METRIC

MIL-STD-2042-6B(SH)
25 July 2002
SUPERSEDING
MIL-STD-2042-6A(SH)
29 September 1997
MIL-STD-2042-6(SH)
7 July 1993

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR NAVAL SHIPS (TESTS)

(PART 6 OF 7 PARTS)

AMSC N/A AREA GDRQ

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FOREWORD

1. This Department of Defense Standard Practice 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. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Department of the Navy, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue Southeast, Stop 5160, Washington Navy Yard, DC 20376-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

4. In order to provide flexibility in the use and update of the installation methods, this standard practice is issued in eight parts; the basic Standard practice 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

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1. SCOPE

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

1.1.1 Applicability. These criteria apply to installations on specific ships when invoked by the governing ship specification or other contractual document. They are intended primarily for new construction; however, they are also applicable for conversion or alteration of existing ships. Where there is a conflict between this document and the ship specification or contract, the ship specification or contract shall take precedence. Where ship design is such that the methods herein cannot be implemented, users shall submit new methods or modifications to existing methods for approval prior to implementation to: Department of the Navy, Naval Surface Warfare Center, Dahlgren Division, ATTN: Code B35, 17320 Dahlgren Road, Dahlgren, VA 22448-5100.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 and 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 documents cited in sections 3, 4 and 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 listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

FEDERAL SPECIFICATIONS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24623/4 - Splice, Fiber Optic, Housing, Fiber.

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

MIL-T-29504 - Termini, Fiber Optic Connector, Removable, General Specification for.

MIL-C-83522 - Connectors, Fiber Optic, Fixed Single Terminus, 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 Naval Ships (Cables)(Part 1 of 7 Parts).

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

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Documents Order Desk, 700 Robbins Ave, Building 4D, Philadelphia, PA, 19111-5094.)

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

DEPARTMENT OF DEFENSE DRAWINGS

NAVSEA Drawing - 6872811 Tool Kit, MIL-C-83522, Fiber Optic, Navy Shipboard.

- 6872812 Tool Kit, MIL-S-24623, Fiber Optic, Navy Shipboard.

- 6877804 Jumpers, Test Equipment, Fiber Optic.

- 7085185 Tool Kit, Fiber Optic, Navy, Submarine.

(Copies of documents should be obtained from the contracting activity or as directed by the contracting officer.)

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 the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

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

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018-3308.)

ELECTRONICS INDUSTRY ASSOCIATION/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

EIA/TIA-455-61 - Measurement of Fiber or Cable Attenuation Using an OTDR.

EIA/TIA-455-171 - Attenuation by Substitution Measurement for Short Length Multimode Graded Index and Single mode Optical Fiber Cable Assemblies.

EIA/TIA-440 - Fiber Optic Terminology.

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

(Application for copies should be addressed to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.4 Order of precedence. 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 practice are in accordance with EIA/TIA-440. Definitions for other terms as they are used in this standard practice are given in the following paragraphs.

3.2 Acronyms. The following acronyms are used in this standard practice:

BOF	Blown optical fiber
CPR	Coupled power ratio
FOCP	Fiber optic cable plant
FOCT	Fiber optic cable topology
FOICB	Fiber optic interconnection box
MQJ	Measurement quality jumper
TRB	Tube routing box

3.3 BOF bundle. A group of optical fibers within a special jacket that allows the entire bundle to be blown into a BOF tube.

3.4 BOF fiber. An optical fiber with a special coating that allows the fiber to be blown into a BOF tube.

3.5 BOF tube. A tube within a BOF cable through which optical fibers or optical fiber bundles are blown.

3.6 BOF tube coupler. A device used to join two BOF tubes together.

3.7 BOF tube routing box (TRB). An enclosure for holding BOF cables (trunk and local), BOF tubes (trunk and local), and BOF tube couplers to interconnect BOF tubes.

3.8 Concatenated optical link. A concatenated optical link is a link made up of two or more individual cable assemblies connected together in series.

3.9 End user equipment. Any cabinet, case, panel, or device that contains components that are either the origin or destination of an optical signal.

3.10 Fiber optic cable plant (FOCP). A subset of the FOCT that excludes local cables and their associated components. A conventional FOCP includes FOICBs, trunk cables and their associated connectors and splices. A BOF FOCP consists of FOICBs, TRBs, tube couplers, BOF trunk cables, BOF fibers, BOF bundles, tube furcation units and associated connectors and splices.

3.11 Fiber optic cable topology. An integrated optical fiber distribution system that provides the optical interconnection between end user equipments. A conventional FOCT includes the conventional FOCP components and outlet boxes, local cables and their associated connectors and splices. A BOF FOCT includes the BOF FOCP components, BOF cable furcations, local conventional cables, local tube cables, and associated connectors and splices.

3.12 Fiber optic interconnection box (FOICB). An enclosure for holding optical fiber cable (BOF and conventional), BOF tubes, tube furcation units, and optical fiber splices, connectors and adapters.

3.13 Local cable.

3.13.1 Local conventional cable. A conventional optical fiber cable that runs between an end user equipment and an FOICB (or outlet box), or between an FOICB and an outlet box.

3.13.2 Local BOF cable. A BOF cable that runs between end user equipment and a TRB, or between a TRB and an outlet box.

3.14 Measurement quality jumper (MQJ). A jumper cable that is of high optical quality, is highly repeatable in successive connections, and is consistent with other measurement quality jumpers in connections.

3.15 Optical fiber cable. A cable that contains optical fibers.

3.15.1 BOF cable. A cable that contains one or more BOF tubes through which BOF fibers or BOF fiber bundles are blown.

3.15.2 Conventional optical fiber cable. An optical fiber cable in which the optical fiber is an integral part of the cable and is installed during the cable manufacturing process.

3.16 Optical fiber cable component (OFCC). A buffered fiber augmented with a concentric layer of strength members and an overall jacket.

3.17 Outlet box. A small termination box used to break out a local cable from an FOICB or TRB to one or more end user equipments within a compartment or area.

3.18 Trunk cable. An optical fiber cable that runs between two FOICBs. Typically, trunk cables are run in the main cableways and have higher fiber counts per cable than local cables.

3.18.1 Conventional trunk cable. A conventional optical fiber cable that runs between two FOICBs.

3.18.2 BOF trunk cable. A single BOF cable connected between two FOCP TRBs or between a FOCP TRB and a FOCP FOICB. A BOF trunk cable contains multiple BOF trunk tubes.

4. GENERAL REQUIREMENTS

4.1 Test methods. The test methods identified in this standard practice shall be used to verify the proper operation and performance of the components that make up the FOCT (see 3.11). These tests shall be performed during various phases of installation of the FOCT, as described in the following paragraphs.

4.1.1 Acceptance tests. Conventional optical fiber cable, 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 should 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 of 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.

4.2.2 Optical power meter and stabilized light source. The optical power meter and stabilized light source (for example, 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 Measurement quality jumpers. MQJs are required for connecting optical fiber cable assemblies or links to test equipment. Typical MQJ configurations shall be in accordance with NAVSEA DWG 6877804. Special MQJ configurations may be used with authorized approval. Typical MQJ configurations are shown in tables I and II. MQJs used with optical power meters, stabilized light sources, optical loss test sets, and optical return loss meters shall have a minimum length of 1 m (3 ft). 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 m (165 feet)] of fiber.

TABLE I. Typical multimode MQJ configurations.

Part number	Fiber type	Length (min) (m)	Used with	Termination to test equipment	Termination to cable assembly or link (see NOTE 1)
6877804-1	MM	50	OTDR	ST type	ST type
6877804-2	MM	50	OTDR	ST type	MIL-PRF-24623/4 Rotary Mechanical Splice
6877804-3	MM	50	OTDR	ST type	MIL-T-29504/14 Pin terminus
6877804-4	MM	50	OTDR	ST type	MIL-T-29504/15 Socket terminus
6877804-5	MM	1	OLTS	ST type	ST type
6877804-6	MM	1	OLTS	ST type	MIL-PRF-24623/4 Rotary Mechanical Splice
6877804-7	MM	1	OLTS	ST type	4 channel MIL-C-28876 plug
6877804-8	MM	1	OLTS	ST type	4 channel MIL-C-28876 receptacle
6877804-9	MM	1	OLTS	ST type	8 channel MIL-C-28876 plug
6877804-10	MM	1	OLTS	ST type	8 channel MIL-C-28876 receptacle
6877804-12	MM	1	OLTS	ST type	31 channel MIL-C-28876 plug
6877804-13	MM	1	OLTS	ST type	31 channel MIL-C-28876 receptacle

NOTE 1: Multi-fiber connector plugs and receptacles on MQJs are only configured with the master polarizing key so that they are compatible with all available plug and receptacle keys.

TABLE II. Typical single mode MQJ configurations.

Part number (see NOTE 1)	Fiber type	Length (min) (m)	Used with	Termination to test equipment	Termination to cable assembly or link (see NOTE 2)
6877804-1SM 6877804-1SME	SM	50	OTDR	ST type	ST type
6877804-3SM 6877804-3SME	SM	50	OTDR	ST type	MIL-T-29504/14 Pin terminus
6877804-4SM 6877804-4SME	SM	50	OTDR	ST type	MIL-T-29504/15 Socket terminus
6877804-5SM 6877804-5SME	SM	1	OLTS ORLM	ST type	ST type
6877804-7SM 6877804-7SME	SM	1	OLTS ORLM	ST type	4 channel MIL-C-28876 plug
6877804-8SM 6877804-8SME	SM	1	OLTS ORLM	ST type	4 channel MIL-C-28876 receptacle
6877804-9SM 6877804-9SME	SM	1	OLTS ORLM	ST type	8 channel MIL-C-28876 plug
6877804-10SM 6877804-10SME	SM	1	OLTS ORLM	ST type	8 channel MIL-C-28876 receptacle
6877804-12SM 6877804-12SME	SM	1	OLTS ORLM	ST type	31 channel MIL-C-28876 plug
6877804-13SM 6877804-13SME	SM	1	OLTS ORLM	ST type	31 channel MIL-C-28876 receptacle

NOTE 1: Single mode MQJs with a SM designation in the part number are used for the measurement of connectors fabricated with the standard dome polishing process (see part 5 of this standard practice). Single mode MQJs with a SME designation in the part number are used for the measurement of connectors fabricated with the enhanced dome polishing process (see part 5 of this standard practice).

NOTE 2: Multi-fiber connector plugs and receptacles on MQJs are only configured with the master polarizing key so that they are compatible with all plug and receptacle keys.

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 an ST compatible connector on one end and a holding mechanism for stripped fiber on the other end
b. a single fiber cable with an ST compatible connector on one end and a temporary splice which mates to the stripped fiber on the other end
c. an unused ST 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 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 ball bearing with diameter of 4.5 or 5 mm 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 BOF tube paths that are installed entirely above the ship’s V-line.

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 (see 3.8). 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 is performed using an optical return loss meter.

