

METRIC

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DEPARTMENT OF DEFENSE  
STANDARD PRACTICE

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

(PART 6 OF 6 PARTS)



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: Commander, Naval Sea Systems Command, SEA 03K12, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160 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 seven parts; the basic Standard practice and six 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

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1. SCOPE

1.1 Scope. This standard practice provides detailed methods for testing fiber optic cable topology (see 3.4) installations.

1.1.1 Applicability. These procedures apply to fiber optic cables, connectors and splices and shall be performed during the installation phases specified. 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 to NAVSEA 03K12 for approval prior to implementation.

## 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 standards 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).

## DEPARTMENT OF DEFENSE SPECIFICATIONS

- |               |  |
|---------------|--|
| MIL-S-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-C-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 6 Parts).    |
| MIL-STD-2042-2 | - Fiber Optic Topology Installation Standard Methods for Naval Ships (Equipment)(Part 2 of 6 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.               |

(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.

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

3.3 End user equipment. End user equipment refers to any cabinet, case, panel, or device that contains components that are either the origin or destination of an optical signal.

3.4 Fiber optic cable topology. The fiber optic cable topology consists of fiber optic interconnection boxes, trunk and local cables and the connectors and splices used to interconnect the trunk and local cables.

3.5 Local cable. A local cable is a fiber optic cable that provides a continuous optical path between an interconnection box (or outlet) and an end user equipment or between an interconnection box and an outlet, and is typically not run through the main cableways.

3.6 Measurement quality jumper. A measurement quality jumper is 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.

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

3.8 Outlet. An outlet is a small termination box used to break out a local cable from an interconnection box to one or more equipments within a compartment.

3.9 Trunk cable. A trunk cable is a fiber optic cable that provides a continuous optical path between interconnection boxes. Typically, trunk cables are run in the main cableways and have higher fiber counts per cable than local cables.

## 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 fiber optic cable topology (see 3.4). These tests shall be performed during various phases of installation of the fiber optic cable topology, as described in the following paragraphs.

4.1.1 Acceptance tests. Fiber optic cable and associated components shall undergo visual inspection and testing upon receipt at the shipyard. The cable shall be tested while still on the shipping reel to ensure that it is mechanically and optically sound. The associated fiber optic components shall be subjected to visual examination only.

4.1.2 Pre-Installation tests. Visual inspection and testing of the cable shall be conducted just prior to installation in the cableways to verify that it is still mechanically and optically sound.

4.1.3 Installation tests. After the cable is installed in the cableways, the pre-installation tests shall be repeated to verify that fibers were not broken or damaged when the cable was pulled through the cableways. Additional testing shall be conducted subsequent to 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 fiber optic cable topology links have been installed, tests shall be conducted to verify that the end-to-end attenuation of the fiber optic cable topology 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. Test jumpers are used to couple light from the stabilized source to the optical link under test, and from the fiber path to the power meter. It is imperative that these test jumpers contain the same type of fiber and connectors as the optical link and meet the requirements identified in Method 6F1 of this standard practice.

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 unit. The OLTS displays 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 talk set. The optical talk set is used to establish two-way voice communication over an optical fiber. The talk set can be used to verify optical link continuity and to expedite other tests.

4.2.5 Measurement quality jumpers. Measurement quality jumpers are required for connecting cable assemblies to test equipment. Measurement quality jumpers may be acquired using NAVSEA DWG 6877804. Typical jumper configurations are shown in table I. Cable assembly cables shall be in accordance with MIL-C-85045. Terminations shall be in accordance with the following:

- a. Single terminus (light duty) connector, MIL-C-83522/16
- b. Multiple terminus (heavy duty) connector, MIL-C-28876
- c. Connector terminus, MIL-T-29504/14 or /15
- d. Splice ferrule, MIL-S-24623/4

The jumpers used in conjunction 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. Test jumper configurations.

CONFIGURATION	TERMINATION TYPE	LENGTH (min) (m)	CABLE TYPE M85045/	TERMINATION 1	TERMINATION 2
A	ST/ST	1	16-01	M83522/16-DNX	M83522/16-DNX
B	ST/SPLICE FERRULE	1	16-01	M83522/16-DNX	M24623/4-01
C	ST/4 CH PLUG	1	15-01	M83522/16-DNX	Packard Hughes 1145846-B042P0S
D	ST/4 CH RECEPT	1	15-01	M83522/16-DNX	Packard Hughes 1145840-B042S0S
E	ST/8 CH PLUG	1	13-01	M83522/16-DNX	Packard Hughes 1145846-C081P0S
F	ST/8 CH RECEPT	1	13-01	M83522/16-DNX	Packard Hughes 1145840-C081S0S
G	ST/ST LONG	50	16-01	M83522/16-DNX	M83522/16-DNX
H	ST/SPLICE FERRULE	50	16-01	M83522/16-DNX	M24623/4-01
I	ST/PIN TERMINUS	50	16-01	M83522/16-DNX	M29504/14-4131C
J	ST/SOCKET TERMINUS	50	16-01	M83522/16-DNX	M29504/15-4171C
K	ST/BARE FIBER	50	16-01	M83522/16-DNX	N/A

4.2.6 Bare fiber adapters. Bare fiber adapters are required for connecting cables that do not have connectors installed to test equipment. A bare fiber adapter may have a MIL-C-83522 compatible connector on one end and a holding mechanism for stripped fiber on the other end or may be a temporary splice which mates the end of the fiber under test to the end of an equipment jumper cable.

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 cable continuity test is a simple test to verify that there is no major damage to or breakage of a fiber. This test can be accomplished with any portable light source, such as a flashlight, or with the optical talk set.

4.3.3 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.

4.3.4 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 a 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.

4.3.5 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 3.2). Typically, this test is performed after interconnection of the fiber optic cable topology 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.

4.4 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 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. 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. Wash your hands after handling bare fibers or performing fiber terminations.
- f. Observe all warning signs when handling solvents and epoxies. Become familiar with the first aid instructions for these agents.

## 5. DETAILED REQUIREMENTS

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

5.1.1 Cable. The tests to be performed on cables will be determined by the cable configurations as follows:

- a. Visual inspection, Method 6A1 - all cables.
- b. Cable attenuation test, Method 6B1 - 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.
- c. Cable assembly link loss test, Method 6C1 - cables with connectors or splice ferrules installed on both ends.
- d. Cable continuity test, Method 6D1 - cables less than 50 m (165 feet) in length without connectors or splice ferrules installed on both ends.

5.1.2 Connectors, splices, and interconnection boxes. All components shall 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 will be determined by the cable configuration as follows:

- a. Visual inspection, Method 6A1 - all cables.
- b. Cable continuity test, Method 6D1 - all cables.

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 Cable. The installation tests will be performed in two phases, as follows:

- a. Phase 1 - Immediately after the 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).
- b. Phase 2 - After installation of connectors or splices on the cable such that the cable is terminated on both ends, perform the cable assembly link loss test, Method 6C1.

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

- a. If required by the contracting activity, 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 fiber optic cable topology 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.

5.5 Measurement quality jumper selection tests. Before placing measurement quality jumpers into use, they shall be tested in accordance with Method 6F1. The cables will 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 fiber optic cable topology 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 alpha-numeric 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

Then the designation system was completed as follows:

```

6   B   1 - 2
*   *   *   *
*   *   *   *
*   *   *   .))))      Alternate procedures within method
*   *   .)))))))))      Method number within group
*   .)))))))))          Functional group
.)))))))))             MIL-STD-2042 Part number
    
```

Thus, method 6B1-2 identifies the second alternate procedure within method 1 of group B in Part 6 (MIL-STD-2042-6) of MIL-STD-2042.

