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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FIBER OPTIC CABLE TOPOLOGY INSTALLATION STANDARD METHODS FOR SURFACE SHIPS AND SUBMARINES (CONNECTORS AND INTERCONNECTIONS)

(PART 5 OF 7 PARTS)

AMSC N/A AREA SESS

FOREWORD

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

2. This standard provides detailed information and guidance to personnel concerned with the installation of fiber optic cable topologies (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 except as noted. They are intended to standardize and minimize variations in installation methods to enhance the compatibility of the installations on all naval ships.

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

Part 1: Cables

Part 2: Equipment

Part 3: Cable Penetrations

Part 4: Cableways

Part 5: Connectors and Interconnections

Part 6: Tests

Part 7: Pierside Connectivity Cable Assemblies and Interconnection Hardware

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

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1. SCOPE

1.1 Scope. This standard provides detailed methods for installing optical fiber cable connectors and interconnecting devices.

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

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24623/4	-	Splice, Fiber Optic, Housing, Rotary Mechanical, Fiber
MIL-PRF-24623/6	-	Splice, Fusion, Fiber Optic Protector
MIL-DTL-24728/8	-	Interconnecting Box, Fiber Optic, Fusion Splice Tray and Tray Holder Module
MIL-DTL-24728/11	-	Interconnecting Box, Fiber Optic, Splice Tray Holder Module, 8 Tray
MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for
MIL-PRF-28876/1	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, Without Backshell, Environment Resisting
MIL-PRF-28876/2	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With Straight Backshell, Environment Resisting
MIL-PRF-28876/3	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/4	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 90-Degree Backshell, Environment Resisting
MIL-PRF-28876/5	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, With Straight Backshell, Environment Resisting

MIL-PRF-28876/6 - Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, Without Backshell, Environment Resisting

MIL-PRF-28876/7 - Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With Straight Backshell, Environment Resisting

MIL-PRF-28876/8 - Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 45-Degree Backshell, Environment Resisting

MIL-PRF-28876/9 - Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 90-Degree Backshell, Environment Resisting

MIL-PRF-28876/11 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, Without Backshell, Environment Resisting

MIL-PRF-28876/12 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting With Straight Backshell, Environment Resisting

MIL-PRF-28876/13 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting with 45-Degree Backshell, Environment Resisting

MIL-PRF-28876/14 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, With 90-Degree Backshell, Environment Resisting

MIL-PRF-28876/27 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, Straight Backshell, Environment Resisting

MIL-PRF-28876/28 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, 45-Degree Backshell, Environment Resisting

MIL-PRF-28876/29 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, 90-Degree Backshell, Environment Resisting

MIL-PRF-29504/3 - Termini, Fiber Optic, Connector, Removable, Environment Resisting, Dummy Terminus, (for MIL-C-28876 and MIL-C-83526 Connectors)

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

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

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

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

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

MIL-PRF-64266/18 - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Backshell, Split, Multiple Fiber Cables, Strength Member Capture and Bend Limiting Interface, Environment Resisting

MIL-DTL-83522/16 - Connector, Fiber Optic, Single Terminus, Plug, Bayonet Coupling (ST Style), 2.5 Millimeters Diameter Ferrule, Epoxy

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1678-1 - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)

MIL-STD-2042 - Fiber Optic Cable Topology Installation Standard Methods for Surface Ships and Submarines

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

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

MIL-STD-2042-6 - Fiber Optic Cable Topology Installation, Standard Methods for Surface Ships and Submarines (Tests) (Part 6 of 7 Parts)

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

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

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

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-440 - Fiber Optic Terminology

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

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

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

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

a. APC: Angled Physical Contact (polish)

b. BOF: Blown Optical Fiber

c. COTS: Commercial Off-the-Shelf

d. EMI: Electromagnetic Interference

e. FOCT: Fiber Optic Cable Topology

f. LED: Light Emitting Diode

g. OFCC: Optical Fiber Cable Component

h. OFCS: Optical Fiber Communication System

i. PC: Physical Contact (polish)

j. UV: Ultraviolet

4. GENERAL REQUIREMENTS

4.1 Optical fiber cable interconnection. Optical fiber cable interconnection within the fiber optic cable topology (FOCT) shall be made by fiber optic connectors or fusion splicing. Fiber optic splices in accordance with MIL-PRF-24623/4 are obsolete for new construction and shall only be used in specific legacy systems previously designed to utilize splices in accordance with MIL-PRF-24623/4.

4.1.1 Interconnection component selection. The interconnection component shall be selected as specified (see 4.2 and 4.3).

4.2 Fiber connectors. Fiber optic connectors shall be as follows:

a. Single terminus (light duty) connectors in accordance with MIL-DTL-83522/16 shall be used to interconnect two optical fiber cable components (OFCCs) inside an interconnection box or equipment.

b. Single terminus (light duty) connectors in accordance with MIL-DTL-83522/16 shall be used to interconnect OFCCs and loose tube furcation cables inside an interconnection box or equipment.

c. Multiple terminus (heavy duty) connectors in accordance with MIL-PRF-28876 or MIL-PRF-64266 shall be used for end user equipment hookup. Plug connectors with inserts configured for pin termini shall be used on shipboard cabling. Receptacle connectors with inserts configured for socket termini shall be used on equipment. Plug connectors shall have backshells with integral strain relief. Receptacle connectors shall be configured without backshells. Receptacle connectors shall be configured with insert retention nuts.

d. Light duty epoxy polish style Commercial Off-the-Shelf (COTS) connectors may be used within shock isolated equipment enclosures to connect to COTS equipment interfaces. COTS connectors are described in A-A-59940 and shall be approved by the Naval Surface Warfare Center, Dahlgren Division (NSWCDD) (see 6.4).

e. Light duty quick connect style COTS connectors may be used within shock isolated equipment enclosures to mate with plastic adapters on commercial interface cards and mate with equipment and patch panels for all applications. For non-tactical applications, light duty quick connect style COTS connectors may be used for connections in outlet (drop) boxes. Light duty quick connect style COTS connectors are described in A-A-59940 and shall be approved by NSWCDD (see 6.4).

f. The use of optical fiber connectors other than those specified above, including expanded beam or lens type connectors, backplane connectors, and card front edge, shall be as approved by NSWCDD (see 6.4).

4.2.1 Installation. Connectors shall be installed on cables in accordance with the methods herein and as follows:

a. Where a heavy duty connector is installed on the end of a cable, the optical fibers shall be connected to pin termini in a plug style connector. For connectors in accordance with MIL-PRF-28876, every terminus position shall have either a dummy or optical terminus in accordance with MIL-PRF-29504/3 or /14. For connectors in accordance with MIL-PRF-64266, every terminus position shall have either an optical terminus in accordance with MIL-PRF-29504/18 or /20 or a dummy terminus in accordance with MIL-PRF-29504/19. Where approved (see 6.4), an approved quick connect style termini may be used.

b. Only receptacle style heavy duty connectors shall be used on equipment. Only dummy termini or socket type termini in accordance with MIL-PRF-29504/3 or /15 shall be used in receptacle style heavy duty connectors in accordance with MIL-PRF-28876. For connectors in accordance with MIL-PRF-64266, every terminus position shall have either an optical terminus in accordance with MIL-PRF-29504/18 or /20 or a dummy terminus in accordance with MIL-PRF-29504/19. Where approved (see 6.4), an approved quick connect style termini may be used.

c. Where electromagnetic interference (EMI) requirements are applicable, an approved EMI gasket shall be utilized with the heavy duty connector that is commensurate with the applicable level of EMI protection required.

d. COTS light duty connectors and other connectors approved by NSWCDD (see 6.4) shall be installed in accordance with the methods herein.

4.3 Fiber optic fusion splices. Fiber optic fusion splices shall be constructed in accordance with the methods herein. Fusion splices shall be protected by splice sleeves in accordance with MIL-PRF-24623/6. Fiber optic fusion splices shall be used to interconnect OFCCs, loose tube furcation cables, or blown optical fiber (BOF) inside an interconnection box or equipment.

4.3.1 Installation. Fiber optic fusion splices shall be installed on buffered fibers in accordance with the methods herein and as follows:

a. Fusion splicing shall be completed in accordance with Method 5C2.

b. Completed splices shall be installed in accordance with the methods in MIL-STD-2042-2.

c. Splices shall be located only inside an approved interconnection box in accordance with MIL-DTL-24728/1, /2, /3, /9, or /10 or shock isolated equipment. Splices shall be housed inside of an approved splice tray and splice tray holder in accordance with MIL-DTL-24728/8 or an approved splice tray holder in accordance with MIL-DTL-24728/11. If located inside of shock isolated equipment, an approved 10-inch COTS splice tray and tray holder/shelf may be used. Alternate splice housings shall be approved by the NSWCDD (see 6.4).

4.4 Tests. Following installation, testing of all components of the FOCT shall be in accordance with MIL-STD-2042-6.

4.5 Safety precautions. The following safety precautions shall apply:

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

b. Observe all warning signs on equipment and materials.

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

(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 hands after handling bare fibers or performing fiber terminations.

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

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

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

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

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

5. DETAILED REQUIREMENTS

5.1 Heavy duty connector installation. Installation of the heavy duty connector in accordance with MIL-PRF-28876 or MIL-PRF-64266 on optical fiber cable shall be in accordance with the methods in this standard. There are four basic connector rear end configurations: with removable backshell, with integral backshell, with insert retention nut, and with split backshells.

