. If the ends of the FOCT link are not going to be immediately connected to their mating connectors, install dust covers over the FOCT link connectors.

# METHOD 6M1
# FIBER OPTIC CONNECTOR INSPECTION AND CLEANING (INBOARD ONLY)

## 1 SCOPE

1.1 Scope. This method describes the procedures for manual inspection and cleaning of ferrule endfaces for both single fiber, single ferrule connectors, and each terminus in a fiber optic, multi-terminus connector. The procedures described herein use hand cleaning procedures in lieu of automated cleaning devices. The criteria defining a clean condition with respect to the ferrule endface are covered in 4.2.1 and 4.2.2 of this method.

## 2. DOCUMENTS APPLICABLE TO METHOD 6M1

2.1 General. The documents listed in this section are specified in Method 6M1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 6M1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

| | | |
|---|---|---|
| MIL-PRF-28876 | - | Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for |
| MIL-PRF-29504/14 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors) |
| MIL-PRF-29504/15 | - | Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors) |

DEPARTMENT OF DEFENSE STANDARDS

| | | |
|---|---|---|
| MIL-STD-2042-5 | - | Fiber Optic Topology Installation Standard Methods for Surface Ships and Submarines (Connectors and Interconnections)(Part 5 of 7 Parts) |

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, 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. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 6M1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 6M1-I. Equipment and materials.

| Reference # | Description | Quantity |
|---|---|---|
| TS-0007<br>TS-0008 | Optical microscope, 400× or<br>Fiber Optic Video Inspection System (FOVIS) Kit with probe tips, case, and standard barrel adapter | 1 |
| TL-0016 | Wipes (if not using pre-wetted alcohol pads) | As required |
| TL-0002 or<br>TL-0044 | Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed | 1 |
| | Dispenser, solvent, 4 oz., leak proof (for alcohol) (NSN 8125-01-439-5367, or equal [see 4.7]) | 1 |
| TL-0042 or<br>TL-0043 | Alignment sleeve insertion and removal tool (ceramic termini) | 1 |
| TL-0139 | Cleaning swab, exposed cylindrical ferrule endfaces | As required |
| TL-0141 | Cleaning swab, 1.25 mm (0.049 inch) exposed tip | As required |
| TL-0140 | Cleaning swab, 2.5 mm (0.098 inch) exposed tip | As required |
| TL-0142 | Cleaning swab, 2.0 mm (0.079 inch) exposed tip | As required |
| TL-0138 | Mechanical cleaner (click clean), for use with 2.0 mm M29504 ferrule in 28876 “IBC M20” | As required |
| | Connector cleaning tape cassette, reel cleaner type (OptiPOP R, or equal [see 4.7]) | As required |
| | Replacement cleaning tape (OptiPOP ATC-RS-01, or equal [see 4.7]) | As required |
| NOTE: Products to be considered for addition to the recommended tool or test equipment shall be approved, as specified (see 6.4). | | |

NOTE: Probe tips come in different configurations. Patch cord probe tips are defined as any tip inserted directly onto the ferrule of the connector or terminus. For a socket terminus, the patch cord probe tip is placed onto the surface of the connector insert cavity or socket terminus alignment sleeve. Bulkhead adapter probe tips are placed into a connector adapter (such as an ST-to-ST adapter), a test probe adapter, or the equipment interface port (such as the equipment LC connector interface port).

NOTE: The 2.0 millimeter probe tips can also be used to inspect the MIL-PRF-28876 test probe (the MIL-PRF-28876 test probe is used with the MIL-PRF-28876 test probe adapter).

NOTE: Because the fiber optic video inspection system (FOVIS) is limited to 200× magnification, it may not provide sufficient resolution to inspect for all types of connector endface damage.

4. PROCEDURES

NOTE: Automated inspection of fiber optic single fiber, single ferrule connectors, and multi-terminus connectors may be permitted if equipment and cleanliness metrics are approved by NSWCDD (see 6.5).

4.1 Safety summary. The following safety precautions shall be observed:

a. When visually inspecting an optical fiber, do not stare into the end of a fiber connected to a laser source or LED.

b. Observe warnings and cautions on equipment and materials.

c. Deactivate the system or unplug both ends of cable assembly to be inspected prior to viewing the terminus endface to avoid potential exposure to transmitted light and possible eye injury.

4.2 Fiber optic connector inspection and cleaning process. The following steps provide the process for inspecting fiber optic connectors and termini. The following steps shall be performed:

Step 1. Identify the fiber optic connector or multi-terminus connector mated pair to be inspected.