6.4 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

Preparing activity:  
 NAVY - SH  
 (Project GDRQ-N169-6)

## METHOD 6A1

## VISUAL INSPECTION OF FIBER OPTIC COMPONENTS

## 1. SCOPE.

1.1 Scope. This method describes a procedure for a visual inspection of fiber optic cables and associated fiber optic cable topology 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, the 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 cable conforms to the requirements of MIL-C-85045. Record all of the 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 cable for the following: (NOTE: For cable on a reel, examine that portion of the 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.

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 cables 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. 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 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	1
Canned air or compressed air	As required
Ruler	1
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 cable shall be protected from kinks, twists, crushing, and sharp bends. (See Part 1 of this standard practice for more detailed cable handling procedures.)

Step 1 - Select one end of the cable.

Step 2 - Using the cable stripper, remove approximately 305 mm (12 inches) of the outer jacket from the unterminated end of the 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 OFCC's 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 inches) 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 25 mm (1 inch) 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 inch)) 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 inch) 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 OFCC's in the 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
Test jumper cables (in accordance with Method 6F1 of this standard practice)	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	1
Wipes	As required
Canned air or compressed air	As required

- NOTES:
- These procedures were developed from EIA/TIA-455-61 (FOFP 61) "MEASUREMENT OF FIBER OR CABLE ATTENUATION USING AN OTDR."
  - Ensure the test equipment calibration is current.
  - Use a wipe dampened with alcohol to clean all adapters/connectors and blow them dry with air before making connections.
- Step 1 - **WARNING:** Do not stare into the end of a fiber connected to an LED or laser diode. Light may not be visible but can still damage the eye.
- Following the OTDR manufacturer's instructions, energize the OTDR. If the cable group index is not known, proceed to step 2. If the 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 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).

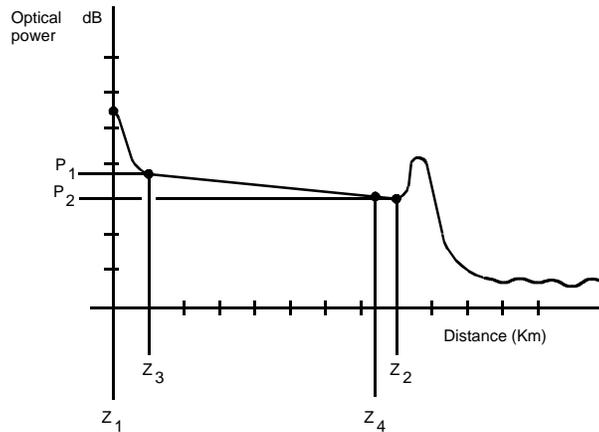


FIGURE 6B1-1. OTDR Display - (typical).

- 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 scale 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 cable under test. (NOTE: If the cable is terminated on one end, select that end.)
- Step 9 - Select the applicable jumper cable configuration (see table I in this part of this standard practice) from table 6B1-III. Connect the cable under test to the OTDR using the applicable view on figure 6B1-2.

TABLE 6B1-III. Test jumpers and adapters.

TERMINATION TO BE CONNECTED TO OTDR	REQUIRED JUMPER CONFIGURATION	APPLICABLE VIEW FIGURE 6B1-2
Bare fibers	K	1
M83522	G	2
M24623	H	3
M28876 4 CH PLUG	J	4
M28876 4 CH RECEPT	I	4
M28876 8 CH PLUG	J	4
M28876 8 CH RECEPT	I	4

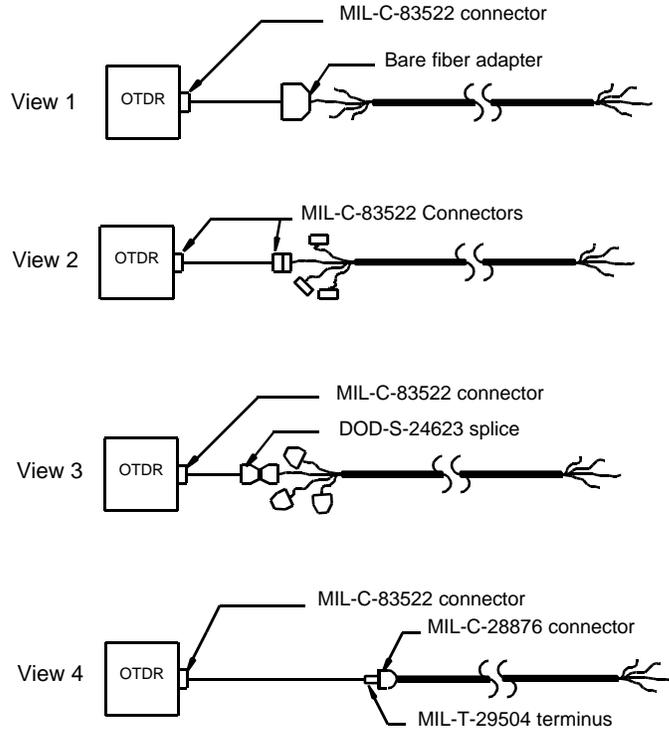


FIGURE 6B1-2. Test setup variations.

- 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 cable under test (see figure 6B1-3). Record the cable length ( $z_2 - z_1$ ) and confirm that the measured length matches the length of the cable under test.

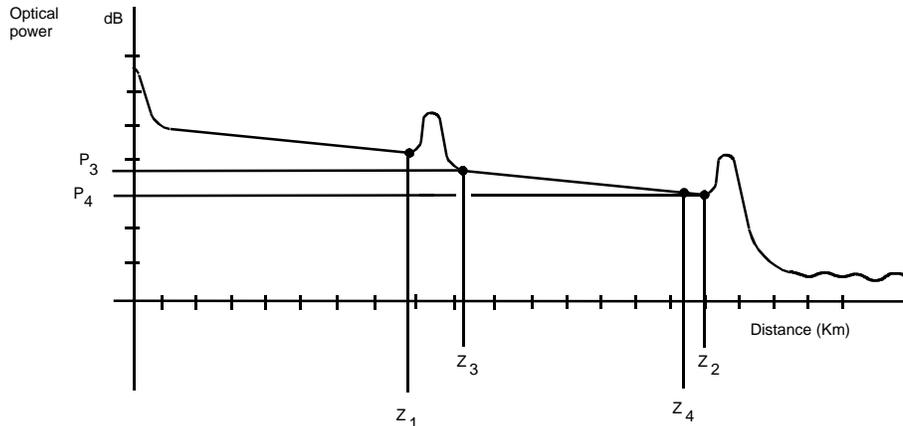


FIGURE 6B1-3. OTDR Display - (typical).

- Step 12 - Adjust and place the cursor at the beginning ( $z_1$ ) and end ( $z_4$ ) of the linear portion of the trace for the cable under test (see figure 6B1-3). Record the cable attenuation in dB. The OTDR may automatically calculate the 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 cable.
- Step 14 - The 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-C-85045. (NOTE: If the maximum measured attenuation for a fiber exceeds the above values, the cable may have been damaged.)
- Step 15 - If the cable is not going to be installed in a cableway within 48 hours, end seal the 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 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. 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. Cable assemblies terminated in connectors do not require the performance of this procedure. 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	As required
Index matching gel (MIL-M-24794)	As required
Splice alignment tool (NAVSEA DWG 6872812-5 or equal)	1

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

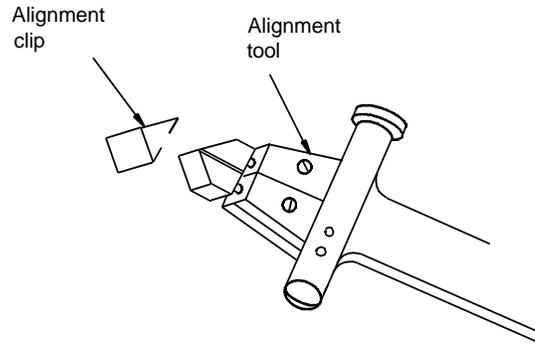


FIGURE 6C1-1. Opening the alignment sleeve.