5.1.1 Heavy duty connectors with removable backshells. Connectors with removable backshells are described with the basic Military Part Numbers M28876/1, M28876/6, and M28876/11. These connectors do not contain an integral backshell with strain relief and shall be assembled to a backshell during installation onto optical fiber cable. Backshells with strain relief for use with these connectors are described with the basic Military Part Numbers M28876/27, M28876/28, and M28876/29. Method 5A1-I or 5A1-II shall be used to install the connector and the backshell on the cable for these connectors.

5.1.2 Heavy duty connectors with integral backshells. Connectors with integral backshells are described with the basic Military Part Numbers M28876/2, M28876/3, M28876/4, M28876/5, M28876/7, M28876/8, M28876/9, M28876/12, M28876/13, and M28876/14. These connectors contain an integral backshell with strain relief. In some cases, these backshells are removable. Method 5A2 shall be used to install the connector on the cable for these connectors with the exception of these part numbers manufactured by Amphenol Fiber Systems International (AFSI), which shall be installed onto fiber optic cables using Method 5A1-II.

5.1.3 Heavy duty connectors with insert retention nuts. Connectors with insert retention nuts are described with the basic Military Part Numbers M28876/1 and M28876/11. These connectors do not contain an integral backshell with strain relief and are not required to be assembled to a backshell during installation. These connectors are for use in situations where strain relief is not required (for example, the equipment side of an equipment fiber optic interface). Method 5A3 shall be used to install the connector within the equipment for these connectors.

5.1.4 Heavy duty connectors with split backshells.

5.1.4.1 Split backshell connectors with compression strain relief. Split backshell connectors with compression strain relief are described with the basic Military Part Numbers M28876/2, M28876/3, M28876/4, M28876/7, M28876/8, M28876/9, M28876/12, M28876/13, and M28876/14, manufactured by Delphi Connection Systems. These connectors shall be installed on cables in accordance with the procedures in Method 5A4.

5.1.4.2 Split backshell connectors with banded strain relief. Split backshell connectors with banded strain relief are described with the basic Military Part Number M64266/18. These connectors shall be installed on cables in accordance with the procedures in Method 5A5.

5.2 Light duty connector installation. Light duty connectors in accordance with MIL-DTL-83522/16 shall be installed on fibers in accordance with Method 5B1. Light duty connectors shall be polished and inspected in accordance with Method 5D3.

5.3 Mechanical (rotary) splice installation. Mechanical (rotary) splice ferrules are obsolete for new construction and only utilized on certain legacy systems. Installation and assembly instructions have been removed from this version of the standard. Installation and assembly methods can be found in parts 2 and 5 of revision B of this standard.

5.4 Fusion splice installation. Fusion splices shall be installed between fibers in accordance with Method 5C2. Fusion splices shall be installed into approved splice trays in accordance with MIL-STD-2042-2, Methods 2K1 or 2K2.

5.5 COTS light duty connector installation. COTS light duty connectors shall be installed in accordance with Method 5B1 for epoxy polish ST connectors, Method 5B2 for epoxy polish LC connectors, Method 5B3 for epoxy polish SC connectors, or manufacturer's instructions for quick connect (mechanical or fusion splice-on) connectors. Epoxy polish COTS light duty connectors shall be polished and inspected in accordance with Method 5D3.

5.6 Polishing.

5.6.1 Standard physical contact (PC) polishing. Standard PC polishing is utilized for multimode fiber terminations and for single mode fiber terminations requiring return loss values greater than 30 decibels (dB). Standard domed PC polishing of M29504/14, M29504/15, and M29504/18 termini shall be completed in accordance with the standard polishing sections of Method 5D1. Standard domed PC polishing of light duty connectors shall be completed in accordance with the standard polishing sections of Method 5D3.

5.6.2 Enhanced PC polishing. Enhanced PC polishing is utilized for single mode fiber terminations requiring return loss values greater than 40 dB. Enhanced domed PC polishing of M29504/14, M29504/15, and M29504/18 termini shall be completed in accordance with the enhanced polishing sections of Method 5D1. Enhanced domed PC polishing of light duty connectors shall be completed in accordance with the enhanced polishing sections of Method 5D3.

5.6.3 Angled physical contact (APC) polishing. APC polishing of M29504/20 termini shall be completed in accordance with Method 5D2.

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 installation of connectors and interconnections depicted in this standard have been developed, tested, and approved so that the shipboard fiber optic installations described can withstand the environmental and operational conditions aboard U.S. Navy vessels. They are intended primarily for new construction; however, they are applicable for conversion, alteration, or repair of existing ships.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

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

Group A: Multiple terminus connector installation

Group B: Single terminus connector installation

Group C: Splicing installation

Group D: Termination processes

Then the designation system was completed as follows:

5	A	1	-	II
MIL-STD-2042 part number	Functional group	Method number within group	-	Alternate procedure within method

Thus, Method 5A1-II identifies the second alternate procedure within Method 1 of Group A in Part 5 (MIL-STD-2042-5) of MIL-STD-2042.

6.4 Proposed new methods or method modifications. As specified (see 4.6), proposed new methods or proposed modifications of existing methods should be submitted to DLGR_NSWC_FO_ENG@navy.mil or Department of the Navy, Naval Surface Warfare Center, Dahlgren Division, ATTN: Fiber Optic Engineering Manager, 17214 Avenue B, Suite 126, Dahlgren, VA 22448-5147.

6.5 Dahlgren shipboard fiber optics website. The NSWCDD fiber optic website houses additional shipboard fiber optic information and policy letters that may be applicable to the requirements in this standard. Due to the dynamic nature of web addresses, the current website URL can be obtained by emailing DLGR_NSWC_FOWEB@navy mil with the subject line “WEBSITE URL REQUEST”. An automated reply will contain the current web address.

6.6 Subject term (key word) listing.

Fiber optic connectors

Fiber optic splices

Fusion splices

Optical fiber cable interconnection

Safety

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

METHOD 5A1
MULTIPLE TERMINUS CONNECTOR (MIL-PRF-28876) ASSEMBLY, SOLID REMOVABLE BACKSHELL WITH MULTIPLE FIBER CABLE

1. SCOPE

1.1 Scope. This method contains two procedures for installation of M28876 connectors with solid removable backshells with the basic Military Part Numbers M28876/1, M28876/6, M28876/11, M28876/27, M28876/28, and M28876/29. Method 5A1-I describes a procedure for installing Veam multiple terminus (heavy duty) connectors with solid removable backshells. Method 5A1-II describes a procedure for installing Amphenol Fiber System International (AFSI) multiple terminus (heavy duty) connectors with solid removable backshells (see 5.1).

1.2 Method dependencies. During execution of this method, the user will, at certain points, need to complete Method 5D1 and either Method 5A6, Procedure I or II. If the user is printing this method for reference, it is recommended to print Method 5D1 and Method 5A6, Procedure I or II as well.

2. DOCUMENTS APPLICABLE TO METHOD 5A1

2.1 General. The documents listed in this section are specified in Method 5A1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for
MIL-PRF-28876/1	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, Without Backshell, Environment Resisting
MIL-PRF-28876/6	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, Without Backshell, Environment Resisting
MIL-PRF-28876/11	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, Without Backshell, Environment Resisting
MIL-PRF-28876/27	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, Straight Backshell, Environment Resisting
MIL-PRF-28876/28	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/29	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, 90-Degree Backshell, Environment Resisting

MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29504/14	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/15	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A1-I. Equipment and materials.

Reference #	Description	Quantity
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	As required
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0046	Marking pen, permanent	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0013	Canned air or compressed air	As required
TL-0012	Cable jacket stripping tool	1
	Masking tape	As required
TL-0045	Aramid yarn shears	1
TL-0078	Strip tool, OFCC	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
	O-ring lubricant (Bray Cote 609, or equal [see 4.8])	As required
	Loctite, or equal (see 4.8)	As required
TL-0101	Heat gun	1
	Adjustable wrench	1
	Backshell grip	1
	Dust covers	As required
TL-0052	O-ring installation tool shell size 11 (AFSI, or equal [see 4.8])	1
TL-0053	O-ring installation tool shell size 13 (AFSI, or equal [see 4.8])	1
TL-0054	O-ring installation tool shell size 15 (AFSI, or equal [see 4.8])	1
TL-0090	Torque wrench, ⅜-inch drive	1
	Pliers	1
TL-0008, TL-0009	Strain relief holding fixture (optional)	1
TL-0005, TL-0006, TL-0007	Conical spring install/removal tool (optional)	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

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

4.2 Procedures. These methods shall be used to install connectors with part numbers M28876/1, M28876/6, and M28876/11 (configured without insert retention nuts), and backshells with part numbers M28876/27, M28876/28, and M28876/29, onto optical fiber cables.

4.2.1 Procedure I: Installation instructions for Veam backshells. This section is applicable only for removable backshells manufactured by Veam, Inc.

4.2.1.1 Cable and fiber preparation. The following steps shall be performed:

Step 1. Ensure the cable is the correct type as specified on the applicable cable diagram.

Step 2. Measure the cable to the required length. Add 380 millimeters (15 inches) to allow for at least two re-terminations.

Step 3. Clean the outer cable jacket that will be in contact with the connector and backshell with a wipe dampened with alcohol and blow it dry with air.

NOTE: Keep the cable and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the part dry with air.

Step 4. Slide the backshell parts onto the cable in the following order (see figure 5A1-1):

a. Sheath (ensure O-rings are in place).

b. Backnut.

c. O-ring.

d. Strain relief spacer.

e. Compression ring (aramid yarn grip).