NOTE: Pass/fail criteria utilized for the optical return loss test must be consistent with the polishing method requirements. Standard dome polish return loss levels are to be not less than 30 dB. Enhanced dome polish return loss levels are to be not less than 40 dB.

4.4 Safety precautions. The following safety precautions apply:

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

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 service group hazard classes have been devised to indicate the degree of hazard and required hazard control measures. Refer to ANSI Z136.2 for a full technical definition. Simplified definitions of the service groups are as follows.

SG1 - No risk when the end of a fiber is viewed with a microscope, eye-loupe or with the unaided eye. The total output power is less than 5 mW.

SG2 - Potentially hazardous when the end of the fiber is viewed for more than 0.25 seconds for a source that emits at wavelengths between 400 nm to 700 nm. (NOTE: This wavelength range is in the visible region and is outside of the 850 nm or 1300 nm wavelength ranges used in Navy equipment.)

SG3a - Hazardous when the end of the fiber is viewed with a microscope or eye-loupe, but is not hazardous when viewed with the unaided eye. The total output power of the source is between 5 mW and 50 mW. (NOTE: Most sources used in Navy systems or test equipment have output power significantly less than 5 mW.)

SG4a - Hazardous when the end of the fiber is viewed under any condition unless protective eye wear is worn. The total output power of the source is between 50 mW and 500 mW.

The following laser safety precautions shall apply:

(1) Ensure personnel are familiar with the laser degree of hazard and the required control measures.

(2) Light generated by light emitting diodes (LED's) and laser diodes may not be visible but may still be hazardous to the unprotected eye. Never 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.

(3) 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.

d. Safety glasses shall be worn 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.

e. Never 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.

5. DETAILED REQUIREMENTS

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

5.1.1 BOF fibers and bundles. BOF 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 is determined by the optical fiber cable configuration as follows:

a. Visual inspection, Method 6A1 - all cables. (Recommended)

b. Cable attenuation test, Method 6B1 – conventional cables greater than 50 m (165 feet) in length and either without connectors or splice ferrules installed, or with connectors or splice ferrules installed on only one end. (Recommended)

c. Cable assembly link loss test, Method 6C1 – conventional cables with connectors or splice ferrules installed on both ends. (Recommended)

d. Cable continuity test, Method 6D1 – conventional cables less than 50 m (165 feet) in length without connectors or splice ferrules installed on both ends. (Recommended)

e. BOF cable ball bearing Test, Method 6H1 – BOF cables. (Recommended)

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 is determined by the optical fiber cable configuration as follows:

a. Visual inspection, Method 6A1 - all cables. (Mandatory)

b. Cable continuity test, Method 6D1 - conventional cable. (Recommended)

c. BOF cable ball bearing test, Method 6H1 – BOF tube cable. (Recommended)

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 are performed in two phases, as follows:

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

b. Phase 2a - After installation of connectors on the optical fiber cable such that fibers are terminated on both ends, perform the cable assembly link loss test, Method 6C1, on all fibers terminated on both ends. For

single mode fibers terminated on both ends, also perform the cable assembly return loss test, Method 6K1. (Mandatory)

c. Phase 2b – For cables with fibers that are not terminated on both ends, perform the cable continuity test, Method 6D1, on those fibers that are not terminated on both ends. (Mandatory)

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, repeat the visual inspection, Method 6A1, and the BOF cable BB test, Method 6H1, on all tube cables. (Recommended)

b. Phase 2 – Immediately before installation of the BOF fiber into the BOF tubes perform the BOF pressurization test, Method 6I1, and BOF cable BB test, Method 6H1, on all tubes identified for BOF fiber installation. (Recommended)

c. Phase 3 - After installation of fiber into the BOF cable, and the installation of tube furcation units, repeat the cable continuity test, Method 6D1. (Recommended)

d. Phase 4a - After installation of connectors on the optical fiber cable such that the optical fiber cable is terminated on both ends, perform the cable assembly link loss test, Method 6C1, and BOF tube seal verification test, Method 6J1. (Mandatory)

e. Phase 4b - For unused BOF tubes, perform the BOF cable BB test, Method 6H1, and BOF tube seal verification test, Method 6J1. (Mandatory)

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

a. If required by the contract, after installation of MIL-C-28876 connectors on the cable, perform the heavy-duty connector mechanical pull test, Method 6G1.

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 a visual inspection, Method 6A1 for cables and associated components, and a cable topology end-to-end attenuation test, Method 6E1. (Mandatory)

5.5 Measurement quality jumper selection tests. Measurement quality jumpers shall be tested in accordance with Method 6F1. The cables shall be marked such that each cable can be readily identified as being a measurement quality jumper (see NAVSEA drawing 6877804).

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 practice are intended to ensure the FOCT is properly installed during and after each phase of installation procedures.

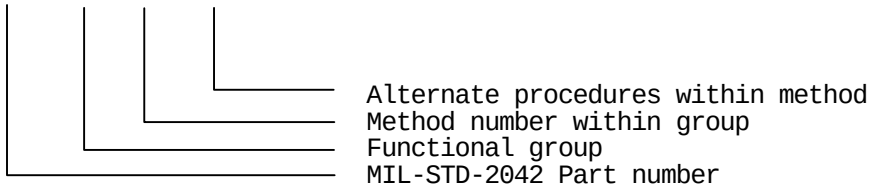
6.2 Issue of DODISS. When this standard practice is used in acquisition, the applicable issue of DODISS must be cited in the solicitation (see 2.2.1).

6.3 Standard method designation. To simplify the usage of this standard practice, 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.
B: Cable attenuation test.
C: Cable assembly link loss test.
D: Cable continuity test.
E: Cable topology end-to-end attenuation test.
F: Measurement quality jumper selection test
G: Heavy-duty connector mechanical pull test.
H: BOF cable BB test.
I: BOF cable pressurization test.
J: BOF tube seal verification test.
K: Cable assembly return loss test.
L: Cable topology end-to-end return loss test.

Then the designation system was completed as follows:

6 B 1 -



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 Data requirements. Contracts, purchase orders and other procurement documents referencing this standard should require the delivery of the test data obtained in the conduct of these procedures.

6.5 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
Pre-installation tests
Safety procedures
Visual inspections

6.6 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.

Preparing activity:
NAVY - SH

(Project SESS-0010)

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. REQUIRED EQUIPMENT AND MATERIALS.

2.1 Safety glasses are required if bare fibers are present.

3. PROCEDURES.

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

a. Safety glasses shall be worn 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.

3.2 Procedure I. Cable inspection.

NOTE: During handling, conventional optical fiber cable and BOF cable shall be protected from kinks, twists, crushing, and sharp bends. (More detailed handling procedures are given in Part 1 of this standard practice.)

Step 1 - Examine the cable documentation to ensure that the optical fiber cable conforms to the requirements of 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: (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.)

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

b. Marking - As a minimum, the part number, manufacturer's identification, 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).

Step 3 - Examine the BOF fiber and BOF bundles for the following: (NOTE: For items on a reel, examine that portion of the item that can be seen without removing the item from the reel.)

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

b. Marking - As a minimum, the part number and manufacturer's identification.

c. Color code - BOF fiber colorations should be easily discernable.

3.3 Procedure II. Connector, splice and interconnection box inspection.

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

Step 2 - Examine the components for the following:

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

b. Marking - As 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 BOF fibers 50 m (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. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in the tables located in the applicable sections of this method shall be used to perform these procedures.

3. PROCEDURES.

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

a. Safety glasses shall be worn 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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure I. Cable and fiber preparation for test.

3.2.1 Applicability. This procedure is applicable when the optical fiber cable is not terminated with connectors or splices on either end.

3.2.2 The equipment and materials in table 6B1-I shall be used to perform this procedure.

TABLE 6B1-I. Equipment and materials.

Description	Quantity
Cable jacket stripping tool (NAVSEA DWG 6872811-8 or equal)	1
Kevlar shears (NAVSEA DWG 6872811-16 or equal)	1
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol (sealable type)	1
Canned air or compressed air	As required
Ruler	1

TABLE 6B1-I. Equipment and materials - continued.

Description	Quantity
OFCC strip tool (NAVSEA DWG 6872811-10 or equal)	1
Safety glasses	1
Buffer strip tool (NAVSEA DWG 6872811-9 equal)	1
Cleaver (NAVSEA DWG 6872811-7 or equal)	1

NOTE: During handling, the optical fiber cable shall be protected from kinks, twists, crushing, and sharp bends. (See Part 1 of this standard practice 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 mm (12 in) of the outer jacket from the unterminated end of the optical fiber cable.

CAUTION: Do not cut or nick OFCC jackets.

Using the kevlar shears, carefully cut off the kevlar strength members, the exposed central member and any fillers.

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 50 mm (2 in) from the end of the fiber. Using the OFCC stripper, remove the OFCC jacket back to the mark.

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

Step 6 - Measure and mark the buffer approximately 30 mm (1 in) from the end of the fiber.

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

Using the buffer stripper, remove the buffer and coating back to the mark. Remove the buffer and coating in small sections (approximately 6 mm (0.25 in)) at a time. (NOTE: Normally, the buffer and coating are tightly adhered to one another and come off of the fiber at the same time.)

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 - Using one short light stroke with the cleaving tool, score the fiber approximately 12 mm (0.5 in) from the end of the fiber. (NOTE: Do not break the fiber with the tool.) Pull off the fiber with a gentle straight pull. Deposit the waste fiber in a trash container.

Step 9 - Repeat steps 4 through 8 above for all of the OFCCs in the optical fiber cable.

3.3 Procedure II. Method 6B1-1 Cable attenuation test for cables 50 m (165 feet) or greater in length.

3.3.1 The equipment and materials in table 6B1-II shall be used to perform this procedure.

TABLE 6B1-II. Equipment and materials.

Description	Quantity
Safety glasses	1
Measurement quality jumper cables (NAVSEA DWG 6877804)	As required
Bare fiber adapters	As required
Calibration cable (known length greater than 100 meters)	1
Optical time domain reflectometer (OTDR) (NSN 7Z 6625 01 383 3789 or equal)	1
Alcohol bottle with alcohol/2-propanol (sealable type)	1
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Canned air or compressed air	As required
ST to ST adapter	As required
Hybrid adapter	As required

NOTE: These procedures were developed from EIA/TIA-455-61 (FOTP 61) "MEASUREMENT OF FIBER OR CABLE ATTENUATION USING AN OTDR."

NOTE: Ensure the test equipment calibration is current.

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

Step 1 - WARNING: When visually inspecting an optical fiber, never 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.

Following the OTDR manufacturer's instructions, energize the OTDR. If the optical fiber cable group index is not known, proceed to step 2. If the optical fiber cable group index is known, proceed to step 8.

Step 2 - Connect the calibration cable to the OTDR.

Step 3 - Enter the required parameters, except the optical fiber cable group index, in accordance with the OTDR manufacturer's instructions.

Step 4 - Adjust and place the cursor at the beginning of the trace to obtain the distance coordinate z_1 (see figure 6B1-1).