Step 2. Disconnect the fiber optic connector or multi-terminus connector mated pair.

NOTE: Place clean dust covers over the fiber optic ferrules or multiple terminus connectors to prevent contamination or damage. Details on cleaning dust covers are specified in 4.4.

Step 3. Using the flowchart shown in figure 6M1-1, perform the steps required to inspect and clean the selected mated pair.

NOTE: For single fiber, single ferrule connectors such as the ST, SC, FC, and LC, see 4.2.2.1.

NOTE: For multi-terminus connectors such as the MIL-PRF-28876 and MIL-PRF-64266, see 4.2.2.2.

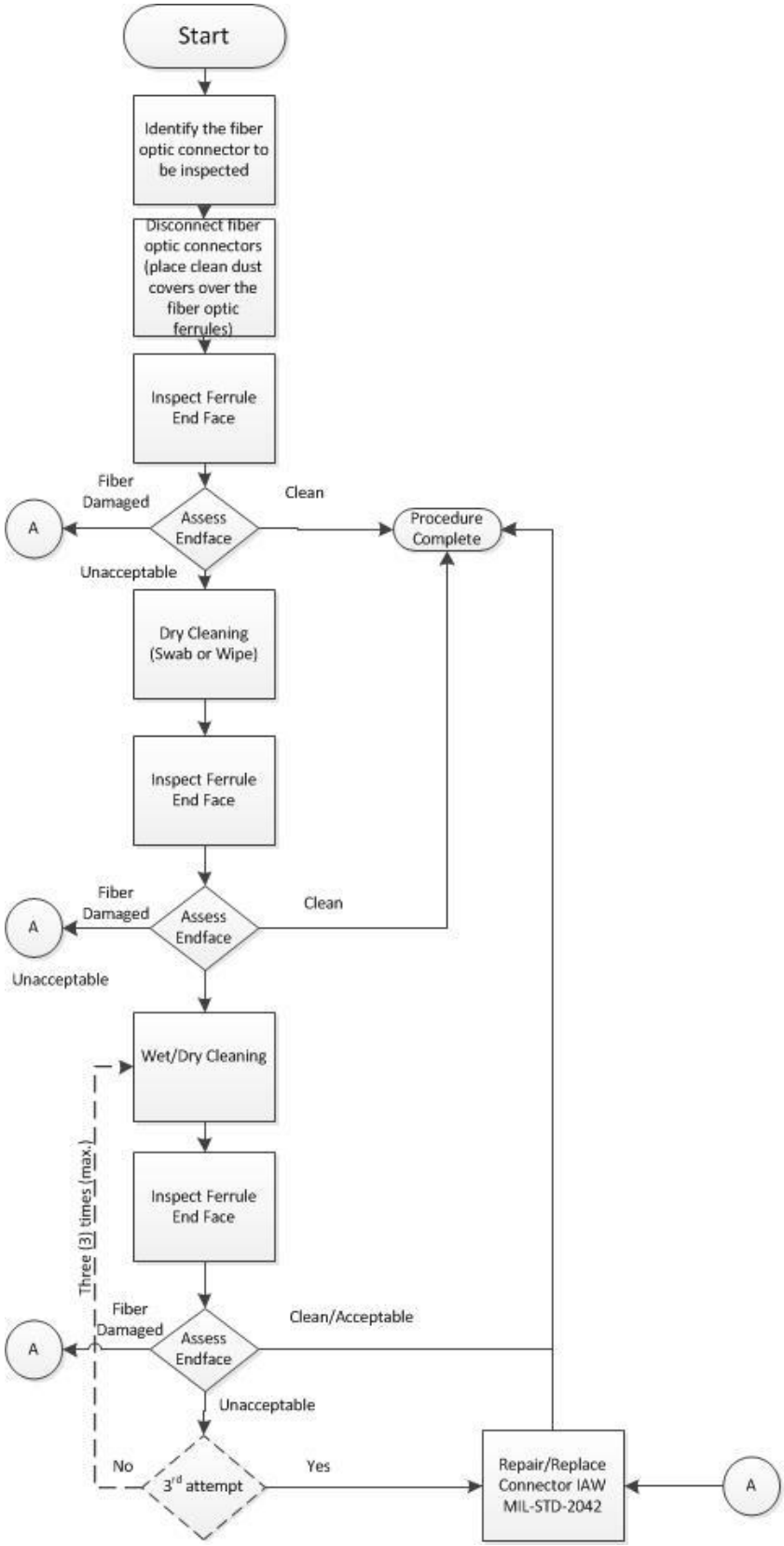


FIGURE 6M1-1. Inspection and cleaning flowchart.