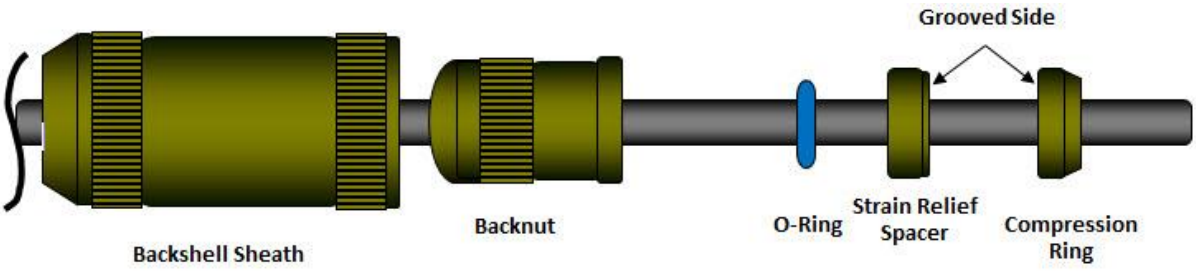


FIGURE 5A1-1. Backshell parts on the cable (straight backshell).

NOTE: Ensure that the strain relief spacer and the compression ring are orientated in the proper direction. The grooved side of the strain relief housing should face the grooved side of the strain relief compression ring.

Step 5. Mark the cable jacket approximately 190 millimeters (7.5 inches) from the end and strip back the outer cable jacket to the mark using the cable stripper.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, optical fiber damage may occur.

Cut off the exposed central member and any fillers using the aramid yarn shears.

CAUTION: Do not cut or nick OFCC jackets.

Step 6. Remove any water blocking material, clean the OFCCs using a wipe dampened with alcohol, and blow them dry with air.

Step 7. Ensure the aramid yarn strands are evenly distributed over the OFCCs. Slide down the compression ring off of the cable's outer jacket and onto the aramid yarn strands so that it rests up against the end of the cables outer jacket (see figure 5A1-2).

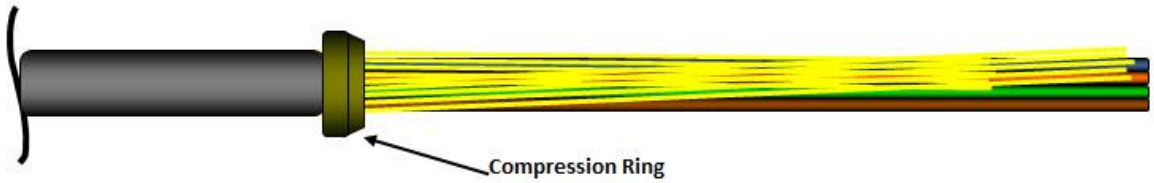


FIGURE 5A1-2. Correct position of the compression ring.

Step 8. Holding the compression ring at the end of the cable's outer jacket, fold the aramid yarn strands back over the compression ring and evenly distribute the strands over the compression ring. Hold the aramid yarn strands taut over the cables outer jacket and slide down the strain relief compression spacer over the aramid yarn strands until it seats against the compression ring (see figure 5A1-3).

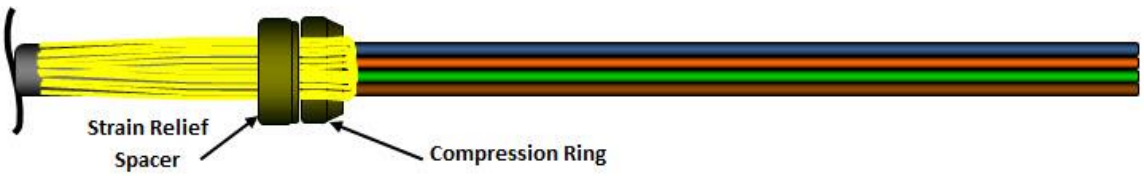


FIGURE 5A1-3. Capturing aramid yarn strands between the compression ring and strain relief spacer.

Step 9. Keep the aramid yarn strands tight and pull them back over the strain relief assembly. Slide down the blue O-ring to the back of the strain relief compression spacer. Lay the aramid yarn strands back over the blue O-ring and tape them to the cable (see figure 5A1-4).

NOTE: Do not cut the aramid yarn strands until the assembly of the backshell is completed.

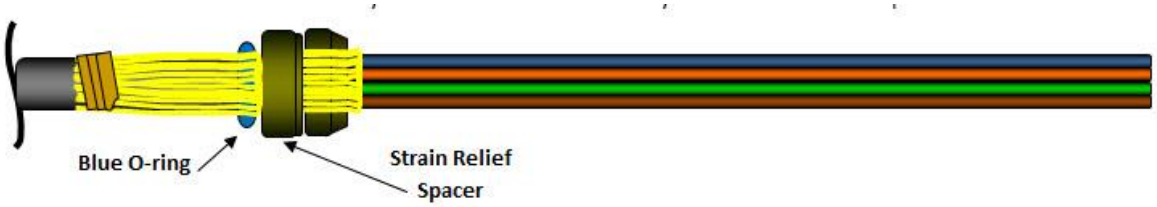


FIGURE 5A1-4. Correct position of blue O-ring and aramid yarn strands.

Step10. Install a crimp sleeve onto each OFCC (see figure 5A1-5).

NOTE: Only use crimp sleeves intended for termini. Do not use crimp sleeves intended for other types of connectors. The standard crimp sleeve for the terminus may be oriented in either direction.

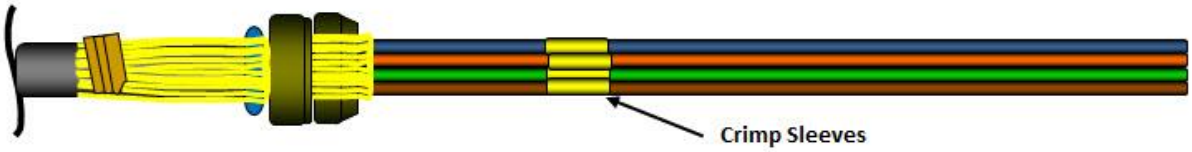


FIGURE 5A1-5. Installing crimp sleeves onto OFCCs.

Step 11. Trim the OFCCs to the length (A + B + C) shown in table 5A1-II using the aramid yarn shears (see figure 5A1-6).

TABLE 5A1-II. Cable stripping dimensions for Veam connectors.

Connector shell size	Backshell configuration	Dimensions mm (in)					
		Long backshell			Short backshell		
		A	B	C	A	B	C
13	Straight	105 (4.13)	10 (0.39)	22 (0.87)	88 (3.46)	10 (0.39)	22 (0.87)
	45 degrees	120 (4.72)	10 (0.39)	22 (0.87)	100 (3.94)	10 (0.39)	22 (0.87)
	90 degrees	120 (4.72)	10 (0.39)	22 (0.87)	100 (3.94)	10 (0.39)	22 (0.87)
15	Straight	130 (5.12)	10 (0.39)	22 (0.87)	105 (4.13)	10 (0.39)	22 (0.87)
	45 degrees	126 (4.96)	10 (0.39)	22 (0.87)	101 (3.98)	10 (0.39)	22 (0.87)
	90 degrees	126 (4.96)	10 (0.39)	22 (0.87)	101 (3.98)	10 (0.39)	22 (0.87)

NOTES:
1. The tolerance on dimensions A and B is ±1 millimeter (±0.04 inch).
2. Shorter values for dimension C may be used.

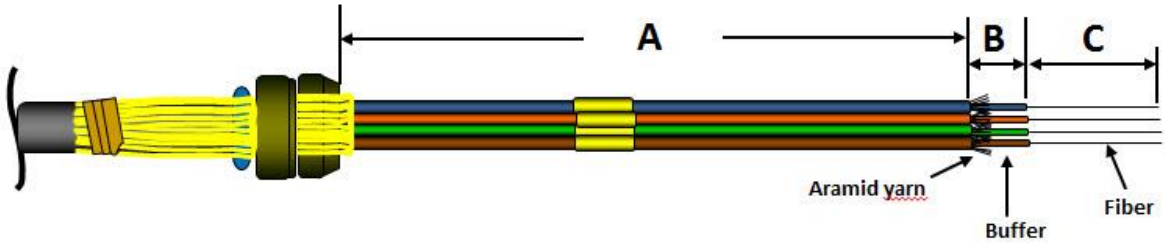


FIGURE 5A1-6. Cable stripping dimensions for Veam connectors.

Step 12. Remove the OFCC jacket back on each OFCC to the dimensions (B + C) shown in table 5A1-II using the OFCC stripper, and trim the OFCC aramid yarn using the aramid yarn shears so that approximately 3 millimeters (0.12 inch) extends past the OFCC jacket (see figure 5A1-6).

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

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

Step 13. For each OFCC, remove the fiber buffer and coating back to the dimension (C) shown in table 5A1-II using the buffer stripper (see figure 5A1-6). Remove the buffer and coating in small sections (approximately 6 millimeters [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 14. For each OFCC, remove any residual coating material 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.

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Breakage of any one fiber from this point until the connector is completely assembled will require repetition of this and the following steps in order to maintain approximately equal lengths of all the fibers in the cable.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.1.2 Construction, polishing, and end face inspection of termini. The following steps shall be performed:

Step 1. Construct, polish, and inspect M29504/14 and M29504/15 termini in accordance with Method 5D1.

NOTE: Alternatively, if approved for this backshell configuration (see 6.4), a quick connect style termini can be constructed per the termini manufacturer's instructions.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to the assembly instructions (see 4.2.1.3).

4.2.1.3 Assembly of the Veam backshell. The following steps shall be performed:

Step 1. Remove the tape from the aramid yarn. Slide the blue O-ring, the strain relief spacer, and the compression ring back down the cable's outer jacket while maintaining the aramid yarn strands between the strain relief spacer and the compression ring (see figure 5A1-7). Re-tape aramid yarn, if desired.