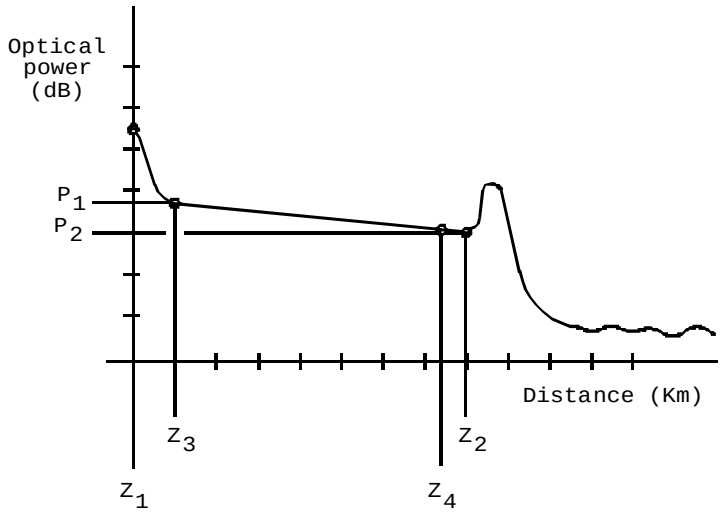


FIGURE 6B1-1. OTDR display – (typical).

Step 5 - Place the second cursor at the end of the trace to obtain the distance coordinate z_2.

Step 6 - Adjust the group index setting until the difference (z_2-z_1) equals the length of the calibration cable.

Step 7 - Disconnect the calibration cable from the OTDR.

Step 8 - 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 9 - Select the applicable MQJ from table 6B1-III. Connect the optical fiber cable under test to the OTDR using the MQJ as shown in figure 6B1-2.

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the MQJ to the optical fiber cable under test.

TABLE 6B1-III. MQJs for OTDR measurements.

Termination on cable	Fiber polish type	MQJ part number
Bare fibers (see NOTE 1)	MM SM SM (enhanced)	6877804-1 6877804-1SM 6877804-1SME
M83522	MM SM SM (enhanced)	6877804-1 6877804-1SM 6877804-1SME
COTS ST	MM SM SM (enhanced)	6877804-1 6877804-1SM 6877804-1SME
COTS SC (see NOTE 2)	MM SM SM (enhanced)	6877804-1 6877804-1SM 6877804-1SME
M24623	MM	6877804-2
M28876 4 CH PLUG	MM SM SM (enhanced)	6877804-4 6877804-4SM 6877804-4SME
M28876 4 CH RECEPT	MM SM SM (enhanced)	6877804-3 6877804-3SM 6877804-3SME
M28876 8 CH PLUG	MM SM SM (enhanced)	6877804-4 6877804-4SM 6877804-4SME
M28876 8 CH RECEPT	MM SM SM (enhanced)	6877804-3 6877804-3SM 6877804-3SME
M28876 31 CH PLUG	MM SM SM (enhanced)	6877804-4 6877804-4SM 6877804-4SME
M28876 31 CH RECEPT	MM SM SM (enhanced)	6877804-3 6877804-3SM 6877804-3SME
Other (see NOTE 2 & NOTE 3)	MM SM SM (enhanced)	6877804-1 6877804-1SM 6877804-1SME

NOTE 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.

NOTE 2: Use the ST to ST MQJ with a hybrid adapter (for example, an ST to SC adapter) to connect to optical fiber cable ends terminated with connectors other than the ST and the MIL-C-28876.

NOTE 3: For COTS connectors that cannot be mated to an ST to ST MQJ using a hybrid adapter, a non-standard MQJ may be used.

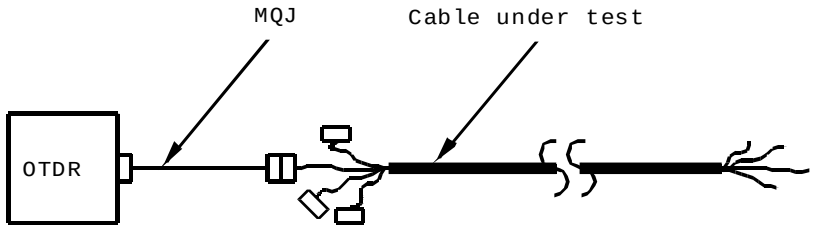


FIGURE 6B1-2. Test setup.

Step 10 - Enter the required parameters in accordance with the OTDR manufacturer's instructions.

Step 11 - 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 6B1-3). 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.

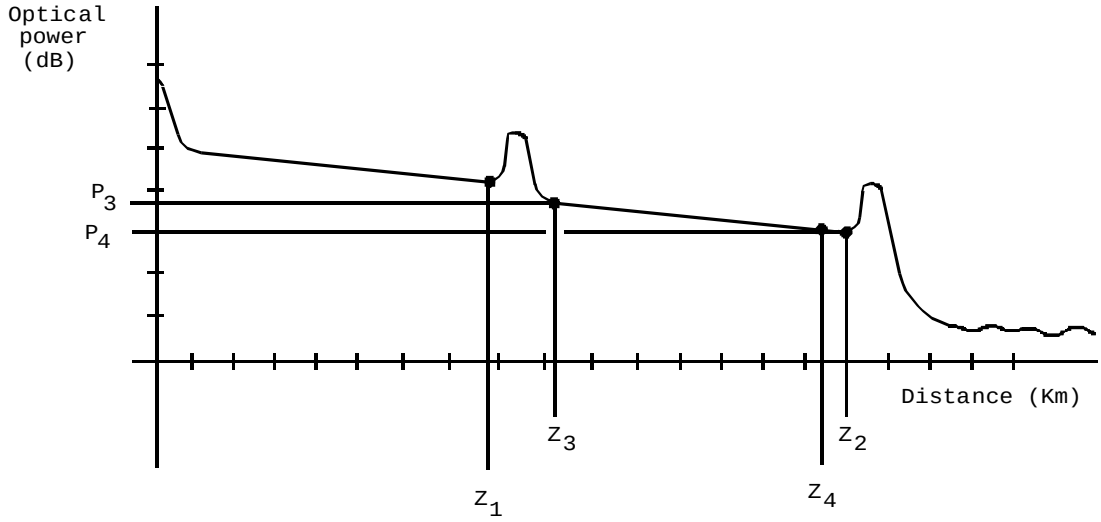


FIGURE 6B1-3. OTDR Display – (typical).

Step 12 - 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 6B1-3). 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 dB/km using the following equation:

$$B = \frac{P_3 - P_4}{z_4 - z_3}$$

Step 13 - Repeat steps 11 and 12 above for all the fibers in the optical fiber cable.

Step 14 - The optical fiber cable is considered satisfactory 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 15 - 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 Method 1A1 in Part 1 of this standard practice.

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. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in the tables located in the applicable sections of this method shall be used to perform these procedures.

3. PROCEDURES.

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

a. Safety glasses shall be worn 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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure I. Cable assembly preparation for test. This procedure is performed in series with Procedure II. Refer to section 3.3 to determine when this procedure is to be applied. Optical fiber cable assemblies terminated in connectors do not require the performance of this procedure. Optical fiber cable assemblies terminated in splice ferrules require the completion of a temporary splice in order to test for link loss. The splice procedures herein are abbreviated; a more detailed description is given in Method 2D1 in Part 2 of this standard practice.

3.2.1 The equipment and materials in table 6C1-I shall be used to perform this procedure.

TABLE 6C1-I. Equipment and materials.

Description	Quantity
Alignment clip tool (NAVSEA DWG 6872812-1 or equal)	1
Splice alignment sleeve (MIL-PRF-24623/4)	As required
Index matching gel (MIL-PRF-24794)	As required
Splice alignment tool (NAVSEA DWG 6872812-5 or equal)	1

NOTE: During handling, the optical fiber cable shall be protected from kinks, twists, crushing and sharp bends. See Part 1 of this standard practice for more detailed optical fiber cable handling procedures.

Step 1 - Mix a small portion of the index matching gel on a clean surface according to the manufacturer's instructions provided (vacuuming is not required).

NOTE: The index matching gel provided may be a one-part gel that does not require mixing.

Step 2 - CAUTION: Opening the sleeve too much may damage the sleeve.

Adjust the splice alignment clip tool so that it opens the splice alignment clip just enough to insert the splice ferrules. Insert the tool tip into the alignment sleeve slot. Open the sleeve (see figure 6C1-1).

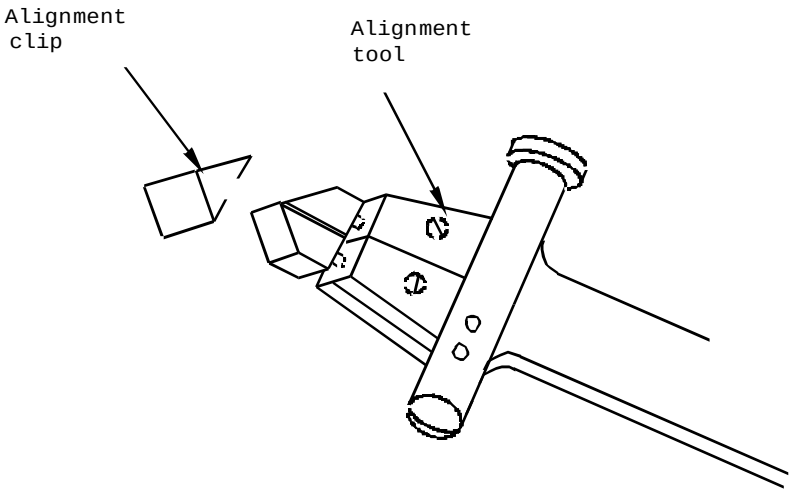


FIGURE 6C1-1. Opening the alignment sleeve.

Step 3 - Dip one of the polished ferrule tips into the gel and slide the ferrule into the alignment clip until the tip is approximately centered in the clip (see figure 6C1-2).

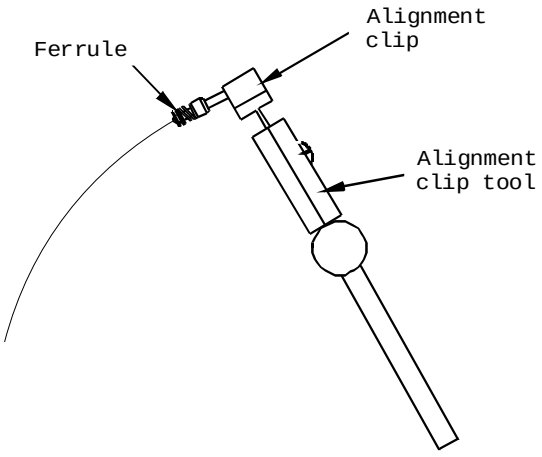


FIGURE 6C1-2. Inserting the ferrule into the alignment sleeve.

Step 4 - Dip the other ferrule tip into the index matching gel and slide the ferrule tip into the other side of the alignment clip (see figure 6C1-3). Ensure that the ferrule tips are centered in the alignment clip and the alignment tabs are facing the clip gap. Remove the alignment clip tool from the alignment clip. Verify that the ferrule tips are in contact by pushing the ferrules together.