- 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).

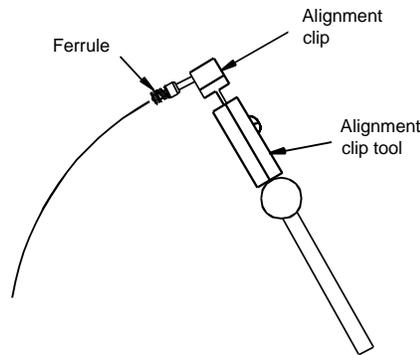


FIGURE 6C1-2. Inserting the ferrule into the alignment sleeve.

- 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.

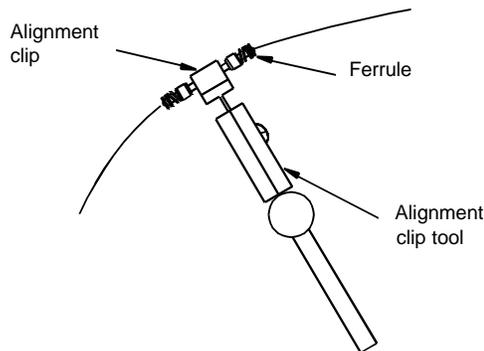
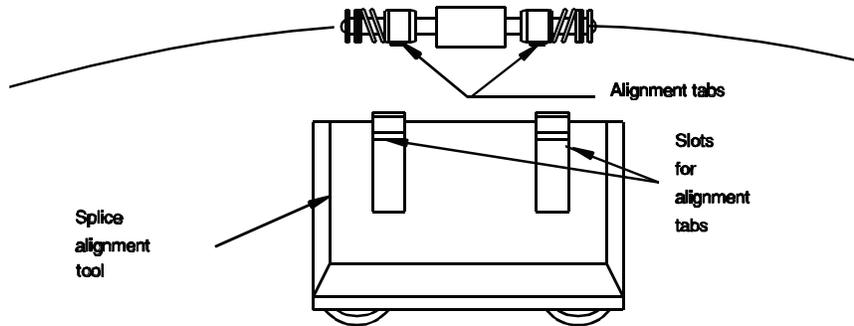


FIGURE 6C1-3. Inserting the second ferrule into the alignment sleeve.

- 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.

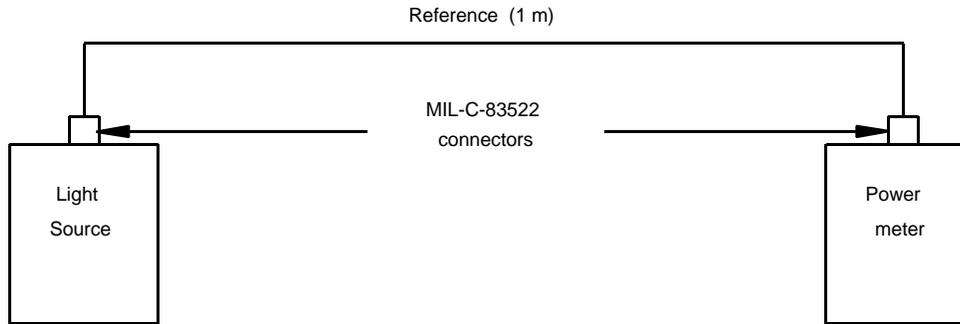
DESCRIPTION	QUANTITY
Wipes (NAVSEA DWG 6872811-18 or equal)	As required
Alcohol bottle with alcohol/2-propanol	1
Canned air or compressed air	As required
Test reference cable (in accordance with Method 6F1 of this standard practice)	1
Test jumper cables (in accordance with Method 6F1 of this standard practice)	As required
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
End seals (in accordance with part 1 of this standard practice)	As required

- NOTES:
1. Ensure the test equipment calibration is current.
  2. Use a wipe dampened with alcohol to clean the adapters/connectors and blow them dry with air before making the connections.
  3. Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

Step 1 - Record the length of the cable from the vendor's data or as measured.

Step 2 - **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.

Connect the test reference cable (configuration A in table I in this part of this standard practice) between the light source and the power meter and record the power (in dBm) at the meter ( $P_1$ ) (see figure 6C1-5).

FIGURE 6C1-5. 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 measurements.

Step 3 - **CAUTION:** Make sure that the keys are correctly aligned to the mating keyways before mating jumper cables to MIL-C-28876 test cables. Incorrect keyway alignment will result in damage to the connector pins.

Select the applicable jumper cable configurations (see table I in this part of this standard practice) from table 6C1-III, and connect the test cable to the light source and the power meter as shown in the applicable view of figure 6C1-6. For cable assemblies terminated in splice ferrules use Procedure I to assemble the cable assembly splice ferrules to the jumper cable splice ferrules.

Note: For cables with single terminus connectors, the reference cable should be used as  $J_1$ .

TABLE 6C1-III. Test jumper configurations.

TERMINATION AT LIGHT SOURCE END	SOURCE JUMPER ( $J_1$ ) CONFIGURATION	TERMINATION AT POWER METER END	POWER METER JUMPER ( $J_2$ ) CONFIGURATION	VIEW FIG. 6C1-5
M83522	A	M83522	A	1
M83522	A	M24623	B	2
M83522	A	M28876 4 CH PLUG (RECEPT)	C (D)	3
M83522	A	M28876 8 CH PLUG (RECEPT)	E (F)	
M24623	B	M83522	A	4
M24623	B	M24623	B	5
M24623	B	M28876 4 CH PLUG (RECEPT)	C (D)	6
M24623	B	M28876 8 CH PLUG (RECEPT)	E (F)	
M28876 4 CH PLUG (RECEPT)	C (D)	M83522	A	7
M28876 4 CH PLUG (RECEPT)	C (D)	M24623	B	8

TABLE 6C1-III. Test jumper configurations - continued.

TERMINATION AT LIGHT SOURCE END	SOURCE JUMPER (J <sub>1</sub> ) CONFIGURATION	TERMINATION AT POWER METER END	POWER METER JUMPER (J <sub>2</sub> ) CONFIGURATION	VIEW FIG. 6C1-5
M28876 4 CH PLUG (RECEPT)	C (D)	M28876 4 CH PLUG (RECEPT)	C (D)	9
M28876 8 CH PLUG (RECEPT)	E (F)	M83522	A	7
M28876 8 CH PLUG (RECEPT)	E (F)	M24623	B	8
M28876 8 CH PLUG (RECEPT)	E (F)	M28876 8 CH PLUG	E (F)	9

- Step 4 - Record the power (in dBm) at the meter (E<sub>2</sub>).
- Step 5 - Calculate the cable assembly link loss using the following formula and record the results:

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

Where: B<sub>CA</sub> = Total cable assembly link loss in dB  
P<sub>1</sub> = Reference power in dBm  
P<sub>2</sub> = Test power in dBm

- Step 6 - Repeat steps 2, 3, 4, and 5 for each fiber in the cable.
- Step 7 - Repeat steps 2, 3, 4, 5, and 6 and remeasure the cable loss in the opposite direction.
- Step 8 - Identify the connectors/splices by type and proceed to 3.3.2 below.