NOTE: Do not allow the aramid yarn strands to slip out between the strain relief spacer and the compression ring.

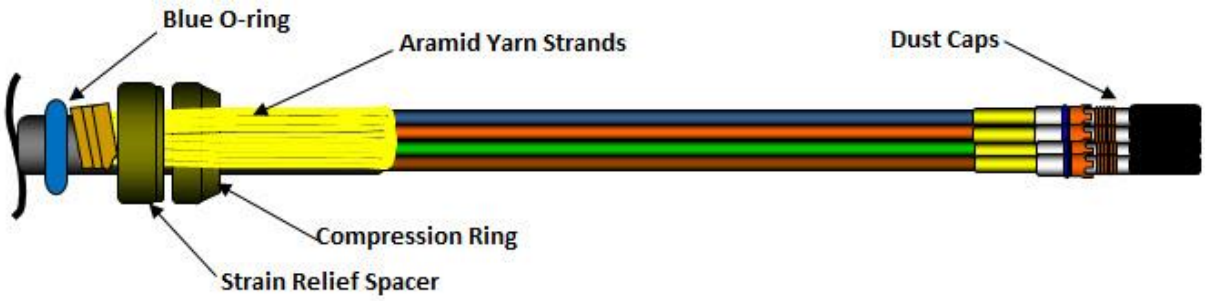


FIGURE 5A1-7. Sliding back the blue O-ring, strain relief spacer, and the compression ring.

Step 2. Slide the internal connector backshell over the terminated OFCCs until it rests against the taper of the compression ring (see figure 5A1-8).

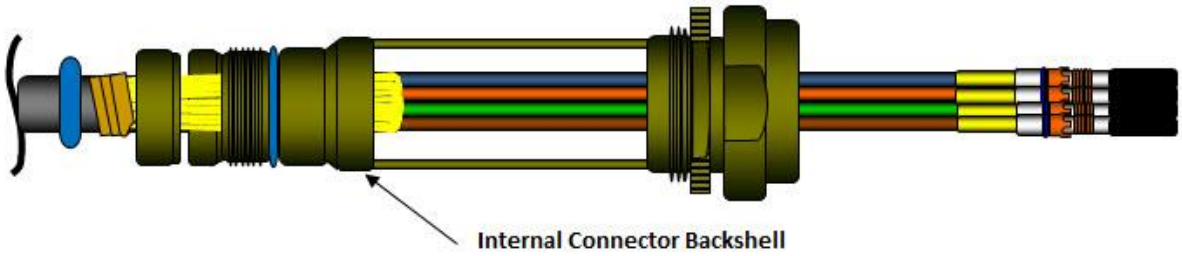


FIGURE 5A1-8. Installing the internal connector shell over the OFCCs.

Step 3. Remove the termini dust caps and insert the termini into the correct positions in the fiber optic termini insert in accordance with Method 5A6, Procedure I for pin termini or Method 5A6, Procedure II for socket termini.

Step 4. Slide the internal connector backshell up to the rear of the connector plug head shell and thread the nut of the internal connector backshell to the connector plug head shell (see figure 5A1-9).

NOTE: Loctite, or equal (see 4.8), may be used to secure the backshell body to the connector shell. If Loctite, or equal (see 4.8), is used, use it sparingly.

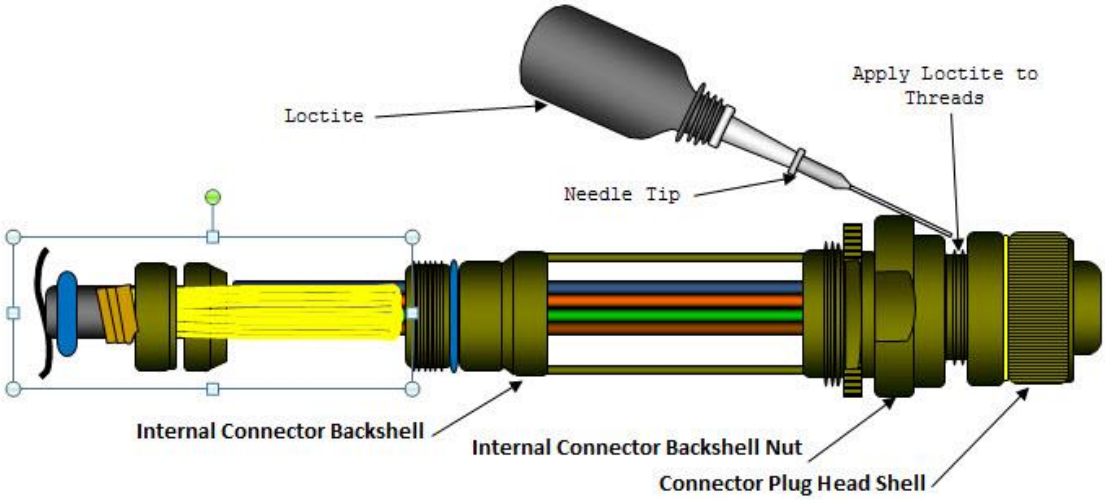


FIGURE 5A1-9. Connecting the connector backshell to the connector head.

Step 5. If necessary, remove the tape from the aramid yarn. Slide the compression ring, strain relief spacer, and the blue O-ring down until fully seated into the back of the internal connector backshell (see figure 5A1-10). Re-tape the aramid yarn strands just behind the blue O-ring. Trim back any aramid yarn that extends beyond the tape.

NOTE: The blue O-ring should be under the aramid yard strands and up against the strain relief spacer to hold the strain relief assembly tightly against the internal connector backshell. The aramid yarn strands should be evenly distributed between the compression ring and the strain relief spacer.

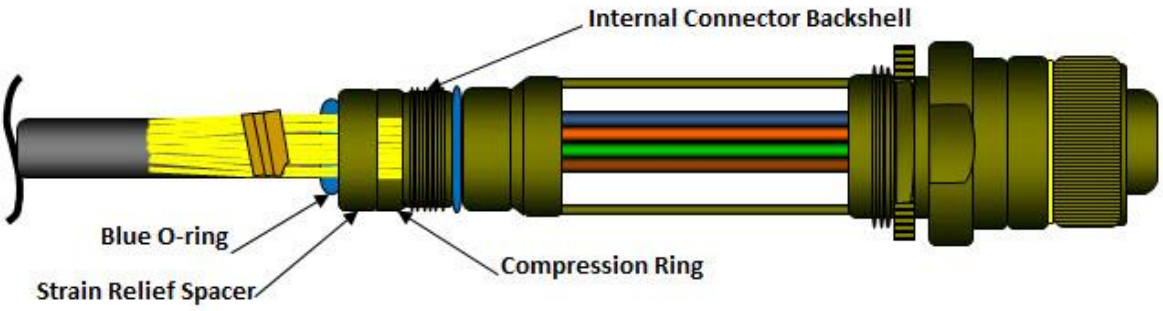


FIGURE 5A1-10. Connecting the connector backshell to the connector head.

Step 6. Slide the backnut up and thread onto the rear section of the internal connector backshell until fully seated (see figure 5A1-11).

NOTE: Use an adjustable wrench on the backshell body flats and the backshell grip on the backnut. Use care to not nick or scratch the backshell coating during assembly.

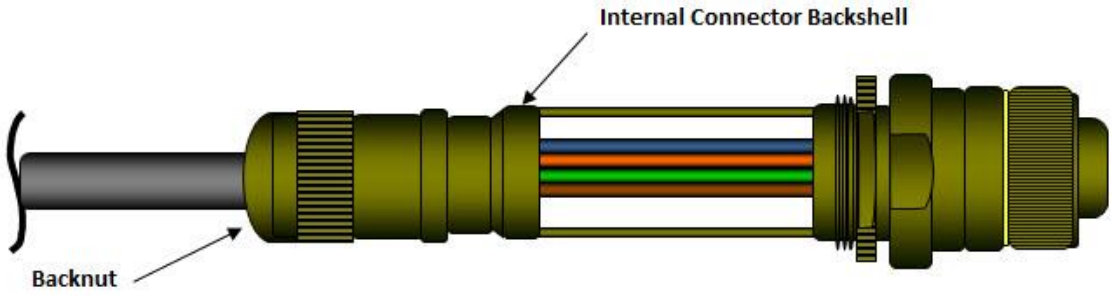


FIGURE 5A1-11. Connecting the backnut to the internal connector backshell.

Step 7. Apply O-ring lube to the O-rings on the sheath and slide the sheath forward and screw it onto the backshell body until it is tight (see figure 5A1-12).

NOTE: When tightening the backshell sheath onto the internal connector backshell, make sure that the wrench is on the second set of wrench flats of the internal connector backshell.