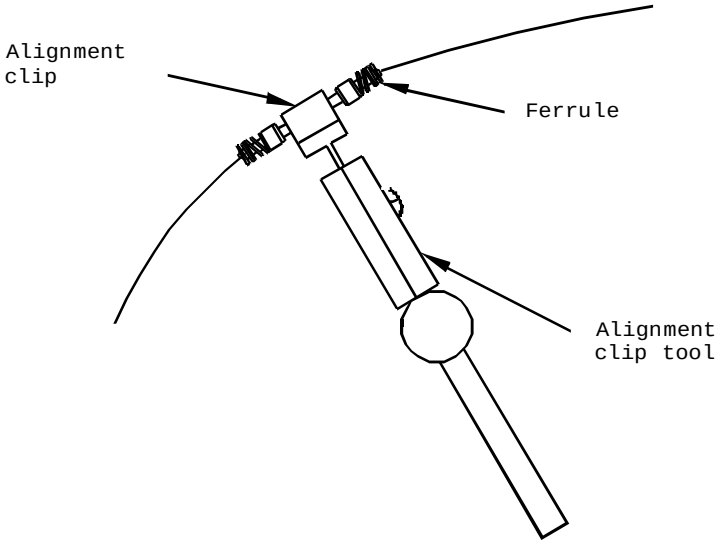


FIGURE 6C1-3. Inserting the second ferrule into the alignment sleeve.

Step 5 - Passive alignment - verify the tab alignment by inserting the splice assembly into the splice alignment tool making sure the tabs fit into the tool slots (see figure 6C1-4). If necessary, rotate either ferrule slightly to align the tabs. Remove the splice from the tool.

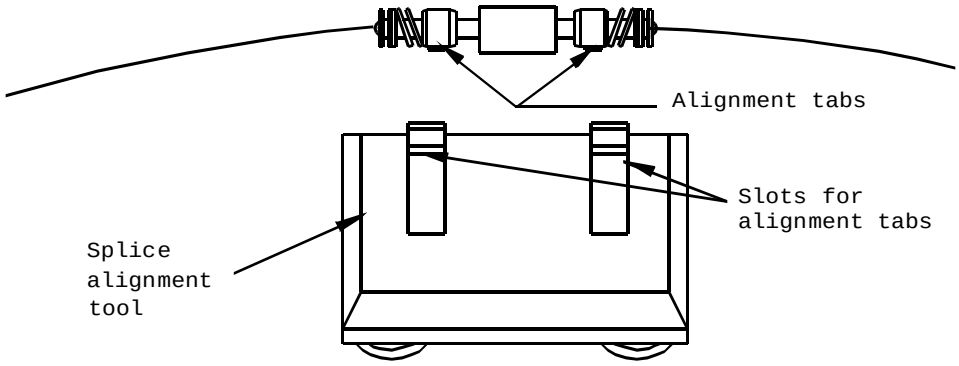


FIGURE 6C1-4. Aligning the tabs

3.3 Procedure II. Method 6C1-1 power meter cable assembly link loss test.

3.3.1 The equipment and materials in table 6C1-II shall be used to perform this procedure.

TABLE 6C1-II. Equipment and materials.

Description	Quantity
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol (sealable type)	1
Canned air or compressed air	As required
Measurement quality jumper cables (NAVSEA DWG 6877804)	As required
ST to ST adapter (Lucent 105 271 142 or equal)	As required
Hybrid adapter, ST to SC (AMP 503638-2 or equal)	As required
Hybrid adapter, ST to COTS connector	As required
LED light source (NSN 7Z 6625 01 304 1739 or equal)	As required
Power meter (NSN 7Z 6625 01 304 1739 or equal)	1
Protective caps (plastic)	As required

NOTE: Ensure the test equipment calibration is current.

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

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

NOTE: The LED light source shall have a CPR value (refer to TIA/EIA-526-14) not less than 21 dB and not greater than 22 dB when measured into a 62.5 um fiber at a wavelength of 1300 nm. Best cable assembly link loss results are obtained with LED light sources with a CPR value between 21 dB and 21.5 dB.

NOTE: A laser light source may be used for single mode optical fiber cable assembly link loss measurements.

NOTE: This procedure involves the use of Measurement Quality Jumper cables (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. Additional guidance on establishing an MQJ verification program can be obtained from the Naval Surface Warfare Center (see 1.1.1).

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 - WARNING: When visually inspecting an optical fiber, never 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.

Connect the reference MQJ (NAVSEA DWG 6877804-1, NAVSEA DWG 6877804-1SM, or NAVSEA DWG 6877804-1SME) between the light source and the power meter.

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

Step 3 - Measure and record the reference power (in dBm) at the meter (designated as P_1) (see figure 6C1-5).

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 indicate either a defective MQJ or a defective light source. If changes in the reference power greater than 0.5 dB occur, clean or replace the MQJ and repeat Step 3.

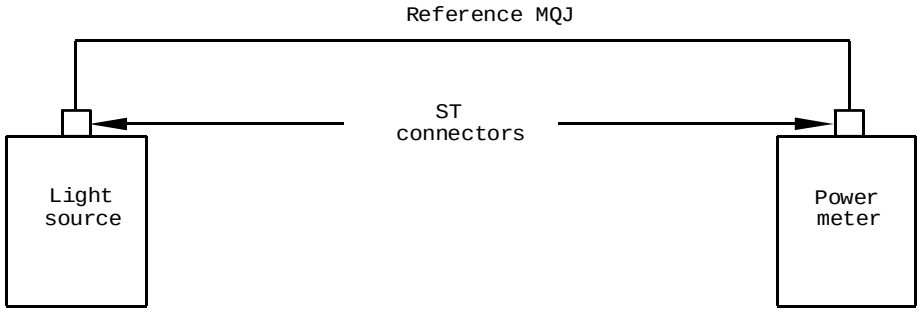


FIGURE 6C1-5. Reference measurement.

Step 4 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

Select the applicable MQJs from table 6C1-III, and connect the optical fiber cable under test to the light source and the power meter as shown in figure 6C1-6. For optical fiber cable assemblies terminated in splice ferrules use Procedure I to assemble the optical fiber cable assembly splice ferrules to the MQJ splice ferrules.

NOTE: For optical fiber cables with single terminus connectors, the reference MQJ shall be used as MQJ_1.

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 MQJs to the optical fiber cable assembly under test. For optical fiber cable assemblies under test terminated with COTS SC or other COTS fiber optic connectors, a hybrid adapter is required to connect the MQJs to the optical fiber cable assembly under test.

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

TABLE 6C1-III. MQJs for cable assembly loss measurements.

Termination on cable end	Fiber polish type	MQJ part number
M83522	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
COTS ST	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
COTS SC (see NOTE 1)	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
M24623	MM	6877804-6
M28876 4 CH PLUG	MM SM SM (enhanced)	6877804-8 6877804-8SM 6877804-8SME
M28876 4 CH RECEPT	MM SM SM (enhanced)	6877804-7 6877804-7SM 6877804-7SME
M28876 8 CH PLUG	MM SM SM (enhanced)	6877804-10 6877804-10SM 6877804-10SME
M28876 8 CH RECEPT	MM SM SM (enhanced)	6877804-9 6877804-9SM 6877804-9SME
M28876 31 CH PLUG	MM SM SM (enhanced)	6877804-13 6877804-13SM 6877804-13SME
M28876 31 CH RECEPT	MM SM SM (enhanced)	6877804-12 6877804-12SM 6877804-12SME
Other (see NOTEs 1 and 2)	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME

NOTE 1: Use the ST to ST MQJ with a hybrid adapter (for example, an ST to SC hybrid adapter) to connect to optical fiber cable ends terminated with connectors other than the ST and the MIL-C-28876.

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

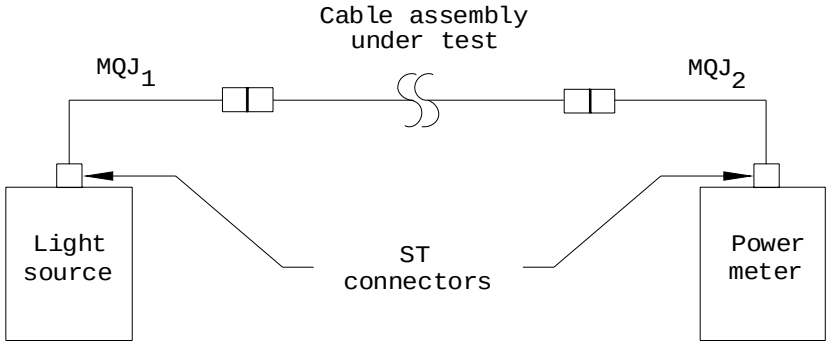


FIGURE 6C1-6. Test measurement (typical).

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 Step 2, Step 3, Step 4 and Step 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 cable assembly loss value should be a positive number and 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, 3, 4, 5 and 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.

Step 8 - For multimode optical fiber cable assemblies, measure the cable assembly link loss in the opposite direction, repeating steps 2, 3, 4, 5, 6, and 7.

Step 9 - Identify the connectors/splices by type and proceed to 3.3.2 below.

3.3.2 Calculations.

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

Step 1 - The optical fiber cable assembly is considered satisfactory 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 below.

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-IV using the following formula:

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

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 direction for multimode optical fiber cable assemblies) is acceptable, proceed to step 4 below. If measured loss (in either direction for multimode optical fiber cable assemblies) is greater than the maximum acceptable loss, proceed to step 3 below.

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

NOTE: The maximum attenuation rate of some MIL-PRF-85045 optical fiber cables is greater than the values identified in table 6C1-IV. If the optical fiber cable used has a maximum attenuation rate greater than that shown in table 6C1-IV, the actual maximum attenuation rate of the optical fiber cable may be used to calculate the MAL.

TABLE 6C1-IV. Maximum component loss values.

Component	Single mode	Multimode
Cable	1.5 dB/km @ 1300 nm 1.5 dB/km @ 1550 nm	4.5 dB/km @ 850 nm 2.0 dB/km @ 1300 nm
Single terminus (light duty) connectors (mated pair)	0.75 dB	0.75 dB
Multiple terminus (heavy duty) connectors (mated pair)	0.75 dB	0.75 dB
COTS connectors (mated pair)	0.75 dB	0.75 dB
Mechanical splice	0.2 dB tuned 0.6 dB untuned	0.2 dB tuned 0.6 dB untuned

NOTE: If components other than those listed in table 6C1-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 the Naval Surface Warfare Center (see 1.1.1) 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, reterminate or replace the defective components.

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

METHOD 6D1

CABLE CONTINUITY TEST

1. SCOPE.

1.1 Scope. This method describes a procedure for performing a 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 The equipment and materials in table 6D1-I shall be used to perform this procedure.

TABLE 6D1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Alcohol bottle with alcohol/2-propanol (sealable type)	As required
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Canned air or compressed air	As required
Flashlight or high intensity light source	1
Bare fiber adapter	As required

3. PROCEDURE.

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

a. Safety glasses shall be worn 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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure.