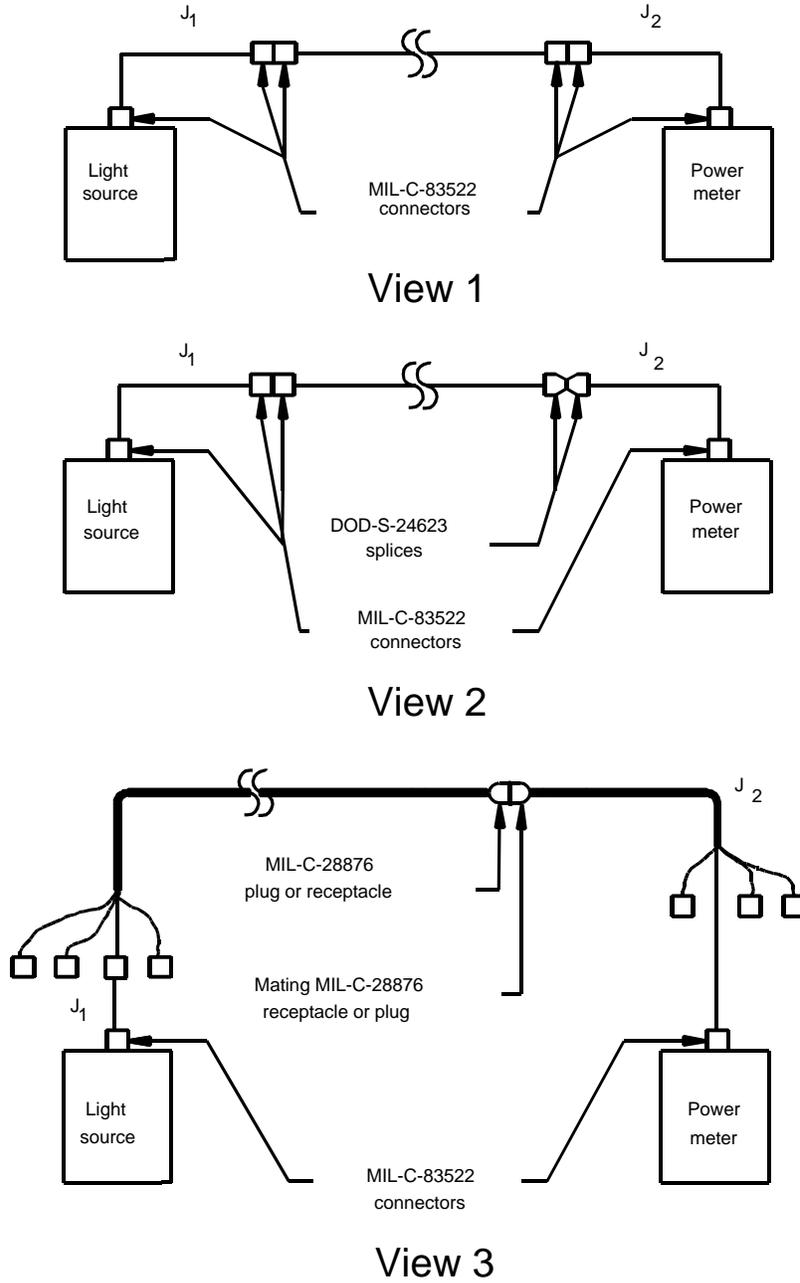
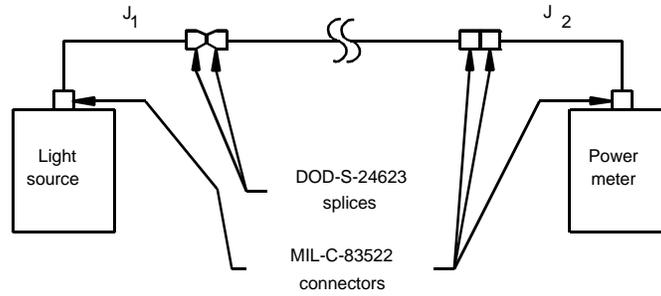
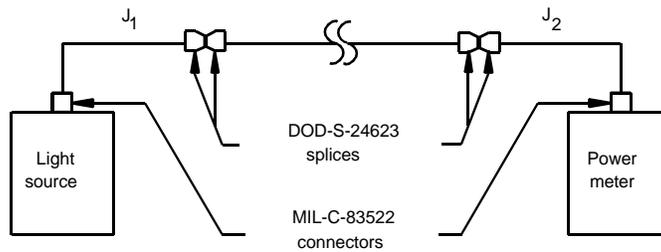


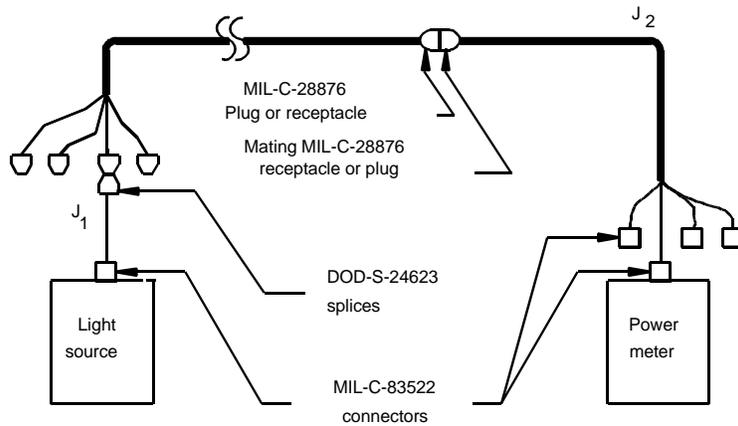
FIGURE 6C1-6. Test setup options.



View 4

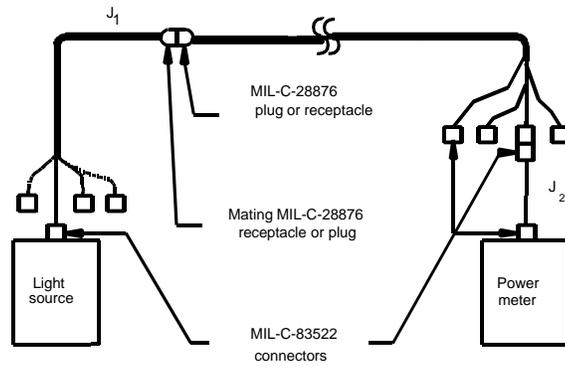


View 5

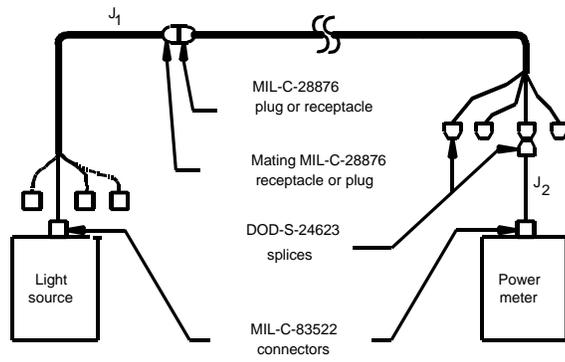


View 6

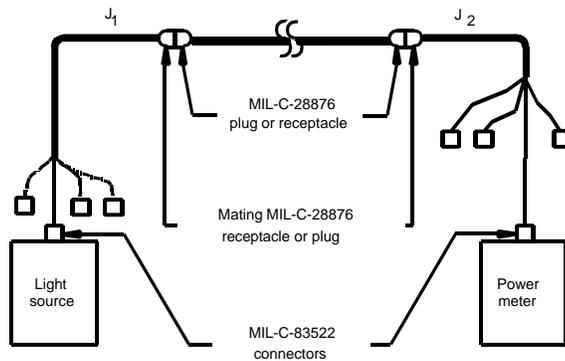
FIGURE 6C1-6. Test setup options - continued.