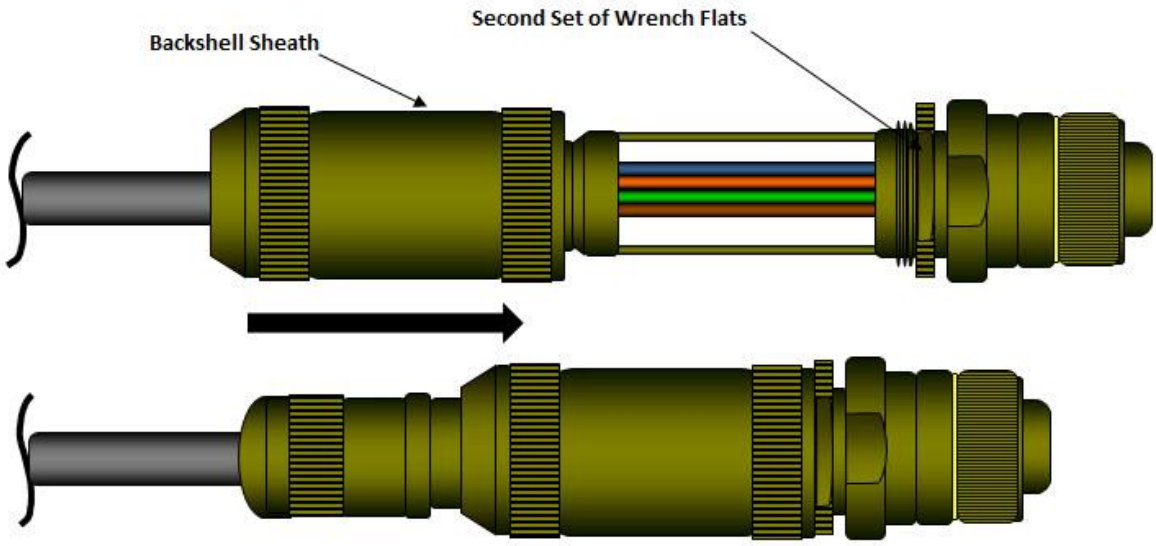


FIGURE 5A1-12. Installation of the sheath and final assembled connector.

Step 8. Install the plastic protective cap over the front of the connector.

4.2.2 Procedure II: Installation instructions for AFSI backshells. This section is applicable only for removable backshells manufactured by AFSI, Inc.

4.2.2.1 Cable and fiber preparation for AFSI backshells. The following steps shall be performed:

Step 1. Ensure the cable is the correct type as specified on the applicable cable diagram.

Step 2. Measure the cable to the required length. Add 380 millimeters (15 inches) to allow for at least two re-terminations.

Step 3. Clean the outer cable jacket that will be in contact with the connector and backshell with a wipe dampened with alcohol and blow it dry with air.

NOTE: Keep the cable and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the parts dry with air.

Step 4. Refer to figure 5A1-13 to identify the AFSI backshell components.

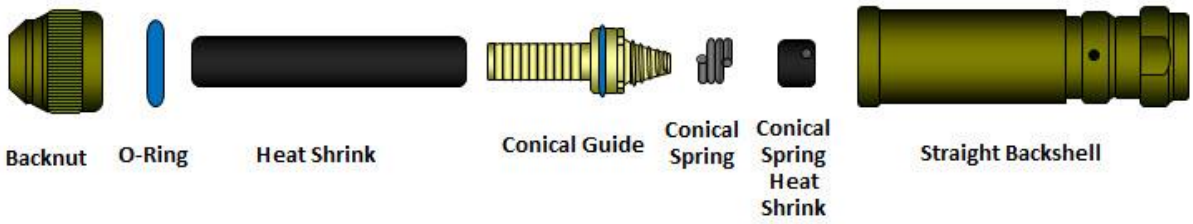


FIGURE 5A1-13. Identification of AFSI backshell components.

Step 5. Slide the labels (as required), the backnut, blue O-ring, and the heat shrink over the cable's outer jacket (see figure 5A1-14).

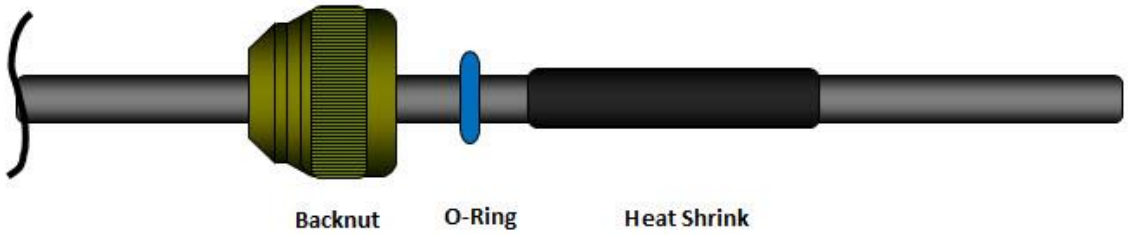


FIGURE 5A1-14. Order of AFSI backshell components.

Step 6. Mark the cable jacket approximately 190 millimeters (7.5 inches) from the end and strip back the outer cable jacket to the mark using the cable stripper. Fold back the aramid yarn strength members and temporarily tape them to the cable outer jacket. Cut off the exposed central strength member and any fillers using the aramid yarn shears.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bending diameter during cable jacket removal, optical fiber damage may occur.

CAUTION: Do not cut or nick OFCC jackets.

Step 7. Remove any water blocking material, clean the OFCCs using a wipe dampened with alcohol, and blow them dry with air.

Step 8. Trim the OFCCs to the length (A + B + C) shown in table 5A1-III using the aramid yarn cutting shears (see figure 5A1-15).

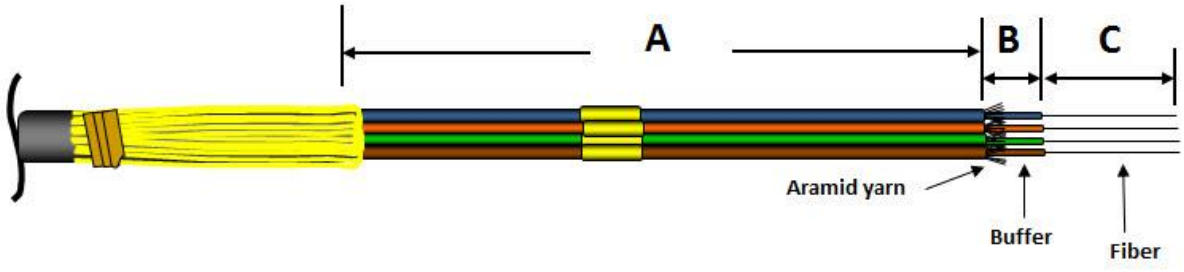


FIGURE 5A1-15. Cable stripping dimensions for AFSI connectors.

Step 9. Feed each OFCC into a crimp sleeve and slide the sleeve back from the end of the OFCC.

NOTE: Only use crimp sleeves intended for termini. Do not use crimp sleeves intended for other types of connectors. The standard crimp sleeve for the terminus may be oriented in either direction.

TABLE 5A1-III. Cable stripping dimensions for AFSI connectors.

Connector shell size	Backshell configuration	Dimensions mm (inch)		
		A	B	C
13	Straight	91 (3.58)	11 (0.43)	15 (0.59)
	45 degrees	102.75 (4.045)	11 (0.43)	15 (0.59)
	90 degrees	102.75 (4.045)	11 (0.43)	15 (0.59)
15	Straight	100.5 (3.96)	11 (0.43)	15 (0.59)
	45 degrees	108.75 (4.28)	11 (0.43)	15 (0.59)
	90 degrees	108.75 (4.28)	11 (0.43)	15 (0.59)
23	Straight	112.5 (4.43)	11 (0.43)	15 (0.59)
	45 degrees	135.5 (5.335)	11 (0.43)	15 (0.59)
	90 degrees	135.5 (5.335)	11 (0.43)	15 (0.59)

NOTES:
1. The tolerance on dimensions A and B is ±1 millimeter (±0.04 inch).
2. Shorter values for dimension C may be used.

Step 10. For each OFCC, remove the OFCC jackets back to the dimensions (B + C) shown in table 5A1-III using the OFCC stripper, and trim the OFCC aramid yarn using the aramid yarn cutting shears so that approximately 3 millimeters (0.12 inch) extends past the OFCC jacket (see figure 5A1-15).

NOTE: The optimum way to remove the OFCC jacket is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

Step 11. For each OFCC, remove the fiber buffer and coating back to the dimension (C) shown in table 5A1-III using the buffer stripper (see figure 5A1-15). Remove the buffer and coating in small sections approximately 6 millimeters (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 12. Remove any residual coating material from each of the bare fibers with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Breakage of any one fiber from this point until the connector is completely assembled will require repetition of this and the following steps in order to maintain approximately equal length of all the fibers in the cable.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.2.2 Construction, PC polishing, and end face inspection of termini. The following steps shall be performed:

Step 1. Proceed to Method 5D1 to construct, PC polish, and inspect M29504/14 and M29504/15 termini.

NOTE: Alternatively, if approved for this backshell configuration (see 6.4), a quick connect style termini can be constructed in accordance with the termini manufacturer's instructions.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to the termini insertion instructions (see 4.2.2.3).

4.2.2.3 Assembly of the aramid yarn retainer mechanism and installation of the terminus into the connector insert for AFSI backshells. The following steps shall be performed:

Step 1. Feed the termini and cable aramid yarn through the conical guide (see figure 5A1-16).

Step 2. Hold the aramid yarn in one hand and slide the conical guide toward the cable jacket with the other hand. Pull the aramid yarn and conical guide in opposite directions to ensure the cable seats firmly in the conical guide.

NOTE: The cable should not pass all the way through the conical guide.

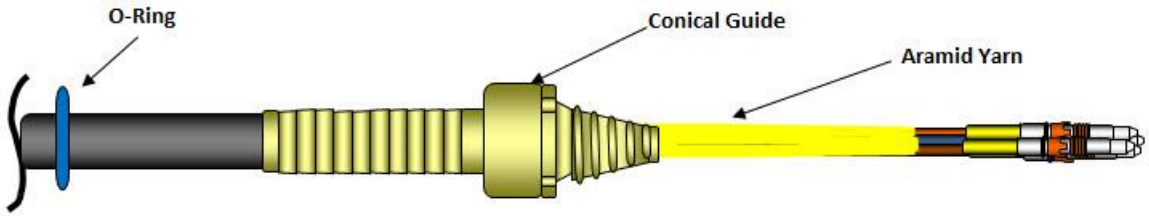


FIGURE 5A1-16. Placing the conical guide over the OFCCs and aramid yarn.