4.2.1 Definitions for criteria of cleanliness. Definitions for criteria of cleanliness are as follows (when viewing through a 400× handheld optical microscope):

a. Contaminant: Any visible substance (liquid or solid) that has deposited on the endface surface of the single fiber, single ferrule connector, or termini.

b. Damage: Any visible defect on the endface surface of the single fiber, single ferrule connector, or termini.

4.2.2 Criteria for categorizing the level of cleanliness. The criteria for categorizing the level of cleanliness are as follows (when viewing through a 400× handheld optical microscope):

a. Clean: no contaminants or damage are visible on the endface of the single fiber, single ferrule connector, or termini.

b. Acceptable: all of the following shall be true:

(1) No contaminants or damage are visible on the core or the cladding region of the fiber in the single fiber, single ferrule connector, or termini.

(2) Contaminants or damage visibly exist on the ceramic endface (excluding fiber) that three attempts cannot remove, change, or relocate.

(3) Contaminants that visibly exist on the ceramic endface (excluding fiber) cannot migrate onto the core or cladding region of the fiber.

d. Unacceptable: any condition that fails to meet “clean” or “acceptable” as defined above. An inspection classified as unacceptable requires a repair or replacement of the single fiber, single ferrule connector, or termini.

4.2.2.1 Single fiber, single ferrule connector inspection and cleaning process. The following provides the procedure for inspecting and cleaning single fiber, single ferrule fiber optic connectors. The following steps shall be performed:

Step 1. Using a 400× handheld optical microscope, inspect the selected connector.

Step 1.1. Alternate Method: The FOVIS with the 2.5-millimeter probe tip can be used to inspect FC, SC, and ST connectors. If LC connectors are to be inspected, the 1.25-millimeter probe tip should be used.

a. If the endface condition of the connector is clean and not damaged, the procedure is complete for the selected connector. Proceed to step 7.

b. If the endface condition is not clean and not damaged, proceed to step 2.

c. If the endface condition is visibly damaged, refer to MIL-STD-2042-5 to repair or replace the connector.

Step 2. Using a dry, lint-free wipe, wipe the connector endface to clean off the contaminants from the connector.

Step 2.1. Alternate Method: using a Reel Cleaner (or equal [see 4.7]), wipe the connector endface on an unused section of the cartridge tape. Make only one pass with the connector and only apply light pressure.

NOTE: It may be necessary to advance the cartridge in order to expose an unused section of the cleaner tape.

Step 3. Using a 400× handheld optical microscope, (see step 1.1), inspect the selected connector.

a. If the endface condition of the connector is clean and not damaged, the procedure is complete for the selected connector. Proceed to step 7.

b. If the endface condition is not clean and not damaged, proceed to Step 4.

c. If the endface condition is visibly damaged, refer to MIL-STD-2042-5 to repair or replace the connector.

Step 4. Using a lint-free wipe dampened with 99-percent alcohol, wipe the connector endface to clean the contaminants off of the connector.

Step 5. Using a dry lint-free wipe, wipe the connector endface to dry the exposed area.

Step 5.1. Alternate Method: Using a Reel Cleaner (or equal [see 4.7]), wipe the connector endface on an unused section of the cartridge tape to dry the exposed area. Make only one pass with the connector and only apply light pressure.

NOTE: It may be necessary to advance the cartridge in order to expose an unused section of the cleaner tape.

Step 6. Using a 400× handheld optical microscope (see step 1.1), inspect the selected connector.

a. If the endface condition of the connector is clean and not damaged, the procedure is complete for the selected connector. Proceed to step 7.

b. If the endface condition is not clean, repeat steps 4 and 5.

NOTE: Steps 4 and 5 can be performed for a maximum of three attempts.

c. If after three attempts the microscope is showing that the cleaning process is not effective, assess the connector against the "acceptable" criteria found herein. If the connector is found to be "acceptable", proceed to step 7. If connector is found to be "unacceptable", refer to MIL-STD-2042-5 to repair or replace connector.

NOTE: Inspect and clean other connectors in the cable assembly according to the procedures contained herein prior to testing the cable assembly.

Step 7. Place clean dust cap on clean connector. Refer to 4.4 for the process to clean dust covers.

Step 8. Repeat steps 1 through 7 for the mating connector that was selected.

Step 9. Proceed to 4.3 to clean the alignment sleeve of the connector adapter.

Step 10. Remove dust covers from connectors and re-mate connectors using the connector adapter.