View 7



View 8



View 9

FIGURE 6C1-6. Test setup options - continued.

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 cable assembly is considered satisfactory if the measured loss in each direction does not exceed the loss specified by the vendor for the cable assembly. If either measured loss is greater than the vendor specified loss, proceed to step 2 below.
- Step 2 - Compare the measured loss in each direction 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:

$$MAL = (A_{ca}) (L) + \sum L_{co} + \sum L_s$$

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

The cable assembly is considered acceptable if the measured loss in each direction is equal to or less than the maximum acceptable loss. If the measured loss in both directions is acceptable, proceed to step 4 below. If measured loss in either direction is greater than the maximum acceptable loss, proceed to step 3 below.

TABLE 6C1-IV. Maximum component loss values.

Component	Single mode	Multimode
Cable	1.0 dB/km	2.0 dB/km
Single terminus (light duty) connector (mated pair)	1.0 dB	1.0 dB
Multiple terminus (heavy duty) connector (mated pair)	1.0 dB	1.0 dB
Mechanical splice	0.2 dB tuned 0.6 dB untuned	0.2 dB tuned 0.6 dB untuned

- Step 3 - If the measured loss in either direction is 0.5 dB or more above the maximum acceptable loss, reject the cable assembly. If the measured loss in either direction 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 is still unacceptable, reterminate or replace the defective components.
- Step 4 - If the cable is not going to be installed in a cableway within 48 hours, install protective caps over the connectors or splices or end seal in accordance with Method 1A1 in Part 1 of this standard practice.

## METHOD 6D1

## CABLE CONTINUITY TEST

## 1. SCOPE.

1.1 Scope. This method describes a procedure for performing a cable continuity test on 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
Optical intercom	1
Alcohol bottle with alcohol/2-propanol	As required
Wipes	As required
Canned air or compressed air	As required
Flashlight	1

## 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. 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 the optical intercom or other available communication equipment.
- Step 2 - Using a wipe dampened with alcohol, clean the fibers on both ends of the 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.

## 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 fiber optic cable topology 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. Never stare into the end of a fiber connected to a laser source or LED.

3.2 Procedure I. Cable topology 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. Cable topology links terminated in connectors do not require the performance of Procedure I. Cable topology 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
Splice alignment clip tool (NAVSEA DWG 6872812-1 or equal)	1
Splice alignment sleeve	As required
Index matching gel (MIL-M-24794)	As required
Splice alignment tool (NAVSEA DWG 6872812-5 or equal)	1

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).

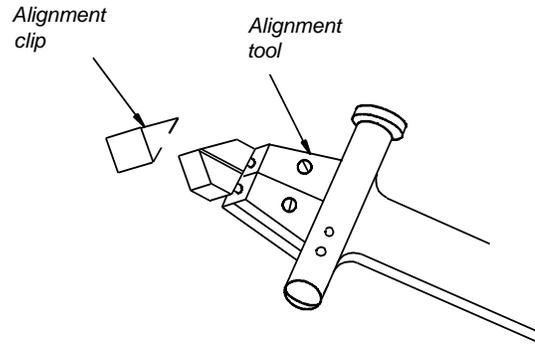


FIGURE 6E1-1. Opening the alignment sleeve.

- 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).

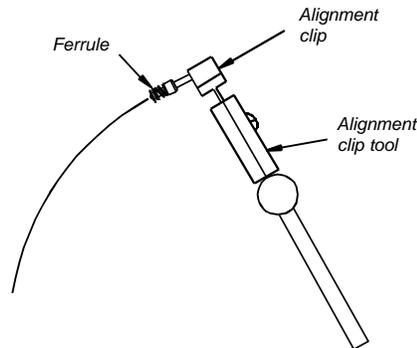


FIGURE 6E1-2. Inserting the ferrule into the alignment sleeve.

- 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 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.

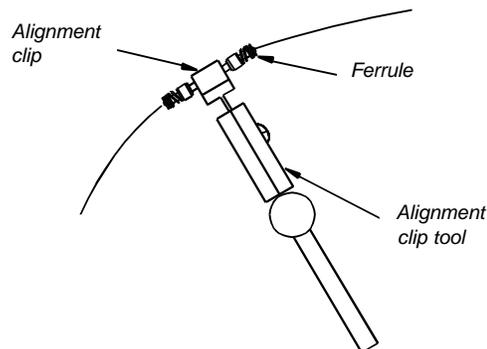
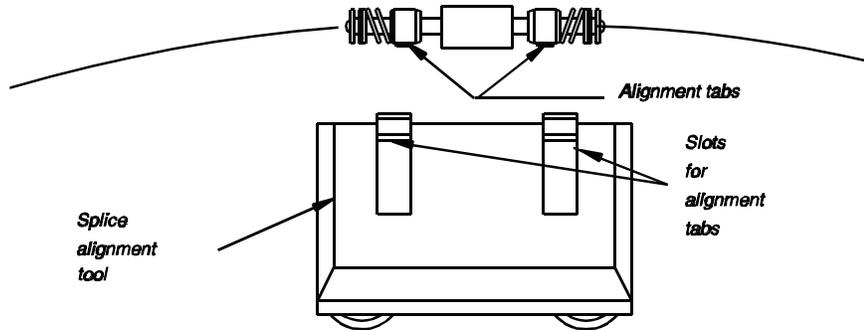


FIGURE 6E1-3. Inserting the second ferrule into the alignment sleeve.

- 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	1
Canned air or compressed air	As required
Test reference cable (in accordance with Method 6F1 of this standard practice)	1
Test jumper cables (in accordance with Method 6F1 of this standard practice)	As required
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
End seals (in accordance with part 1 of this standard practice)	As required

- NOTES:
1. Ensure the test equipment calibration is current.
  2. Use a wipe dampened with alcohol to clean the adapters/connectors and blow them dry with air before making the connections.
  3. Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

Step 1 - **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.

Connect the test reference cable (configuration A in table I in this part of this standard practice) between the light source and the power meter and record the power (in dBm) at the meter ( $P_1$ ) (see figure 6E1-5).

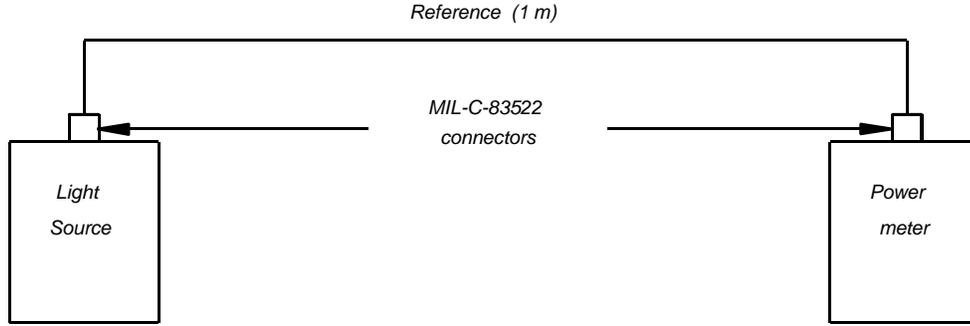


FIGURE 6E1-5. Connecting the reference cable.

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

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

Select the applicable jumper cable configurations (see table I in this part of this standard practice) from table 6E1-III, and connect the fiber optic topology link to the light source and the power meter as shown in the applicable view of figure 6E1-6. For cable topology links terminated in splice ferrules use Procedure I to assemble the cable topology link splice ferrules to the jumper cable splice ferrules.

NOTE: For cables with single terminus connectors, the reference cable should be used as  $J_1$ .