Step 3. Fold back the aramid yarn over the conical guide and tape it to the cable jacket to maintain the tension on it (see figure 5A1-17). This helps to prevent the conical guide from sliding back from the cable jacket.

NOTE: See table 5A1-I for proper conical guide and spring tools depending on shell size.

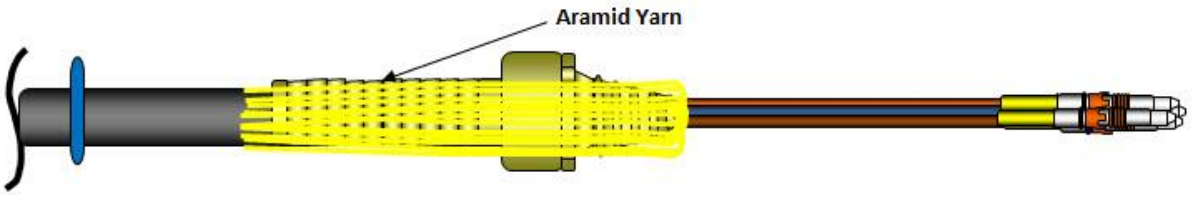


FIGURE 5A1-17. Folding back aramid yarn.

Step 4. Slide the conical spring over the termini and OFCCs and position it over the aramid yarn and conical guide. Use a pair of pliers. Position the jaws around the spring (above the lower tang), take hold of the upper tang, and turn the spring clockwise until it is flush with the top of the conical guide (see figure 5A1-18). Do not over-tighten spring.

NOTE: AFSI conical guide tools may be used in place of pliers to ease the installation of the conical spring onto the conical guide.

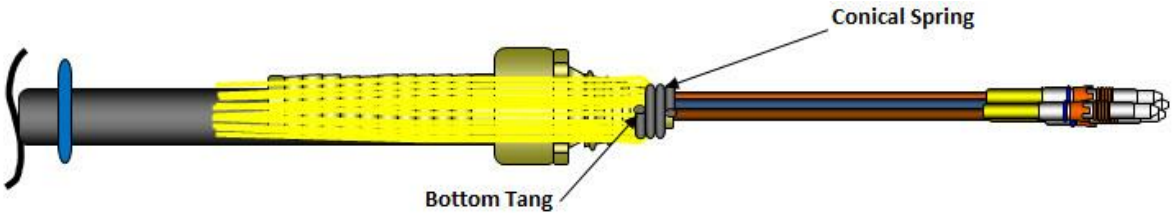


FIGURE 5A1-18. Installation of conical spring.

Step 5. Pull the aramid yarn up toward the termini. Feed the aramid yarn through the conical spring heat shrink sleeve. Slide the shrink sleeve over the conical spring with the punched hole over the bottom tang at the spring's larger end. Heat the shrink sleeve down with a heat gun (see figure 5A1-19).

CAUTION: Do not overheat the OFCCs. Prolonged exposure of the OFCCs in excess of 160 °C (320 °F) may damage the OFCCs. Discontinue heating of the tubing and allow the OFCCs to cool before reheating if the OFCCs show any signs of bubbling or swelling.

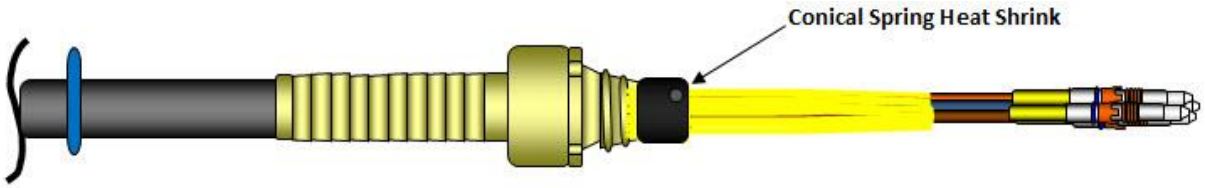


FIGURE 5A1-19. Installation of conical spring heat shrink.

Step 6. Trim the aramid yarn as close to the top of the conical guide as possible.

Step 7. Slide the heat shrink, which has already been placed onto the cable earlier, over the conical guide and shrink it down with a heat gun (see figure 5A1-20).

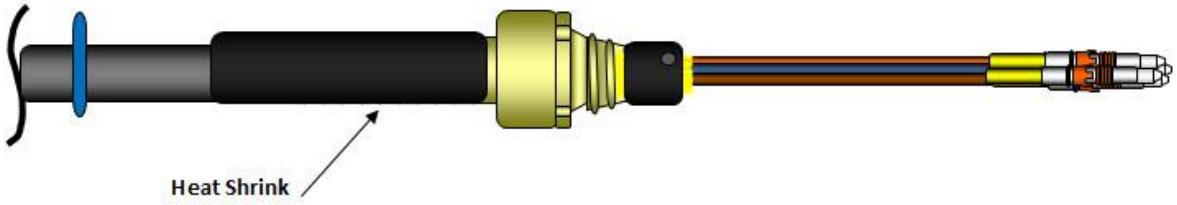


FIGURE 5A1-20. Installation of heat shrink over conical guide.

Step 8. After allowing the heat shrink to cool, roll the O-ring up over the heat shrink until it is against the back of the conical guide (see figure 5A1-21).

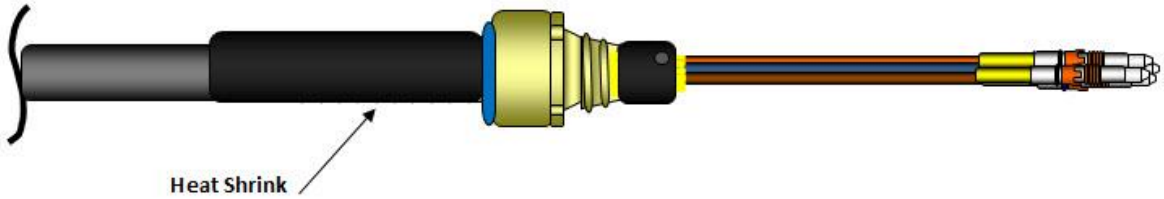


FIGURE 5A1-21. O-ring installation.

Step 9. Feed the termini through the backshell from the rear.

NOTE: For 45- and 90-degree backshells, group the termini together and bundle them up with a piece of masking tape. Attach the bundle of termini to one end of a piece of twisted masking tape (22.86 to 25.4 centimeters [9 to 10 inches] long), then feed the other end through the backshell. Gently pull the twisted masking tape out of the backshell until the termini exit the backshell.

CAUTION: Be sure to place the dust cover over the termini prior to bundling them up.

Step 10. Slide the aramid yarn retainer (conical guide) into the backshell barrel as far as possible. Some rotation of the conical guide is necessary to get it to enter the backshell. Remove the masking tape and set the termini free.

Step 11. Insert termini in accordance with Method 5A6, Procedure I for pin termini, and Method 5A6, Procedure II for socket termini.

Step 12. When all termini have been successfully inserted into the connector, proceed to the backshell assembly instructions (see 4.2.2.4).

4.2.2.4 Assembly of the AFSI backshell. The following steps shall be performed:

Step 1. Install the insert body into the plug or receptacle. Match the key on the outside of the insert with the slot in the plug or receptacle.

Step 2. Slide the whole cable assembly toward the back of the backshell and pull the conical guide out of the backshell. The plug body should be seated on the top of the backshell attachment nut. Press the plug or receptacle into the groove.

NOTE: For 45- and 90-degree backshells, the large key on the face should be in line with the angle on the backshell. Rotate the plug or receptacle until the largest key is aligned with the angle.

Step 3. Screw the backshell attachment nut tightly onto the plug/receptacle.

Step 4. Tighten the attachment nut using a torque wrench (6.78 newton-meters [60 inch-pounds]) on the attachment nut flats and hand grip on the backshell. A strap wrench may be used if necessary.

NOTE: Be careful not to nick or scratch the backshell plating during assembly.

Step 5. Push the conical guide up against the rear of the backshell and rotate it until the tabs seat properly onto the armrest sections (see figure 5A1-22).

Step 6. Slide the backnut onto the back of the backshell and hand-tighten until it bottoms out. A strap wrench may be used if necessary.

NOTE: Ensure that the tabs of the conical guide do not slide out of the armrest sections during tightening of the rear cap.

NOTE: Be careful not to nick or scratch the backshell plating during assembly.

Step 7. Place the dust cover over the front of the plug/receptacle.