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

Step 2 - Using a wipe dampened with alcohol, clean the fibers on both ends of the optical fiber cable and blow them dry with air.

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. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in the tables located in the applicable sections of this method shall be used to perform these procedures.

3. PROCEDURES.

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

a. Safety glasses shall be worn 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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure I. FOCT preparation for test. This procedure is performed in series with Procedure II. Refer to section 3.3 to determine when this procedure is to be applied. FOCT links terminated in connectors do not require the performance of Procedure I. FOCT links terminated in splice ferrules require the completion of a temporary splice in order to test for cable topology end-to-end attenuation. The splice procedure description herein is abbreviated; a more detailed description is given in Method 2D1 in Part 2 of this standard practice.

3.2.1 The equipment and materials in table 6E1-I shall be used to perform this procedure.

TABLE 6E1-I. Equipment and materials.

Description	Quantity
Alignment clip tool (NAVSEA DWG 6872812-1 or equal)	1
Splice alignment sleeve (MIL-PRF-24623/4)	As required
Index matching gel (MIL-PRF-24794)	As required
Splice alignment tool (NAVSEA DWG 6872812-5 or equal)	1

NOTE: During handling, the optical fiber cable shall be protected from kinks, twists, crushing and sharp bends. See Part 1 of this standard practice for more detailed optical fiber cable handling procedures.

Step 1 - Mix a small portion of the index matching gel on a clean surface according to the manufacturer's instructions provided (vacuuming is not required).

NOTE: The index matching gel provided may be a one-part gel that does not require mixing.

Step 2 - CAUTION: Opening the sleeve too much may damage the sleeve.

Adjust the splice alignment clip tool so that it opens the splice alignment clip just enough to insert the splice ferrules. Insert the tool tip into the alignment sleeve slot. Open the sleeve (see figure 6E1-1).

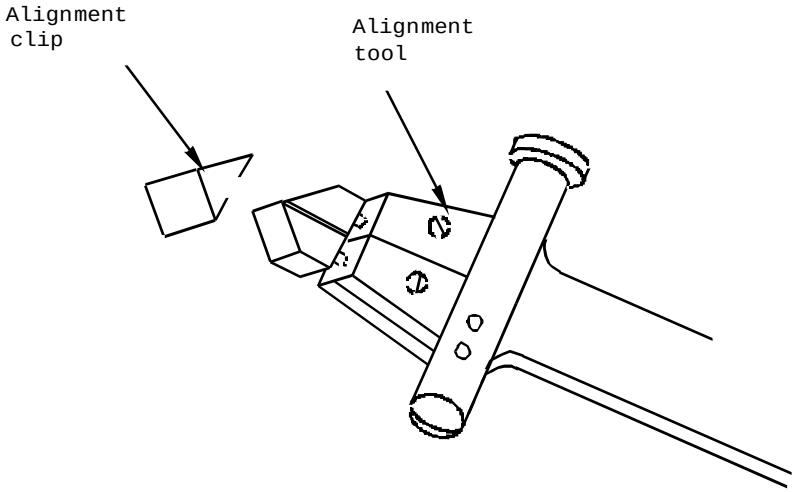


FIGURE 6E1-1. Opening the alignment sleeve.

Step 3 - Dip one of the polished ferrule tips into the gel and slide the ferrule into the alignment clip until the tip is approximately centered in the clip (see figure 6E1-2).

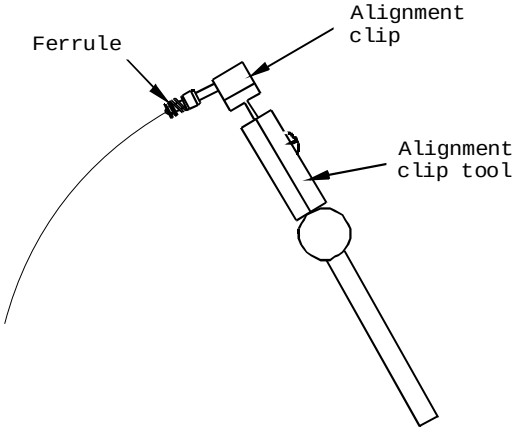


FIGURE 6E1-2. Inserting the ferrule into the alignment sleeve.

tep 4 - Dip the other ferrule tip into the index matching gel and slide the ferrule tip into the other side of the alignment clip (see figure 6E1-3). Ensure that the ferrule tips are centered in the alignment clip and the alignment tabs are facing the clip gap. Remove the alignment clip tool from the alignment clip. Verify that the ferrule tips are in contact by pushing the ferrules together.

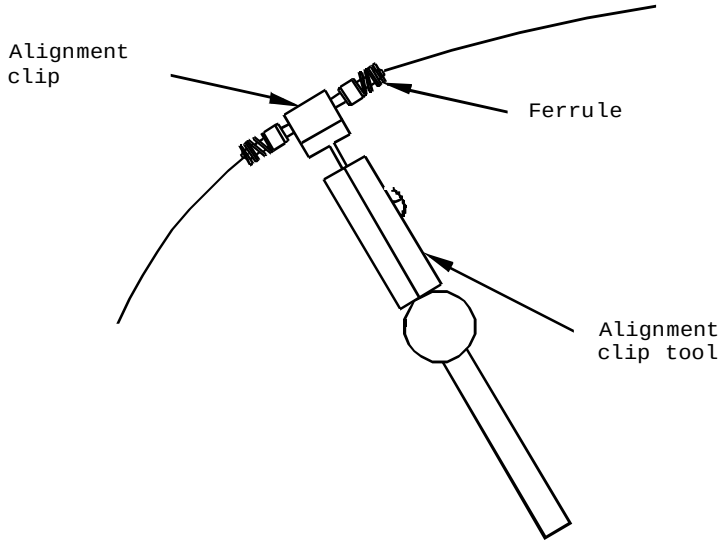


FIGURE 6E1-3. Inserting the second ferrule into the alignment sleeve.

Step 5 - Passive alignment - verify the tab alignment by inserting the splice assembly into the splice alignment tool making sure the tabs fit into the tool slots (see figure 6E1-4). If necessary, rotate either ferrule slightly to align the tabs. Remove the splice from the tool.

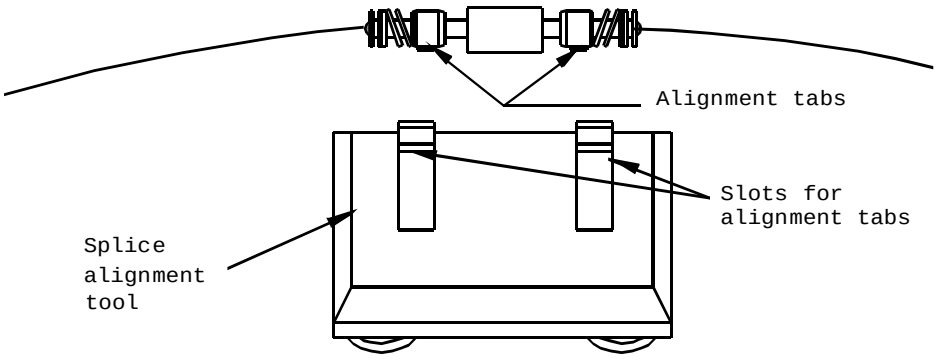


FIGURE 6E1-4. Aligning the tabs

3.3 Procedure II. Method 6E1-1 cable topology end-to-end attenuation test.

3.3.1 The equipment and materials in table 6E1-II shall be used to perform this procedure.

TABLE 6E1-II. Equipment and materials.

Description	Quantity
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol (sealable type)	1
Canned air or compressed air	As required
Measurement quality jumper cables (NAVSEA DWG 6877804)	As required
ST to ST adapter (Lucent 105 271 142 or equal)	As required
Hybrid adapter, ST to SC (AMP 503638-2 or equal)	As required
Hybrid adapter, ST to COTS connector	As required
LED light source (NSN 7Z 6625 01 304 1739 or equal)	1
Power meter (NSN 7Z 6625 01 304 1739 or equal)	1
Protective caps (plastic)	As required

NOTE: Ensure the test equipment calibration is current.

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

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

NOTE: The LED light source shall have a CPR value (refer to TIA/EIA-526-14) not less than 21 dB and not greater than 22 dB when measured into a 62.5 um fiber at a wavelength of 1300 nm. Best FOCT end-to-end attenuation results are obtained with LED light sources with a CPR value between 21 dB and 21.5 dB.

NOTE: A laser light source may be used for single mode optical fiber FOCT link measurements.

NOTE: This procedure involves the use of Measurement Quality Jumper cables (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 the Naval Surface Warfare Center (see 1.1.1).

Step 1 - WARNING: When visually inspecting an optical fiber, never 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.

Connect the reference MQJ (NAVSEA DWG 6877804-1, NAVSEA DWG 6877804-1SM, or NAVSEA DWG 6877804-1SME) between the light source and the power meter and record the power (in dBm) at the meter (P_1) (see figure 6E1-5).

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 mm (1 in) 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 indicate either a defective MQJ or a defective light source. If changes in the reference power greater than 0.5 dB occur, clean or replace the MQJ and repeat Step 3.

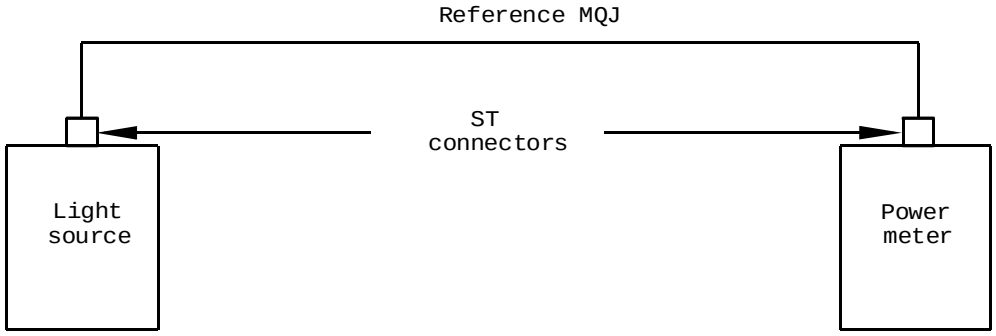


FIGURE 6E1-5. Connecting the reference MQJ.

Step 2 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

Select the applicable MQJs from table 6E1-III, and connect the optical fiber cable under test to the light source and the power meter as shown in figure 6E1-6. For optical fiber cable assemblies terminated in splice ferrules use Procedure I to assemble the optical fiber cable assembly splice ferrules to the MQJ splice ferrules.

NOTE: For FOCT links with single terminus connectors, the reference MQJ shall be used as MQJ_1.

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the MQJs to the FOCT link under test.

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

TABLE 6E1-III. MQJs for cable topology end-to-end attenuation measurements.