TABLE 6E1-III. Test jumper configurations.

TERMINATION AT LIGHT SOURCE END	SOURCE JUMPER ( $J_1$ ) CONFIGURATION	TERMINATION AT POWER METER END	POWER METER JUMPER ( $J_2$ ) CONFIGURATION	VIEW FIG. 6E1-5
M83522	A	M83522	A	1
M83522	A	M24623	B	2
M83522	A	M28876 4 CH PLUG (RECEPT)	C (D)	3
M83522	A	M28876 8 CH PLUG (RECEPT)	E (F)	
M24623	B	M83522	A	4
M24623	B	M24623	B	5
M24623	B	M28876 4 CH PLUG (RECEPT)	C (D)	6
M24623	B	M28876 8 CH PLUG (RECEPT)	E (F)	
M28876 4 CH PLUG (RECEPT)	C (D)	M83522	A	7
M28876 4 CH PLUG (RECEPT)	C (D)	M24623	B	8

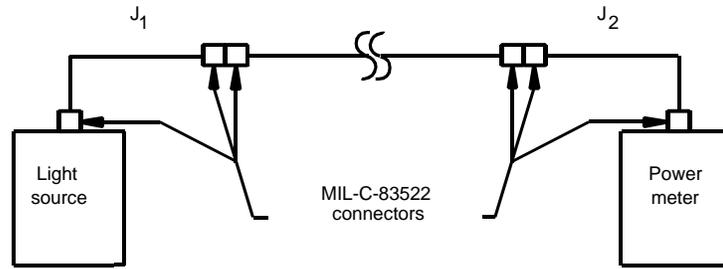
TERMINATION AT LIGHT SOURCE END	SOURCE JUMPER (J <sub>1</sub> ) CONFIGURATION	TERMINATION AT POWER METER END	POWER METER JUMPER (J <sub>2</sub> ) CONFIGURATION	VIEW FIG. 6E1-5
M28876 4 CH PLUG (RECEPT)	C (D)	M28876 4 CH PLUG (RECEPT)	C (D)	9
M28876 8 CH PLUG (RECEPT)	E (F)	M83522	A	7
M28876 8 CH PLUG (RECEPT)	E (F)	M24623	B	8
M28876 8 CH PLUG (RECEPT)	E (F)	M28876 8 CH PLUG	E (F)	9

- Step 4 - Record the power (in dBm) at the meter (P<sub>2</sub>).
- Step 5 - Calculate the cable topology end-to-end attenuation using the following formula and record the results:

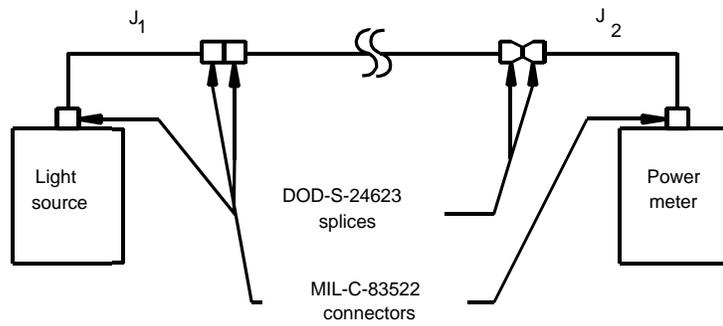
$$B_{TL} = (P_1 - P_2)$$

Where: B<sub>TL</sub> = Total cable topology end-to-end attenuation in dB  
P<sub>1</sub> = Reference power in dBm  
P<sub>2</sub> = Test power in dBm

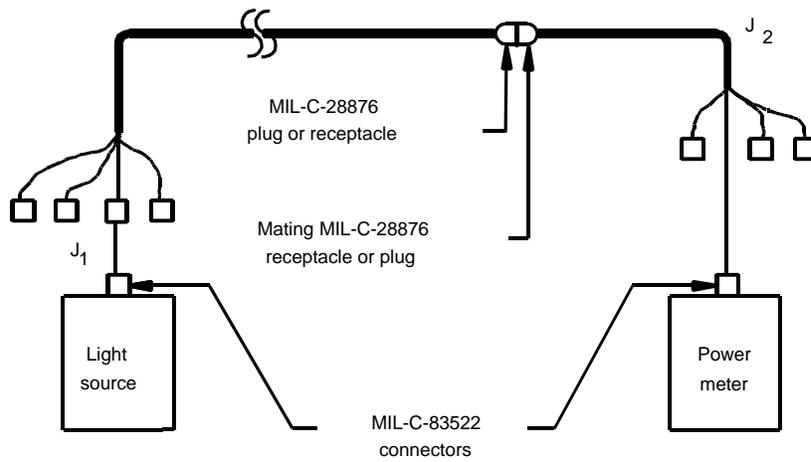
- Step 6 - Repeat steps 2, 3, 4, and 5 for each fiber in the cable.
- Step 7 - Repeat steps 2, 3, 4, 5, and 6 to measure the topology link in the opposite direction.
- Step 8 - Identify the connectors/splices by type.



View 1



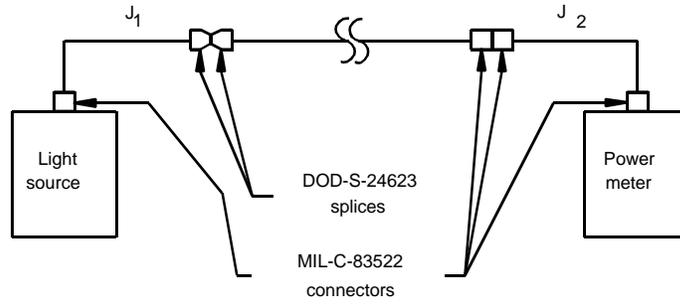
View 2



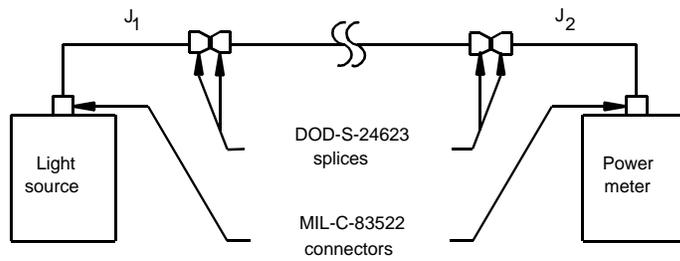
View 3

FIGURE 6E1-6. Test setup options.