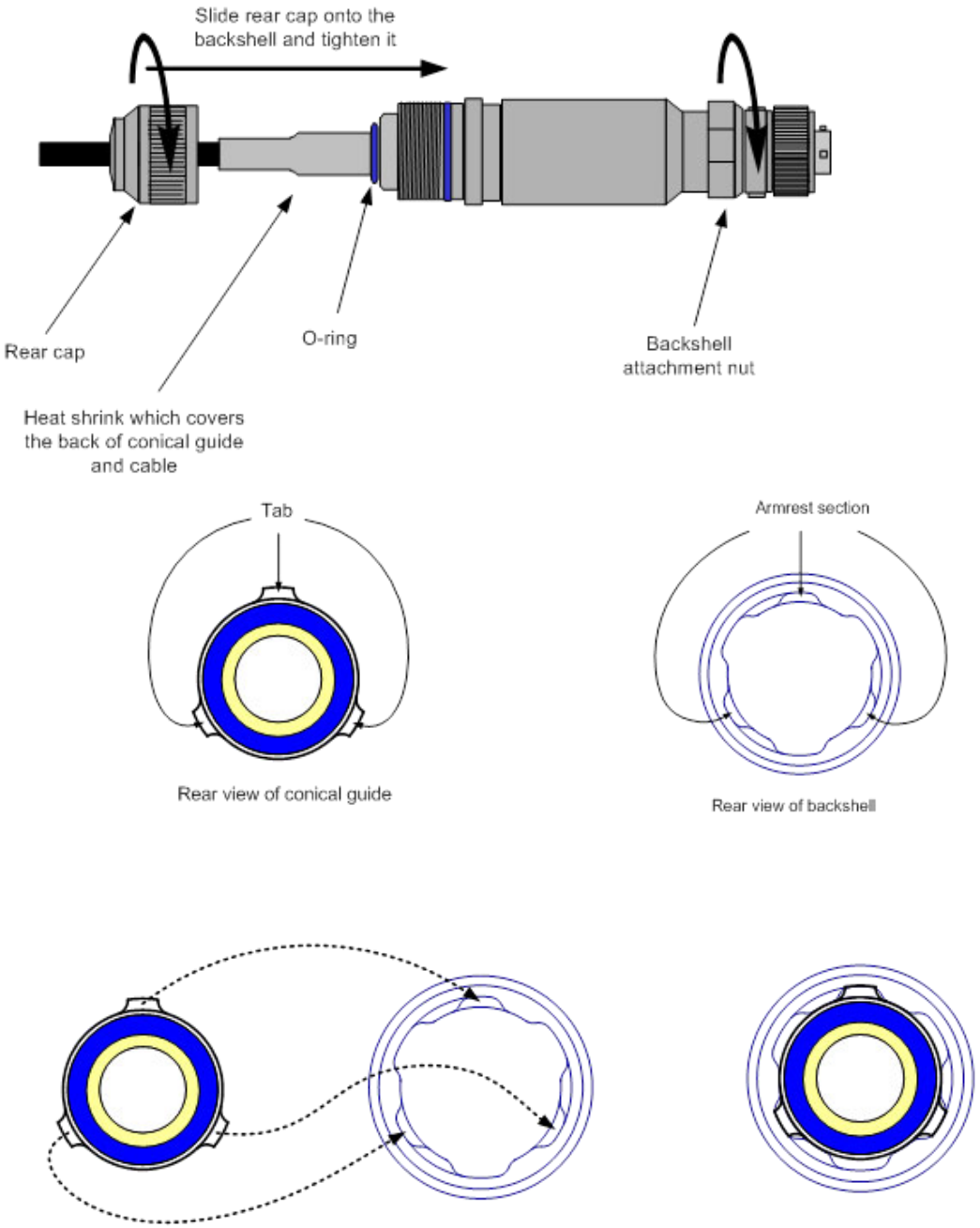


FIGURE 5A1-22. Installing the conical guide and rear cap.

METHOD 5A2
MULTIPLE TERMINUS CONNECTOR (MIL-PRF-28876) INSTALLATION, CONNECTORS WITH INTEGRAL BACKSHELL

1. SCOPE

1.1 Scope. This method describes a procedure for installing connectors manufactured by Delphi Connection Systems with part numbers M28876/2, M28876/3, M28876/4, M28876/7, M28876/8, M28876/9, M28876/12, M28876/13, and M28876/14 onto fiber optic cables. Connectors manufactured by AFSI with part numbers M28876/2, M28876/3, M28876/4, M28876/7, M28876/8, M28876/9, M28876/12, M28876/13, and M28876/14 will be installed onto fiber optic cables using Method 5A1-2.

1.2 Method dependencies. During execution of this method, the user will, at certain points, need to complete Method 5D1 and either Method 5A6, Procedure I or II. If the user is printing this method for reference, it is recommended to print Method 5D1 and Method 5A6, Procedure I or II as well.

2. DOCUMENTS APPLICABLE TO METHOD 5A2

2.1 General. The documents listed in this section are specified in Method 5A2. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A2, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-272	-	Caulking Compounds
A-A-59730	-	Plugs, Tapered Tube, Blown Optical Fiber

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876/1	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, Without Backshell, Environment Resisting
MIL-PRF-28876/2	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With Straight Backshell, Environment Resisting
MIL-PRF-28876/3	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/4	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 90-Degree Backshell, Environment Resisting
MIL-PRF-28876/7	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With Straight Backshell, Environment Resisting
MIL-PRF-28876/8	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 45-Degree Backshell, Environment Resisting

MIL-PRF-28876/9 - Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 90-Degree Backshell, Environment Resisting

MIL-PRF-28876/11 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, Without Backshell, Environment Resisting

MIL-PRF-28876/12 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting With Straight Backshell, Environment Resisting

MIL-PRF-28876/13 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting With 45-Degree Backshell, Environment Resisting

MIL-PRF-28876/14 - Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, With 90-Degree Backshell, Environment Resisting

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

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

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

DEPARTMENT OF DEFENSE STANDARDS

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

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A2-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A2-I. Equipment and materials.

Reference #	Description	Quantity
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	As required
TL-0013	Canned air	As required
TL-0012	Cable jacket stripping tool	1
	Masking tape	As required
	O-ring lubricant (Bray Cote 609, or equal [see 4.8])	As required
TL-0052, TL-0053, or TL-0054	O-ring installation tool shell sizes 11, 13, or 15	As required
TL-0055	O-ring installation tool shell size 23	1
TL-0004	Backshell wrench, C-type	1
TL-0091, TL-0092, or TL-0093	Dual-post, torque wrench adapter, shell sizes 11, 13, or 15	As required
TL-0070	Socket, socket wrench ¼-inch hex adapter for $^{3}/_{8}$-inch drive	1
TL-0090	Torque wrench, $^{3}/_{8}$-inch drive	1
TL-0045	Aramid yarn cutting shears	1
TL-0078	Strip tool, OFCC	1
	Razor blade	1
TL-0046	Marking pen, permanent	1
	Backshell grip	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
TL-0101	Heat gun	1
	Adjustable wrench	1
	Dust covers	As required
	Cold shrink tubing (3M CST 045-095-600, or equal [see 4.8])	As required
	40.0-mm (1.57-inch) inside diameter heat shrink tubing (Raychem ATUM, or equal [see 4.8])	As required
TL-0077	Strap wrench, with $^{3}/_{8}$-inch drive adapter	1
	Flat washer (steel SAE number 8)	As required
	Tapered tube plug (6-fiber bundle, 2 to 6 individual fibers) (A-A-59730-TTP-2)	As required
	Tapered tube plug (12- or 18-fiber bundle, 8 to 12 individual fibers) (A-A-59730-TTP-3)	As required
	Adhesive and sealant tape (Raychem Thermofit S1030, or equal [see 4.8])	As required
TL-0130	Tube cutter	1
TL-0081	Bundle jacket stripper (18-gauge for 6-fiber bundles)	1
TL-0113	Bundle jacket stripper (12-gauge for 18-fiber bundles)	1

TABLE 5A2-I. Equipment and materials – Continued.

Reference #	Description	Quantity
TL-0114	Clear jacket stripper (20-gauge for 6-fiber bundles)	1
	3-mm (⅛-inch) shrink sleeve (6 mm [0.236 inch] in length)	As required
	Flat head screwdriver	1
	Silicone caulking compound (A-A-272)	As required
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

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

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

4.2 Installation of connectors with integral backshells.

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

4.2.1 Cable preparation. The following steps shall be performed:

NOTE: The connector is received assembled with O-rings installed, with the exception of the aramid yarn retaining O-ring and the cable sealing O-ring (shell size 23 only) that are packaged with the backshell.

Step 1. Ensure the cable is the correct type as specified on the applicable cable diagram.

Step 2. Measure the cable to the required length. Add 380 millimeters (15 inches) to allow for at least two re-terminations.

NOTE: If a BOF cable is being prepared, allow 610 millimeters (24 inches).

Step 3. Clean the outer cable jacket that will be in contact with the connector and backshell with a wipe dampened with alcohol and blow it dry with air.

NOTE: Keep the cable and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the parts dry with air.

Step 4. For conventional cable installations, proceed to 4.2.2. For BOF single tube cable installation, proceed to 4.2.3.

4.2.2 Securing the strain relief (conventional cable).

4.2.2.1 Securing the strain relief (shell sizes 11, 13, 15, and 23). The following steps shall be performed:

NOTE: For an optional method for shell size 23 connectors, see 4.2.2.2.

Step 1. Slide the strain relief onto the cable in the following order (see figure 5A2-1):

a. Compression nut with boot.

b. Outer heat shrink tubing with a 50-millimeter (2-inch) length (supplied with connector).

c. O-ring and inner heat shrink tubing with a 50-millimeter (2-inch) length (supplied with shell size 23 connector only).

d. Strain relief housing.

e. Compression ring.

FIGURE 5A2-1. Strain relief parts on the cable.

NOTE: The grooved side of the compression ring should face the strain relief housing.

Step 2. Mark the cable approximately 165 millimeters (6.5 inches) from the end and strip back the outer cable jacket using the cable jacket strip tool. Fold back the aramid yarn strength members and temporarily tape them to the cable outer jacket.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, optical fiber damage may occur.

Cut off the exposed central strength member and any fillers using the aramid yarn shears.

CAUTION: Do not cut or nick the OFCC jackets.

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

Step 4. Remove the tape from the aramid yarn strength members and fold them forward. Slide the compression ring to the end of the cable jacket. Fold the aramid yarn strength members back over the compression ring and the cable in the direction of the strain relief housing.

NOTE: The grooved side of the compression ring should face the strain relief housing.