Termination on cable end	Fiber polish type	MQJ part number
M83522	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
COTS ST	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
COTS SC (see NOTE 1)	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME
M24623	MM	6877804-6
M28876 4 CH PLUG	MM SM SM (enhanced)	6877804-8 6877804-8SM 6877804-8SME
M28876 4 CH RECEPT	MM SM SM (enhanced)	6877804-7 6877804-7SM 6877804-7SME
M28876 8 CH PLUG	MM SM SM (enhanced)	6877804-10 6877804-10SM 6877804-10SME
M28876 8 CH RECEPT	MM SM SM (enhanced)	6877804-9 6877804-9SM 6877804-9SME
M28876 31 CH PLUG	MM SM SM (enhanced)	6877804-13 6877804-13SM 6877804-13SME
M28876 31 CH RECEPT	MM SM SM (enhanced)	6877804-12 6877804-12SM 6877804-12SME
Other (see NOTEs 1 and 2)	MM SM SM (enhanced)	6877804-5 6877804-5SM 6877804-5SME

NOTE 1: Use the ST to ST MQJ with a hybrid adapter (for example, an ST to SC hybrid adapter) to connect to optical fiber cable ends terminated with connectors other than the ST and the MIL-C-28876.

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

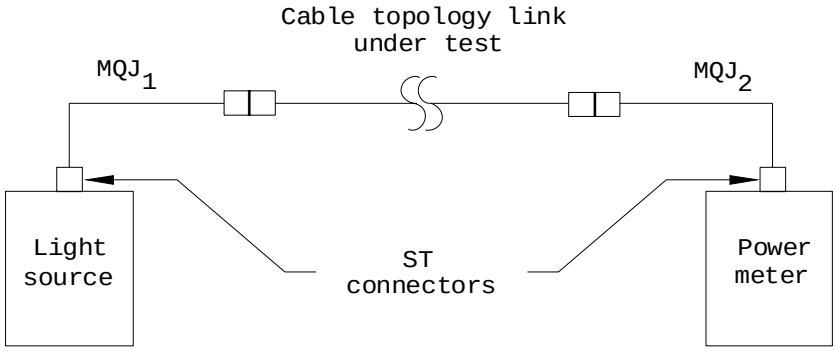


FIGURE 6E1-6. Test setup (typical).

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 Step 2 and Step 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 end-to-end attenuation value should be a positive number and the value of the optical reference power shall be recorded.

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

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

Step 6 - Identify the connectors/splices by type and proceed to 3.3.2 below.

3.3.2 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 6E1-IV using the following formula:

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

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 below. If measured end-to-end attenuation is greater than the maximum acceptable loss, proceed to step 2 below.

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

NOTE: The maximum attenuation rate of some MIL-PRF-85045 optical fiber cables is greater than the values identified in table 6E1-IV. If the optical fiber cable used has a maximum attenuation rate greater than that shown in table 6E1-IV, the actual maximum attenuation rate of the optical fiber cable may be used to calculate the MAL.

TABLE 6E1-IV. Maximum component loss values.

Component	Single mode	Multimode
Cable	1.5 dB/km @ 1300 nm 1.5 dB/km @ 1550 nm	4.5 dB/km @ 850 nm 2.0 dB/km @ 1300 nm
Single terminus (light duty) connectors (mated pair)	0.75 dB	0.75 dB
Multiple terminus (heavy duty) connectors (mated pair)	0.75 dB	0.75 dB
COTS connectors (mated pair)	0.75 dB	0.75 dB
Mechanical splice	0.2 dB tuned 0.6 dB untuned	0.2 dB tuned 0.6 dB untuned

NOTE: If components other than those listed in table 6E1-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 the Naval Surface Warfare Center (see 1.1.1) 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 protective caps over the FOCT link connectors.

METHOD 6F1

MEASUREMENT QUALITY JUMPER CABLE SELECTION TEST

1. SCOPE.

1.1 Scope. This method describes procedures for measuring the loss of measurement quality jumper cable end terminations. Alternative methods shall be approved by the Naval Surface Warfare Center (see 1.1.1).

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in the tables located in the applicable sections of this method shall be used to perform these procedures.

3. PROCEDURES.

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

a. Safety glasses shall be worn 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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure.

3.2.1 The equipment and materials in table 6F1-I shall be used to perform this procedure.

TABLE 6F1-I. Equipment and materials.

Description	Quantity
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol (sealable type)	1
Canned air or compressed air	As required
Reference cable (ST on both ends)	1
Reference cable (ST to MIL-T-29504/14 pin terminus)	1
Reference cable (ST to MIL-T-29504/15 socket terminus)	1
Reference cable (ST to MIL-S-24623/4 splice ferrule)	1
Light source (NSN 7Z 6625 01 304 1739 or equal)	1
Power meter (NSN 7Z 6625 01 304 1739 or equal)	1

TABLE 6F1-I. Equipment and materials - continued.

Description	Quantity
Protective caps (plastic)	As required
ST adapter (Lucent 105 271 142 or equal)	1
MIL-C-28876 plug connector	1
MIL-C-28876 receptacle connector	1
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

NOTE: Ensure the test equipment calibration is current.

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

NOTE: Identify and label all of the measurement quality jumper cables to be evaluated.

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

NOTE: The LED light source shall have a CPR value (refer to TIA/EIA-526-14) not less than 21 dB and not greater than 22 dB when measured into a 62.5 um fiber at a wavelength of 1300 nm. Best FOCT end-to-end attenuation results are obtained with LED light sources with a CPR value between 21 dB and 21.5 dB.

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 may be used for single mode optical fiber MQJs.

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 - 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.

Connect the ST to ST reference cable between the light source and the power meter and record the power at the meter (P_1) (see figure 6F1-1). Disconnect the reference cable from the power meter.

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

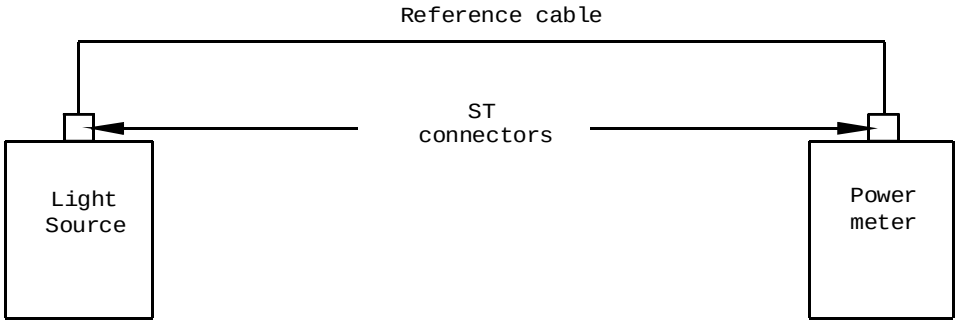


FIGURE 6F1-1. Connecting the reference cable.

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).

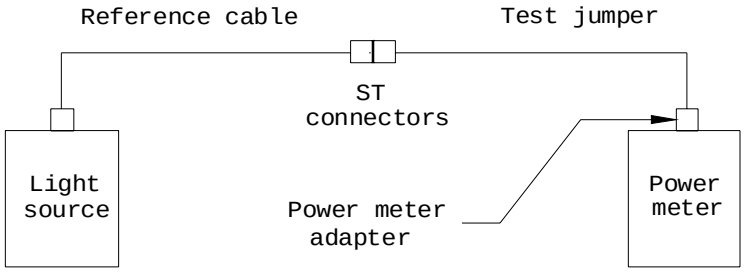


FIGURE 6F1-2. Connecting the test jumper.

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 step 3 through step 6 a minimum of three times (a maximum of ten times) for the selected MQJ. (A wipe dampened with alcohol may be used to clean the adapters/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 8 - Connect the ST to ST, ST to pin terminus, ST to socket terminus, or ST to MIL-S-24623 splice 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.

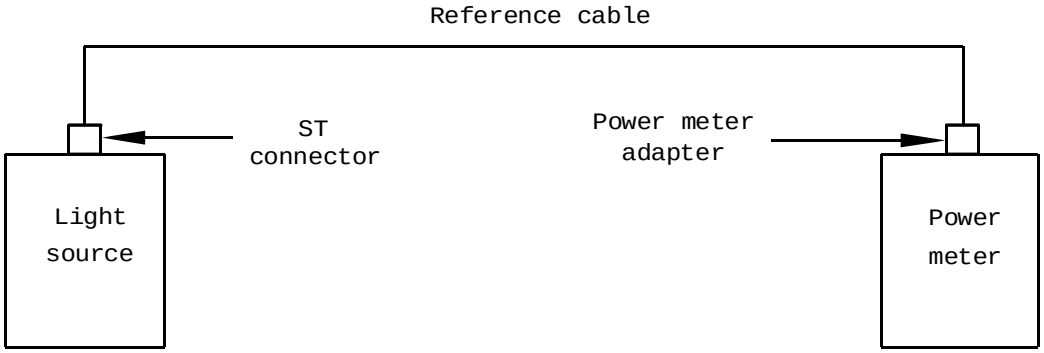


FIGURE 6F1-3. Connecting the reference cable.

NOTE: 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 mm (1 in) to eliminate higher order mode power.

Step 9 - 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-C-28876 plug or receptacle connectors and mated.

NOTE: For MIL-S-24623 splices, the splice ferrules shall be mated using a splice alignment clip as specified in MIL-STD-2042-2.

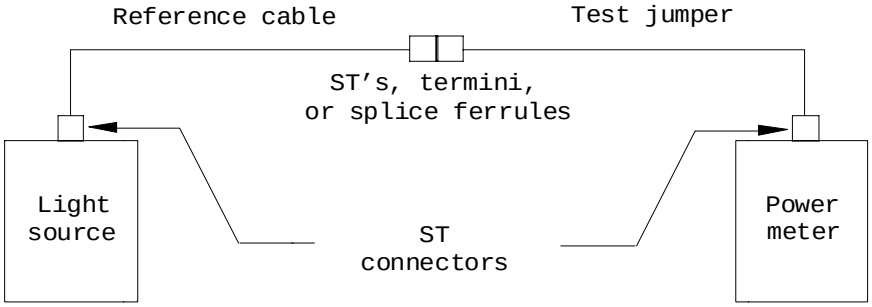


FIGURE 6F1-4. Connecting the test jumper.

Step 10 -Record the power at the meter (P_2).

Step 11 -Calculate the ST, terminus or splice connection loss using the 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 12 -Record the ST, terminus or splice connection loss along with the test jumper identification.

Step 13 -Repeat step 9 through step 12 a minimum of three times (a maximum of ten times) for the selected MQJ. (A wipe dampened with alcohol may be used to clean the adapters/connectors and they may be blown dry with air before making each connection.)

3.3 Calculations.

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: u_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: s_c = Standard deviation of the connection loss in dB
m = Number of loss measurements performed

Step 3 - An MQJ is considered satisfactory 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 m 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	$0.00 \leq u_{ST} \leq 0.35$	0.05 max (multimode) 0.10 max (single mode)
MIL-T-29504/14 pin terminus	$0.00 \leq u_{c} \leq 0.70$	0.05 max (multimode) 0.10 max (single mode)
MIL-T-29504/15 socket terminus	$0.00 \leq u_{c} \leq 0.70$	0.05 max (multimode) 0.10 max (single mode)
MIL-S-24623/4 splice	$0.00 \leq u_{c} \leq 0.30$	0.05 max (multimode) 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. The performance of this method is required only when specified by the contract.