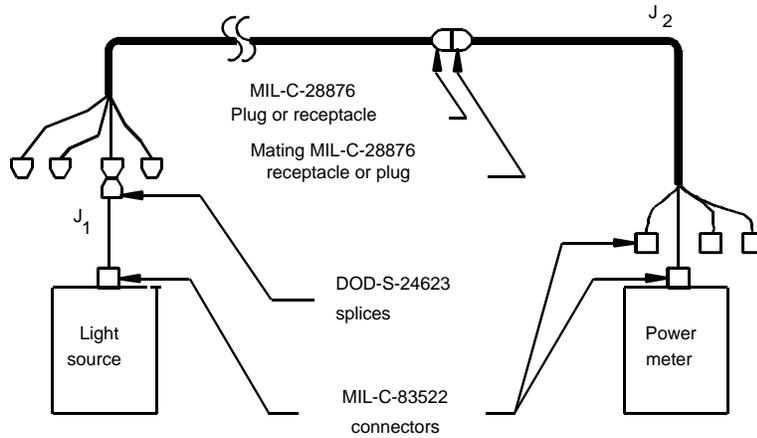




View 4

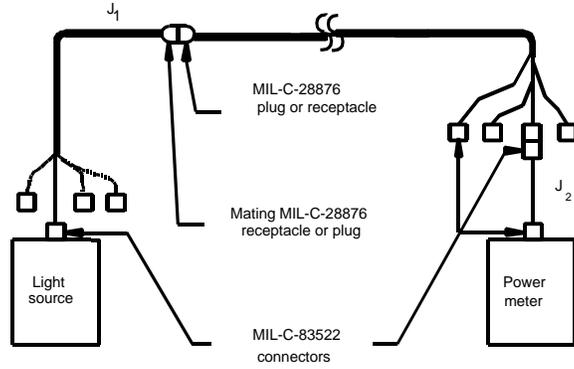


View 5

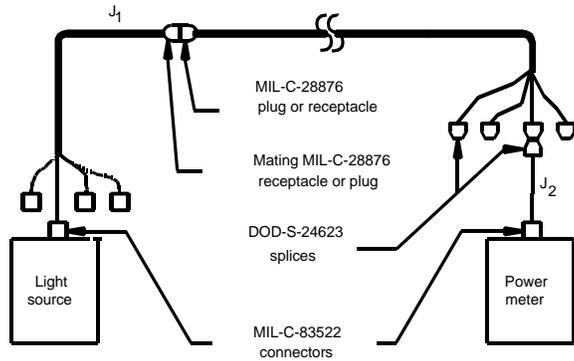


View 6

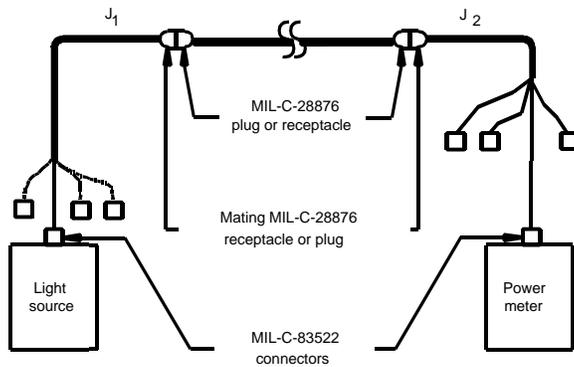
FIGURE 6E1-6. Test setup options - continued.



View 7



View 8



View 9

FIGURE 6E1-6. Test setup options - continued.

## 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:

$$MAL = (A_{ca}) (L) + \sum L_{co} + \sum L_s$$

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

The cable topology 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.

TABLE 6E1-IV. Maximum component loss values.

Component	Single mode	Multimode
Cable	1.0 dB/km	2.0 dB/km
Single terminus (light duty) connector (mated pair)	1.0 dB	1.0 dB
Multiple terminus (heavy duty) connector (mated pair)	1.0 dB	1.0 dB
Mechanical splice	0.2 dB tuned 0.6 dB untuned	0.2 dB tuned 0.6 dB untuned

- Step 2 - If the measured end-to-end attenuation is 1.0 dB or more above the maximum acceptable loss, reject the cable topology link. If the measured end-to-end attenuation is less than 1.0 dB above the maximum acceptable loss, disconnect and clean all of the connections and retest. If the end-to-end attenuation is still unacceptable, reterminate or replace the defective components.
- Step 3 - If the cable topology link is not going to be immediately connected to equipment, install protective caps over the connectors or splices or end seal in accordance with Method 1A1 in Part 1 of this standard practice.

## METHOD 6F1

## MEASUREMENT QUALITY JUMPER CABLE SELECTION TEST

## 1. SCOPE.

1.1 Scope. This method describes procedures for performing a measurement quality jumper cable selection test on jumper 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 bare fiber.
- c. Observe warnings and cautions on equipment and materials.
- d. 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	As required
Alcohol bottle with alcohol/2-propanol	1
Canned air or compressed air	As required
Test reference cable (ST on both ends)	1
Test reference cable (ST to MIL-T-29504/14 pin terminus)	1
Test reference cable (ST to MIL-T-29504/15 socket terminus)	1
Test reference cable (ST to MIL-S-24623/4 splice ferrule)	1
Test jumper cable (ST on both ends with each end labeled A or B)	1
Test jumper cable (ST to socket terminus)	1
Test jumper cable (ST to pin terminus)	1
Test jumper cable (ST to 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
Protective caps (plastic)	As required
ST adapter (single mode)	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

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

DESCRIPTION	QUANTITY
Splice ferrule termination type power meter adapter	1

- NOTES:
1. Ensure the test equipment calibration is current.
  2. Use a wipe dampened with alcohol to clean the adapters/connectors and blow them dry with air before making connections.
  3. Identify and label all of the jumpers to be evaluated.
  4. Reference quality jumper cables are cables constructed using fibers and connectors with tightened geometrical specifications (for example, diameter, concentricity). For more information on reference quality jumper cables, see EIA/TIA-455-171.
  5. Make sure that both the light source and power meter have been energized long enough to have stable performance before making measurements.

Step 1 - Select a test jumper.

NOTE: The loss of the test jumper end with an ST connector is measured first. If both ends of the test jumper 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 jumper between the light source and the power meter and record the power at the meter ( $P_1$ ) (see figure 6F1-1). Disconnect the reference jumper from the power meter.

- NOTES:
1. The time delay between the measurement of  $P_1$  and  $P_2$  shall be kept to a minimum to prevent inaccurate readings.
  2. The reference jumper to light source connection shall not be disturbed between measurement of  $P_1$  and  $P_2$  to prevent inaccurate readings.

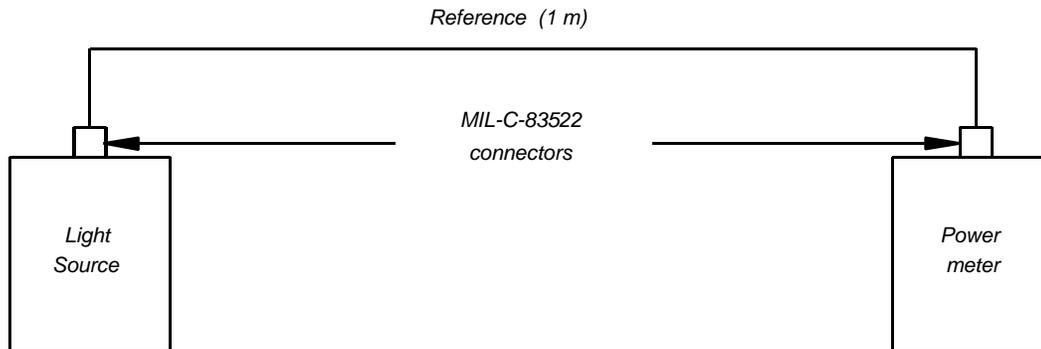
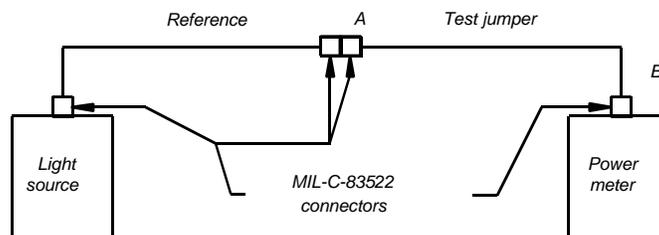
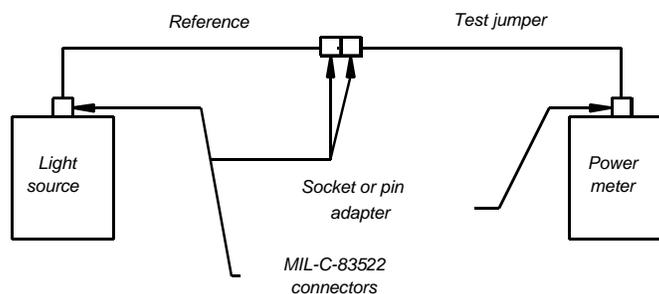


FIGURE 6F1-1. Connecting the reference cable.