NOTE: Do not mate connectors until both connectors and the alignment sleeve have been inspected and cleaned. Failure to do so will result in contamination of the already-cleaned connectors and alignment sleeves.

4.2.2.2 Multi-terminus connector inspection and cleaning process. The following provides the procedure for inspecting and cleaning termini while they remain installed (i.e., pinned) within their respective multi-terminus connectors. The following steps shall be performed:

FIGURE 6M1-2. Example fiber optic video inspection system.

Step 1. Using an approved FOVIS as shown on figure 6M1-2, inspect the termini contained within the selected connector with the attached probe.

NOTE: When inspecting the ferrule endface, ensure the correct inspection tip is used.

a. If the endface conditions of the termini within the connector are clean and not damaged, the procedure is complete. Proceed to step 7.

(1) When inspecting MIL-PRF-29504/15 termini, it may be necessary to use the alignment sleeve insertion and extraction tool to extricate the alignment sleeves so that inspection can occur.

NOTE: Exercise caution when handling the alignment sleeves so that contamination is not introduced. As a precaution, it is recommended that the alignment sleeves be cleaned in accordance with 4.3.

(2) If the endface condition is not clean, proceed to step 2.

(3) If the terminus endface is clean but damaged, refer to MIL-STD-2042-5 to repair or replace the connector.

Step 2. Using a dry lint-free swab, wipe the connector endface(s) to clean off the contaminants from the connector.

NOTE: For 2-millimeter ferrules (e.g., MIL-PRF-29504/14 and /15 termini with alignment sleeves detached), the 2-millimeter cleaning swabs are recommended.

NOTE: If the alignment sleeves on the MIL-PRF-29504/15 socket termini are still attached, the 1.25-millimeter cleaning swabs are recommended.

NOTE: Because the MIL-PRF-29504/14 and /15 termini do not have an anti-rotation design, do not use a twisting or circular motion while cleaning. Wipe with one straight-line movement across the terminus endface. To clean MIL-PRF-29504/15 socket termini with the alignment sleeves attached, use a straight-on dabbing motion in lieu of the single, crosswise wiping motion across the endface. When cleaning socket termini with alignment sleeves attached, no angular deviation (i.e., bending) of the cleaning swab from the projected centerline of the ferrule should be introduced during the dabbing motion to avoid flexing, and possible breakage, of the ceramic member within the alignment sleeve.

NOTE: For MIL-PRF-64266 connectors, the 1.25-millimeter cleaning swabs are recommended.

NOTE: Do not repeatedly wipe with the same section of the swab. Dirt that has been picked up by the swab can be transferred back to the terminus.

NOTE: Fiber optic swabs are of a low-lint design. Care must be exercised to avoid contaminating them with any particulates or unintended fluids before they are used. Once taken out of the storage package, the cleaning tip end must not contact anything other than the ferrule endface to be cleaned.

NOTE: Use one swab per ferrule, and then discard.

NOTE: Apply light pressure when using the cleaning swab to clean the ferrule endface. Light pressure minimizes the risk of scratching the endface by dragging a hard particle across the endface of the terminus.

Step 3. Using the FOVIS with the appropriate probe tip installed, inspect each terminus contained within the multi-terminus connector.

a. If the endface condition of the terminus is clean and not damaged, continue with the inspection of the other termini within the multi-terminus connector. When complete, proceed to step 7.

b. If the endface condition is still not clean, proceed to step 4.

c. If the endface condition is visibly damaged, refer to MIL-STD-2042-5 to repair or replace the connector.

Step 4. Using a lint-free swab dampened with 99-percent alcohol, wipe the connector endface to clean off the contaminants (refer to the notes in step 2).

Step 5. Using a dry lint-free swab, wipe the terminus endface dry in the alcohol-exposed region (refer to the notes in step 2).

Step 6. Using the FOVIS with the appropriate probe tip installed, inspect the cleaned terminus:

a. If the endface condition of the terminus is clean and not damaged, the procedure is complete for the selected terminus. Proceed to step 8. If a MIL-PRF-28876 receptacle is being inspected and cleaned, proceed to step 7.

b. If the endface condition is not clean, repeat steps 3 through 5.

NOTE: Steps 3 through 5 can be performed for a maximum of three attempts.

c. If after three attempts the FOVIS is showing that the cleaning process is not effective, perform the following activities. Assess the terminus against the "acceptable" criteria found herein. If the terminus is found to be "acceptable", proceed to step 7. If terminus is found to be "unacceptable," refer to MIL-STD-2042-5 to repair or replace the terminus.

NOTE: Inspect and clean other connectors in the cable assembly according to the procedures contained herein prior to testing the cable assembly.