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in table 6G1-I shall be used to perform this procedure.

TABLE 6G1-I. Equipment and materials.

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, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure.

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 lbs) for one 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 BALL BEARING TEST

1. SCOPE.

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

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in table 6H1-I shall be used to perform this procedure.

TABLE 6H1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Projectile trap (Kitco 0745-2140 or equal)	1
Pressure source	As required
BB with diameter of 4.5 or 5.0 mm (0.17 in or 0.20 in)	As required

NOTE: Use a BB with a 4.5 mm (.17 in) diameter for individual BOF fiber installations. Use a BB with a 5.0 mm (0.20 in) diameter for bundle BOF fiber installations.

3. PROCEDURE.

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

a. Safety glasses shall be worn when blowing a BB.

b. Observe warnings and cautions on equipment and materials.

c. Never 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 1032 kPa (150 PSI) within the BOF tube when attempting to dislodge a stuck BB. BOF tube damage can occur at pressures greater than 150 PSI.

3.2 Procedure.

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 pressure to the near end of the BOF tube to be tested and observing air flow at the tube remote end. 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.

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.

NOTE: A pressure of 344 to 688 kPa (50 to 100 PSI) should be sufficient to send the BB through the BOF tube.

Step 6 - If the BB exits the BOF tube, proceed to step 8. If the BB does not exit the BOF tube, proceed to step 7.

Step 7 - Apply pressure at the remote end of the tube and remove the BB. Record the test failure on the test data sheet.

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).

NOTE: A BB stuck within a BOF tube can also be dislodged by injecting a BB with a diameter smaller than 4.5 mm (0.17 in) from the remote end of the BOF tube.

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

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 The equipment and materials in table 6I1-I shall be used to perform this procedure.

TABLE 6I1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Variable pressure source	As required
Pressure gauge	1

3. PROCEDURE.

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

a. Safety glasses shall be worn when pressurizing the BOF cable.

b. Observe warnings and cautions on equipment and materials.

c. Never 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.

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.

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 - 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

BOF TUBE SEAL VERIFICATION TEST

1. SCOPE

1.1 Scope. This method describes the procedures for verifying the integrity of blown optical fiber tube end seals.

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in table 6J1-I shall be used to perform this procedure.

TABLE 6J1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Pressure source	1
Isolation valve	1
Pressure gauge	1
Bleed valve	1
BOF tube	As required
BOF tube coupler (AA59731-U-8 or AA59731-U-8E)	As required
Wipes	As required

3. PROCEDURES

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

a. Safety glasses shall be worn when pressurizing the BOF cable.

b. Observe warnings and cautions on equipment and materials.

c. Never 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.

3.1 Procedure.

CAUTION: Do not disengage mated BOF tube couplers. Disengaging utilized BOF tube couplers may damage/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 in figure 6J1-1. Visually verify that the end of all BOF tubes are cut perpendicular to the tube length. Apply an axial load of approximately 22 N (5 lbs) 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 method 2J1 of this Standard Practice.

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 method 2F1 of this Standard Practice.

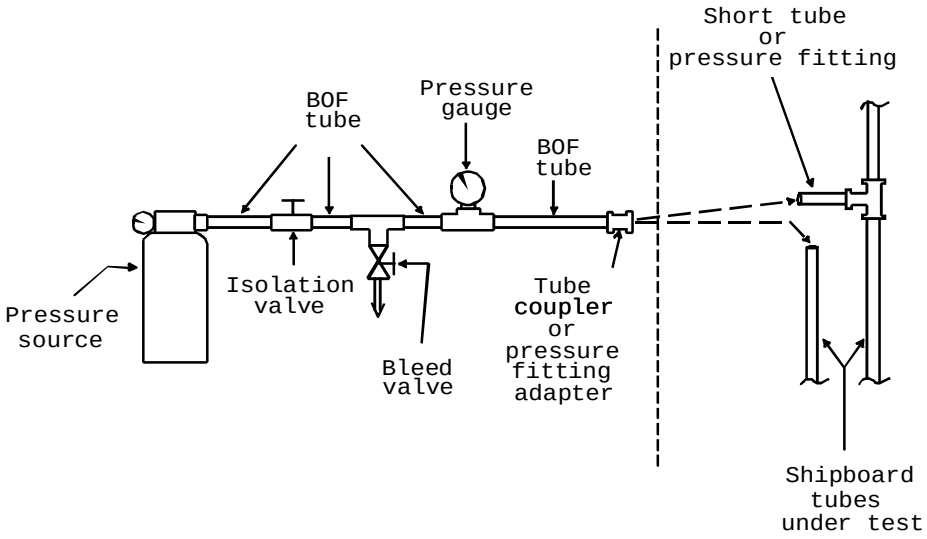


FIGURE 6J1-1. BOF tube seal verification test setup (typical).

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), 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 Method 2F1 or Method 2J1 of this Standard Practice and retested.

Step 8 – If the testing was performed on a BOF tube end, end seal the BOF tube end in accordance with Method 2J1 of this Standard Practice.

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 Method 2J1 of this Standard Practice.

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 connection of the tee tube coupler and firmly seat it within the tube coupler. Apply an axial load of approximately 22 N (5 lbs) 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. REQUIRED EQUIPMENT AND MATERIALS.

2.1 Equipment and materials. The equipment and materials in table 6K1-I shall be used to perform these procedures.

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.

TABLE 6K1-I. Equipment and materials.

Description	Quantity
Optical Return Loss Meter (Noyes Fiber Systems model ORL 3 or equal)	1
Optical Return Loss Meter (ORLM) interface cable (COTS SC/APC to COTS SC jumper cable)	1
ST to ST adapter (Lucent 105 271 142 or equal)	As required
Hybrid adapter, ST to SC (AMP 503638-2 or equal)	As required
Hybrid adapter, ST to COTS connector	As required
Measurement quality jumper cables (NAVSEA DWG 6877804)	As required
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol or equal (sealable type)	1
Canned air or compressed air	As required
Protective caps	As required

3. PROCEDURE.

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

a. When visually inspecting an optical fiber, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure.

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.

NOTE: Ensure the test equipment calibration is current.

NOTE: Use a wipe dampened with alcohol to clean the adapters/connectors and wipe them dry with a clean, lint free, cotton (100%) cloth before making the connections.

NOTE: This procedure involves the use of Measurement Quality Jumper cables (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 the Naval Surface Warfare Center (see 1.1.1).

NOTE: Make sure of the specified return loss for the cable assembly under test. Use standard dome polish MQJs for test of cable assemblies with return loss requirements not less than 30 dB. Use enhanced dome polish MQJs for test 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 nm wavelength (if the ORLM can perform return loss measurements at multiple wavelengths).

Step 4 - Attach the SC/APC connector of the ORLM interface cable to the optical receptacle of the ORLM.

NOTE: The SC/APC connector is an angle polished SC connector. The angle on the end of the connector ferrule can be observed in a visual inspection.

NOTE: If the ORLM input port is an ST connection, do not use an ORLM interface cable.

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

NOTE: If the ORLM input port is an ST connection, 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. MQJs for cable assembly return loss measurements.

Termination on cable end	Fiber polish type	MQJ part number
M83522	SM SM (enhanced)	6877804-5SM 6877804-5SME
COTS ST	SM SM (enhanced)	6877804-5SM 6877804-5SME
COTS SC (see NOTE 1)	SM SM (enhanced)	6877804-5SM 6877804-5SME
M28876 4 CH PLUG	SM SM (enhanced)	6877804-8SM 6877804-8SME
M28876 4 CH RECEPT	SM SM (enhanced)	6877804-7SM 6877804-7SME
M28876 8 CH PLUG	SM SM (enhanced)	6877804-10SM 6877804-10SME
M28876 8 CH RECEPT	SM SM (enhanced)	6877804-9SM 6877804-9SME
M28876 31 CH PLUG	SM SM (enhanced)	6877804-13SM 6877804-13SME
M28876 31 CH RECEPT	SM SM (enhanced)	6877804-12SM 6877804-12SME
Other (see NOTEs 1 and 2)	SM SM (enhanced)	6877804-5SM 6877804-5SME

NOTE 1: Use the ST to ST MQJ with a hybrid adapter (for example, an ST to SC hybrid adapter) to connect to optical fiber cable ends terminated with connectors other than the ST and the MIL-C-28876.

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

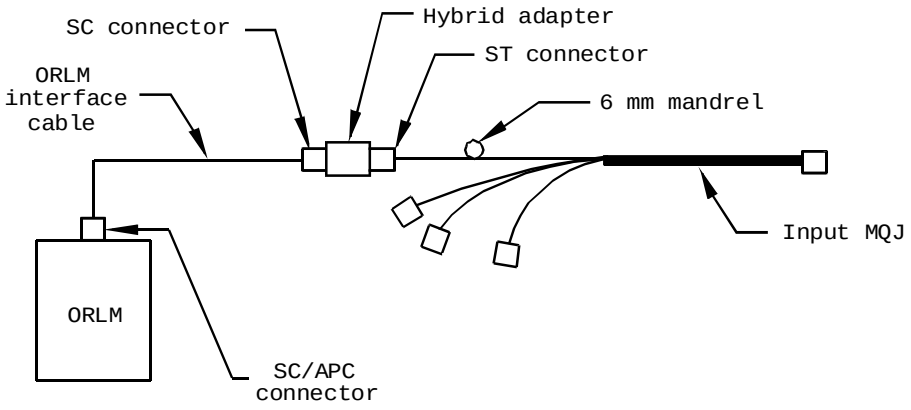


FIGURE 6K1-1. ORLM reference setup (typical).

Step 6 - Wrap the input MQJ (or the appropriate single fiber cable of the input MQJ) around a 6 mm (0.25 in) 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, then reconnect the ORLM interface cable to the input MQJ and repeat steps 6, 7, 8 and 9. If this does not remedy the problem, then clean the ORLM interface cable and the input MQJ connections, and repeat steps 4 through 9.

Step 10 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

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

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the input MQJ to the optical fiber cable assembly under test.

Step 11 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

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 in figure 6K1-2.

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the output MQJ to the optical fiber cable assembly under test.