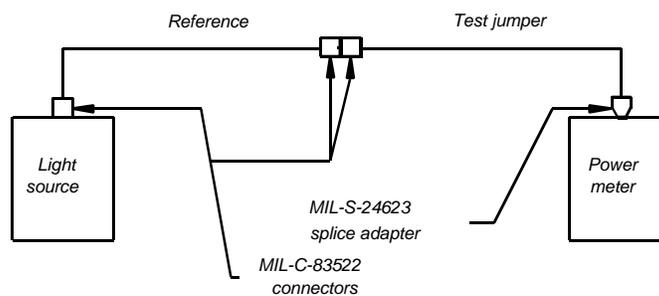
Step 3 - Connect the test jumper to the reference jumper using a single-mode ST to ST adapter and to the power meter using the applicable power meter adapter head (see figure 6F1- 2).



View 1



View 2



View 3

FIGURE 6F1-2. Measurement options.

- 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 power in dBm  
 $P_2$  = Test power in dBm

- Step 6 - Record the ST connector loss along with the test jumper identification.
- Step 7 - Repeat step 2 through step 6 ten times for the selected test jumper. Use a wipe dampened with alcohol to clean the adapters/connectors and blow them dry with air before making each connection.

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

Step 8 - Connect the ST to ST, pin terminus, socket terminus, or MIL-S-24623 splice reference jumper between the light source and the power meter and record the power at the meter ( $P_1$ ) (see figure 6F1-3). Disconnect the reference jumper from the power meter.

- NOTES:
1. The time delay between the measurement of  $P_1$  and  $P_2$  shall be kept to a minimum to prevent inaccurate readings.
  2. The reference jumper to light source connection shall not be disturbed between measurement of  $P_1$  and  $P_2$  to prevent inaccurate readings.

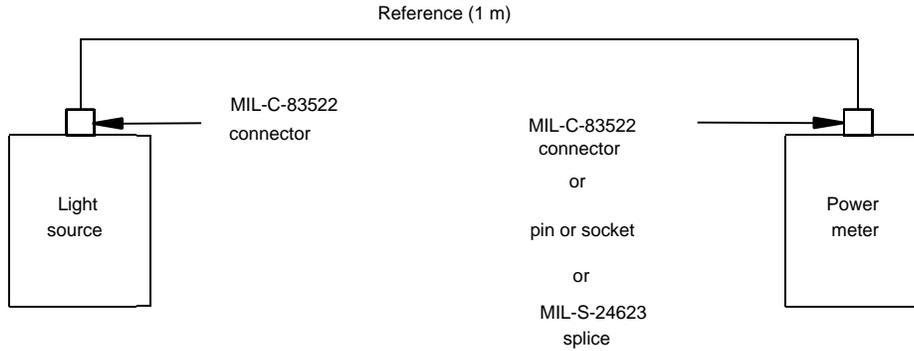


FIGURE 6F1-3. Connecting the reference cable.

Step 9 - Connect the test jumper to the reference jumper and to the power meter using the ST adapter head (see figure 6F1-4).

- NOTES:
1. For either pin or socket termini, the termini shall be inserted into MIL-C-28876 plug or receptacle connectors and mated.
  2. For MIL-S-24623 splices, the splice ferrules shall be mated using a splice alignment clip as specified in MIL-STD-2042-2.

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

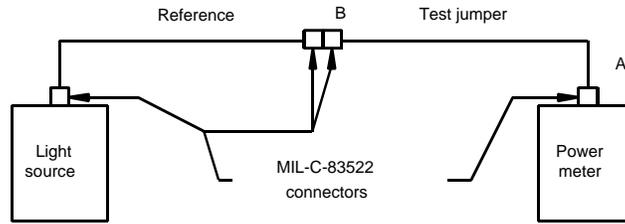
Step 11 - Calculate the terminus or splice connection loss using following formula

$$B_c = (P_1 - P_2)$$

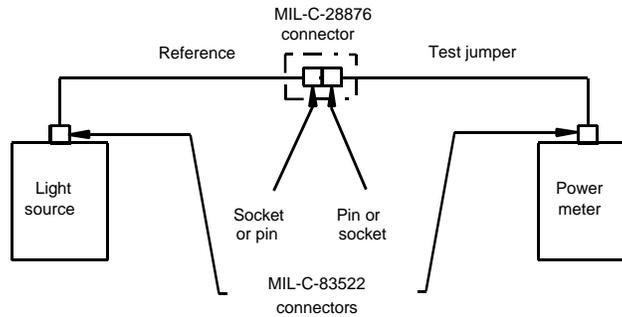
Where:  $B_c$  = Terminus or splice connection loss in dB  
 $P_1$  = Reference power in dBm  
 $P_2$  = Test power in dBm

Step 12 - Record the terminus or splice connection loss along with the test jumper identification.

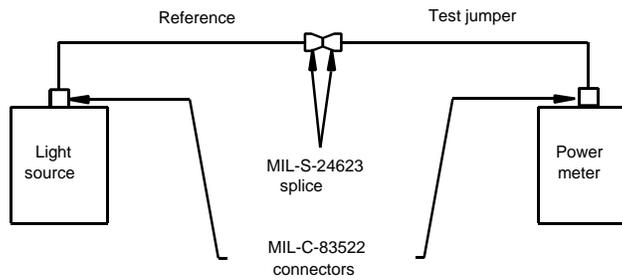
Step 13 - Repeat step 8 through step 12 ten times for the selected test jumper. Use a wipe dampened with alcohol to clean the connectors/splices and blow them dry with air before making each connection.



View 1



View 2



View 3

FIGURE 6F1-4. Measurement options.

3.3 Calculations.

- Step 1 - Calculate the mean loss for each end of the test jumper using the following formula and record the results:

$$\mu_c = \frac{1}{10} \times \sum_{n=1}^{10} B_{cn}$$

Where:  $\mu_c$  = Mean connection loss in dB  
 $B_{cn}$  = Connection loss for measurement n in dB

- Step 2 - Calculate the standard deviation of the measured loss for each test jumper end using the following formula and record the results:

$$\sigma_c = \sqrt{\frac{\sum_{n=1}^{10} (B_{Cn} - \mu_c)^2}{9}}$$

Where:  $\sigma_c$  = Standard deviation of the connection loss in dB

- Step 3 - A test jumper 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: 1. 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. Test jumper loss acceptance criteria.

End connection	Acceptable loss (dB)	Standard deviation (dB)
MIL-C-83522/16	$0.05 < B_{st} < 0.35$	0.05 max
MIL-T-29504/14 pin terminus	$0.00 < B_c < 0.70$	0.05 max
MIL-T-29504/15 socket terminus	$0.00 < B_c < 0.70$	0.05 max
MIL-S-24623/4 splice	$0.00 < B_c < 0.30$	0.05 max

- Step 4 - If the mean loss or the standard deviation of either end is not in accordance with Table 6F1-II, the jumper shall not be used for making optical loss measurements.

## 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 contracting activity.

## 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 fiber optic 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. 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 fiber optic cable.
- Step 4 - Pull on the 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 cable assembly.
- Step 6 - Visually inspect the connector/cable interface for cable pullout and deformation of the cable jacket. Cable assemblies which show these defects shall be rejected.

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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3. DOCUMENT TITLE <b>FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR NAVAL SHIPS (TESTS)</b>		
4. NATURE OF CHANGE <i>(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)</i>		
5. REASON FOR RECOMMENDATION		
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