Step 7. For MIL-PRF-28876 receptacles only, use the alignment sleeve insertion and extraction tool to re-insert the alignment sleeves back onto the termini after they have been cleaned. Refer to 4.3 for details regarding alignment sleeve cleaning.

NOTE: Exercise extreme caution when reinserting the alignment sleeves into the connector so that contaminants are not introduced to the termini or the alignment sleeves. As a precaution, it is recommended that the alignment sleeves be cleaned in accordance with 4.3 of this method.

Step 8. Place clean dust cap on clean connector. Refer to 4.4 for details regarding dust cap cleaning.

Step 9. Repeat steps 1 through 8 for other connector that was selected.

Step 10. Remove dust covers from connectors and re-mate connectors.

NOTE: Do not mate connectors until both of the connectors' termini and associated alignment sleeves have been inspected and cleaned. Failure to do so will result in contamination of the already-cleaned termini and alignment sleeves.

NOTE: Prior to re-mating, observe the keying arrangements of the connectors to properly align and the plug with the receptacle.

4.3 Fiber optic alignment sleeve cleaning process. The following provides the procedure for cleaning fiber optic alignment sleeves. The following steps shall be performed:

Step 1. Using a swab dampened with 99-percent alcohol, insert the swab into the alignment sleeve.

NOTE: For 2.5-millimeter alignment sleeves, the 2.5-millimeter cleaning swab is recommended.

NOTE: For 2.0-millimeter alignment sleeves, the 2.0-millimeter cleaning swab is recommended.

NOTE: For 1.25-millimeter alignment sleeves, the 1.25-millimeter cleaning swab is recommended.

Step 2. Rotate swab 10 times in a clockwise or counterclockwise direction while moving the swab back-and-forth within the sleeve.

NOTE: Once a direction is chosen in which to rotate the swab inside the alignment sleeve, maintain the same direction of rotation until the swab has been rotated 10 times.

a. Inspect the inside of the alignment sleeve for debris that could contaminate the ferrule endfaces when mated and re-clean as necessary.

Step 3. Discard the cleaning swab after use to prevent cross-contaminating other alignment sleeves.

Step 4. Inspect the alignment sleeve for damage that could cause misalignment of the connectors.

a. Replace connector adapter (for single terminus connectors) or alignment sleeve (for multi-terminus connectors) if damage is observed.

Step 5. Repeat steps 1 through 4 for the remaining alignment sleeves.

4.4 Fiber optic dust cap cleaning process. The following provides the method for cleaning fiber optic dust covers. For single terminus connector and adapter dust covers, see 4.4.1. For multi-terminus connector dust covers, see 4.4.2 of this method.

4.4.1 Single ferrule connector and adapter dust cover cleaning process. The following steps shall be performed:

Step 1. Identify the dust covers that need to be cleaned.

Step 2. Using a swab a dampened with 99-percent alcohol, insert the swab into the dust cover.

NOTE: For 2.5-millimeter ferrule dust covers, such as those used with FCs, SCs, and STs, the 2.5-millimeter cleaning swab is recommended.

NOTE: For 1.25-millimeter ferrule dust covers, such as those used with LCs, the 1.25-millimeter cleaning swab is recommended.

a. Rotate swab five times in a clockwise or counterclockwise direction while moving the swab back-and-forth within the cap.

NOTE: Once a direction is chosen in which to rotate the swab inside the alignment sleeve, maintain the same direction of rotation until the swab has been rotated five times.

Step 3. Using a dry swab, insert the swab into the dust cap to remove excess alcohol.

a. Inspect the inside of the dust cap for debris that could contaminate the ferrule endface when mated and re-clean as necessary.

Step 4. Place dust cap on dry wipe with the open-endface down to prevent the ingress of contaminants.

Step 5. Repeat steps 1 through 4 for remaining dust covers.

4.4.2 Multi-terminus connector dust cover cleaning process. The following steps shall be performed:

Step 1. Identify the dust covers that need to be cleaned.

Step 2. Using a wipe dampened with 99 percent alcohol, wipe the region of the dust cap that covers the connector.

Step 3. Using a dry wipe, wipe the region of the dust cap that covers the connector to remove excess moisture.

a. Inspect the inside of the dust cap for debris that could contaminate the termini endfaces when attached and re-clean as necessary.

Step 4. Place dust cap on dry wipe with the open-endface down to prevent the ingress of contaminants.

Step 5. Repeat steps 1 through 4 for remaining dust covers.

Preparing activity:
Navy – SH
(Project SESS-2014-010)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.