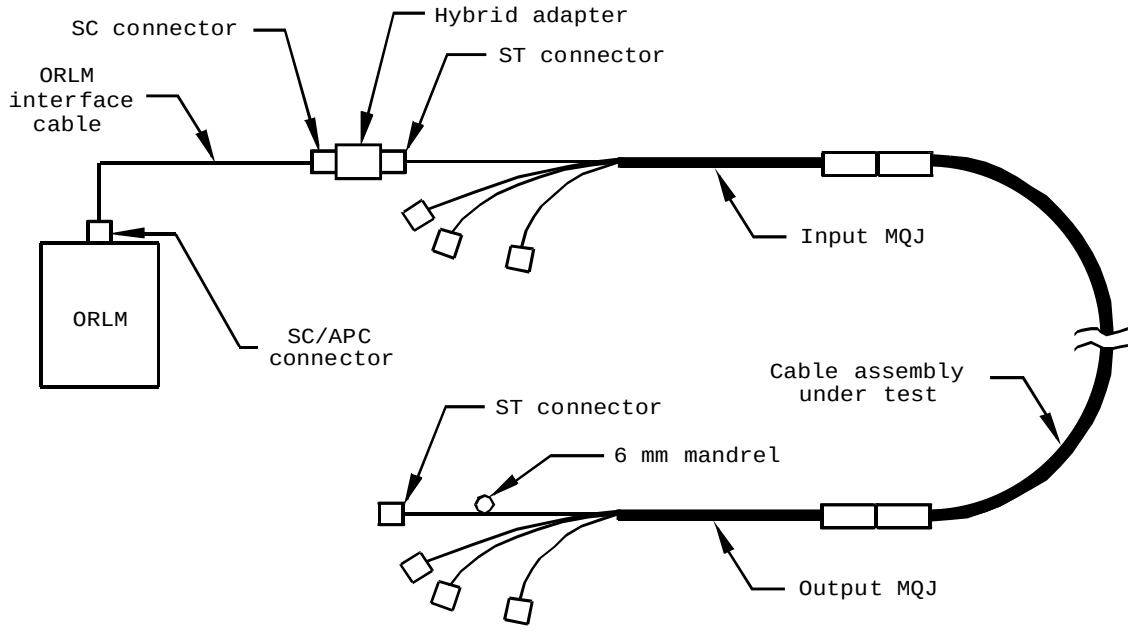


FIGURE 6K1-2. ORLM cable assembly measurement setup (typical).

Step 12 - Wrap the output MQJ (or the appropriate single fiber cable of the output MQJ) around a 6 mm (0.25 in) 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 3.3.

3.3 Cable assembly return loss.

Step 1 - Verify the measured return loss is 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 below. If the measured return loss is less than the minimum cable assembly return loss, proceed to step 2 below.

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.

Step 3 - If the optical fiber cable assembly is not going to be immediately connected to its mating connectors, install protective caps 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 on single mode optical fiber cable FOCT links only when specified by the contract.

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 Equipment and materials. The equipment and materials in table 6L1-I shall be used to perform these procedures.

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.

TABLE 6L1-I. Equipment and materials.

Description	Quantity
Optical Return Loss Meter (Noyes Fiber Systems model ORL 3 or equal)	1
Optical Return Loss Meter (ORLM) interface cable (COTS SC/APC to COTS SC jumper cable)	1
ST to ST adapter (Lucent 105 271 142 or equal)	As required
Hybrid adapter, ST to SC (AMP 503638-2 or equal)	As required
Hybrid adapter, ST to COTS connector	As required
Measurement quality jumper cables (NAVSEA DWG 6877804)	As required
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol or equal (sealable type)	1
Canned air or compressed air	As required
Protective caps	As required

3. PROCEDURE.

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

a. When visually inspecting an optical fiber, never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure.

WARNING: When visually inspecting an optical fiber, never 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/connectors and wipe them dry with a clean, lint free, cotton (100%) cloth before making the connections.

NOTE: This procedure involves the use of Measurement Quality Jumper cables (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. Additional guidance on establishing an MQJ verification program can be obtained from the Naval Surface Warfare Center (see 1.1.1).

NOTE: Make sure of the specified return loss for the link under test. Use standard dome polish MQJs for test of links with return loss requirements not less than 30 dB. Use enhanced dome polish MQJs for test of link 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 nm wavelength (if the ORLM can perform return loss measurements at multiple wavelengths).

Step 4 - Attach the SC/APC connector of the ORLM interface cable to the optical receptacle of the ORLM.

NOTE: The SC/APC connector is an angle polished SC connector. The angle on the end of the connector ferrule can be observed in a visual inspection.

NOTE: If the ORLM input port is an ST connection, do not use an ORLM interface cable.

Step 5 - Select the applicable input MQJ from table 6L1-II, and connect the input MQJ to the ORLM interface cable using the hybrid adapter as shown in figure 6L1-1.

NOTE: If the ORLM input port is an ST connection, 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 10.

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

Termination on FOCT link end	Fiber polish type	MQJ part number
M83522	SM SM (enhanced)	6877804-5SM 6877804-5SME
COTS ST	SM SM (enhanced)	6877804-5SM 6877804-5SME
COTS SC (see NOTE 1)	SM SM (enhanced)	6877804-5SM 6877804-5SME
M28876 4 CH PLUG	SM SM (enhanced)	6877804-8SM 6877804-8SME
M28876 4 CH RECEPT	SM SM (enhanced)	6877804-7SM 6877804-7SME
M28876 8 CH PLUG	SM SM (enhanced)	6877804-10SM 6877804-10SME
M28876 8 CH RECEPT	SM SM (enhanced)	6877804-9SM 6877804-9SME
M28876 31 CH PLUG	SM SM (enhanced)	6877804-13SM 6877804-13SME
M28876 31 CH RECEPT	SM SM (enhanced)	6877804-12SM 6877804-12SME
Other (see NOTEs 1 and 2)	SM SM (enhanced)	6877804-5SM 6877804-5SME

NOTE 1: Use the ST to ST MQJ with a hybrid adapter (for example, an ST to SC hybrid adapter) to connect to optical fiber cable ends terminated with connectors other than the ST and the MIL-C-28876.

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

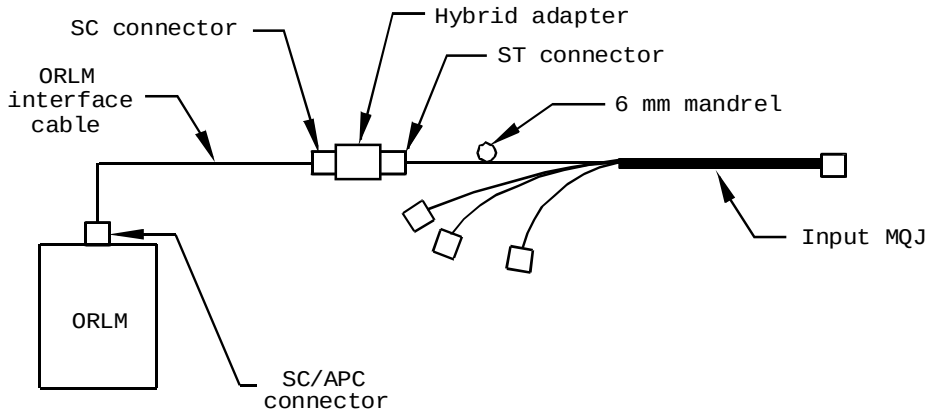


FIGURE 6L1-1. ORLM reference setup (typical).

Step 6 - Wrap the input MQJ (or the appropriate single fiber cable of the input MQJ) around a 6 mm (0.25 in) 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, then reconnect the ORLM interface cable to the input MQJ and repeat steps 6, 7, 8 and 9. If this does not remedy the problem, then clean the ORLM interface cable and the input MQJ connections, and repeat steps 4 through 9.

Step 10 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

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

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the input MQJ to the FOCT link under test.

Step 11 - CAUTION: Make sure that the keys are correctly aligned to the mating keyways before mating MQJs to MIL-C-28876 optical fiber cables. Incorrect keyway alignment will result in damage to the connector pins.

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 in figure 6L1-2.

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 or other COTS fiber optic connectors, a hybrid adapter is required to connect the output MQJ to the optical fiber cable assembly under test.

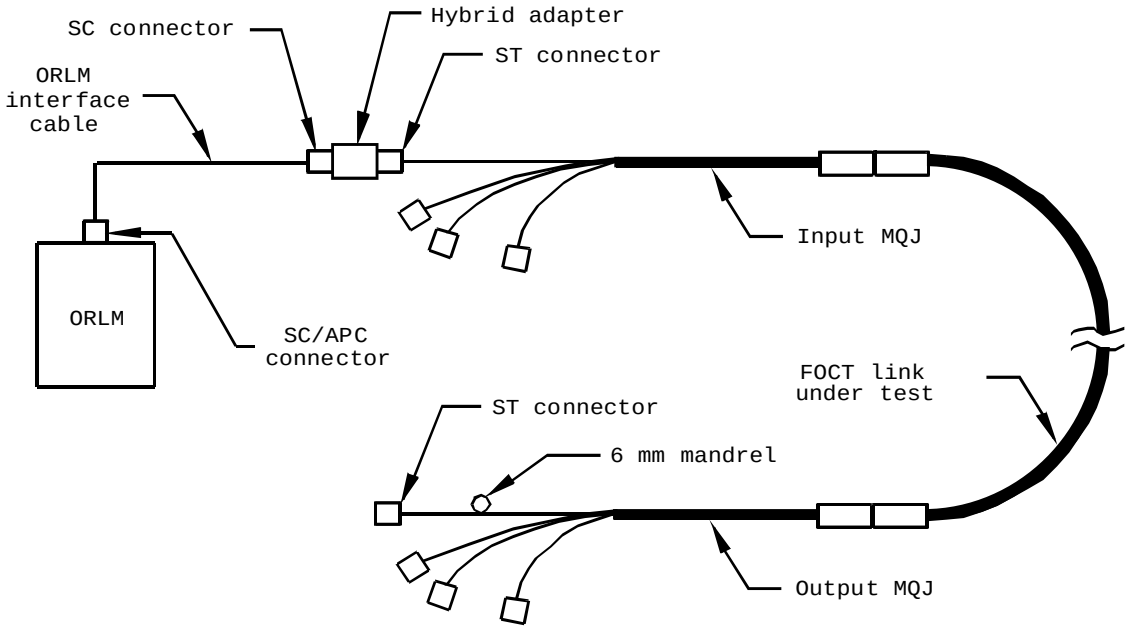


FIGURE 6L1-2. ORLM cable topology end-to-end measurement setup (typical).

Step 12 - Wrap the output MQJ (or the appropriate single fiber cable of the output MQJ) around a 6 mm (0.25 in) 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 FOCT link under test.

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 9 through 15 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 5 through 15 for the other fibers in the FOCT link under test.

Step 16 -Proceed to 3.3.

3.3 Cable topology end-to-end return loss.

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 below. If the measured return loss is less than the specified FOCT link return loss, proceed to step 2 below.

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.

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

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-STD-2042-6	**2. DOCUMENT DATE (YYMMDD)**

3. DOCUMENT TITLE
FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR NAVAL SHIPS (TESTS)

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Ruth Butler	b. TELEPHONE (Include Area Code) (1) Commercial (202) 781-3726 (2) AUTOVON 326-3726
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command ATTN: SEA 05Q 1333 Isaac Hull Avenue Southeast, Stop 5160 Washington Navy Yard, DC 20376-5160	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888