Step 5. Remove the O-ring from the package and apply O-ring lubricant. Place the O-ring on the O-ring installation tool by forcing the O-ring up the cone to the larger end of the tool (see figure 5A2-2).

CAUTION: Do not nick or cut the O-ring when installing the O-ring onto the O-ring install tool. Even a small nick will cause the O-ring to break during the installation process.

NOTE: Alternatively, a flat surface may be used as an aid when placing the O-ring on the O-ring install tool. Place the larger diameter end, of the O-ring tool, face down on a flat surface. Place the O-ring onto the small end of the O-ring install tool and slide it down to the larger end of the tool.

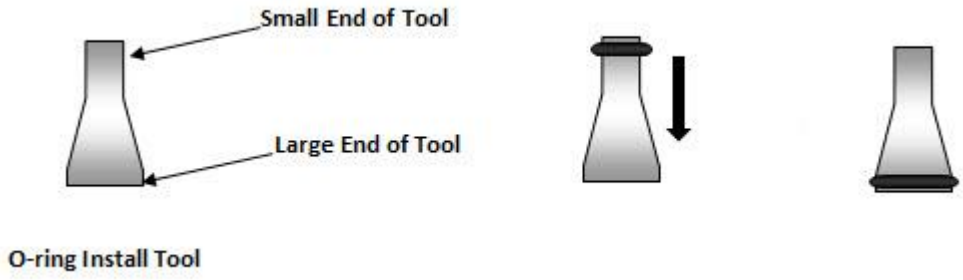


FIGURE 5A2-2. Installation of O-ring onto O-ring install tool.

Step 6. Slide the O-ring tool up the OFCCs (larger opening first) over the compression ring (and aramid yarn strength members) and force the O-ring over the compression ring onto the aramid yarn (see figure 5A2-3). Remove the O-ring tool.

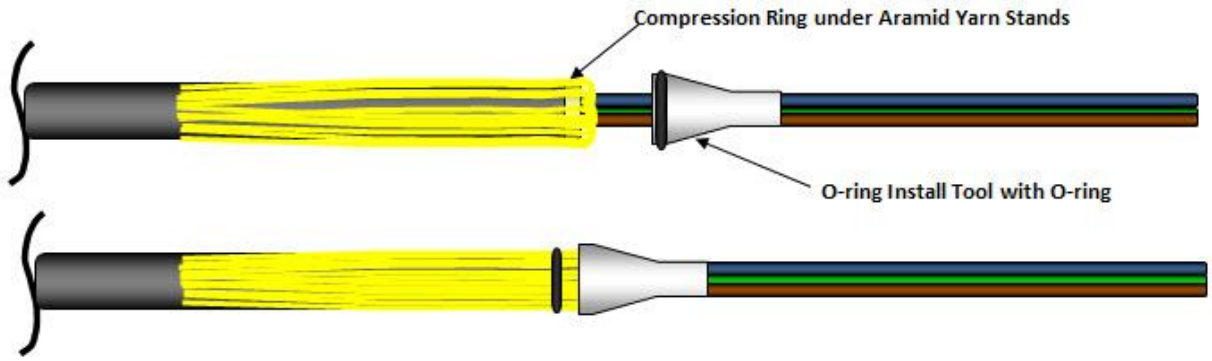


FIGURE 5A2-3. Installing the O-ring.

Step 7. Fold the aramid yarn strength members forward over the O-ring and the compression ring. Tape the aramid yarn members to the OFCCs to ease the installation of the aramid yarn compression nut.

NOTE: The aramid yarn should be uniformly arranged around the compression ring.

Step 8. Slide the strain relief housing up the cable to the compression ring. Gently feed the OFCCs and aramid yarn through the aramid yarn compression nut and slide the nut up to the strain relief housing. Thread the compression nut onto the strain relief housing while pulling the aramid yarn taut (see figure 5A2-4).

NOTE: If the compression nut cannot be threaded onto the strain relief housing because of the amount of aramid yarn in the optical fiber cable, remove the compression nut and ring from the cable, trim back some of the cable aramid yarn to the cable jacket, and return to step 4. The amount of aramid yarn trimmed should be the minimum amount necessary to allow the compression nut to thread onto the strain relief housing. The aramid yarn should be trimmed uniformly around the circumference of the cable.

CAUTION: Do not allow any of the aramid yarn strands to get between the threads of the compression nut and the threads on the strain relief housing.

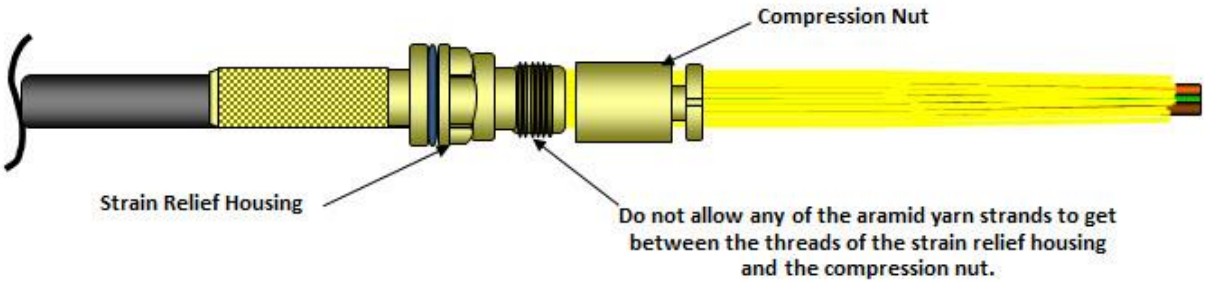


FIGURE 5A2-4. Assembly of the strain relief housing and the compression nut.

Step 9. Tighten the aramid yarn compression nut to 2.75 newton-meters (25 inch-pounds) using the wrench, the torque adapter, the hex adapter, and the torque tool (see figure 5A2-5). Remove the wrench and the other tools.

NOTE: For shell size 23, use the torque wrench inserted into the strap wrench instead of into the hex adapter and torque wrench adapter.

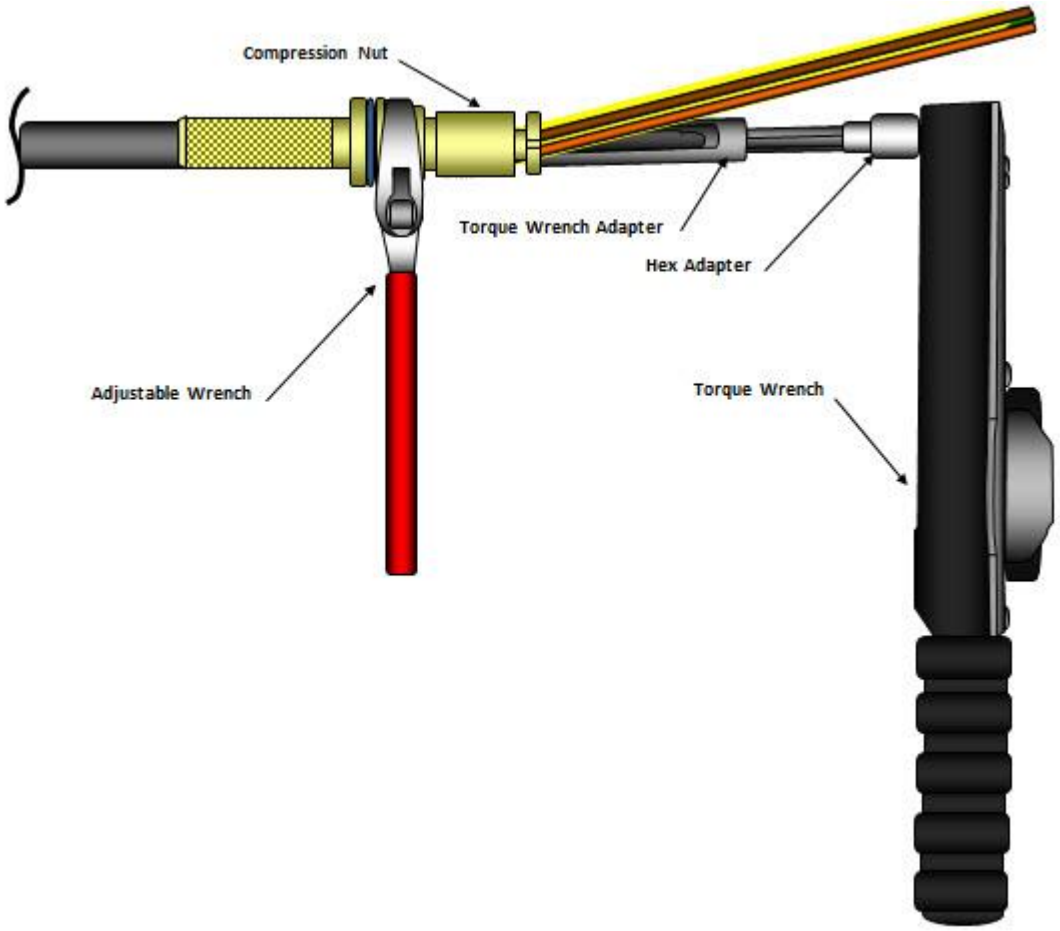


FIGURE 5A2-5. Tightening the aramid yarn compression nut.

Step 10. Remove the tape and trim the aramid yarn down to the face of the aramid yarn compression nut using the aramid yarn shears.

NOTE: The following steps may be performed at this time or later in the connector assembly process before final assembly of the backshell (see 4.2.7).

Step 11. For shell size 23 only, slide the second O-ring over the jacket until it butts up against the knurled end of the strain relief housing (see figure 5A2-6).

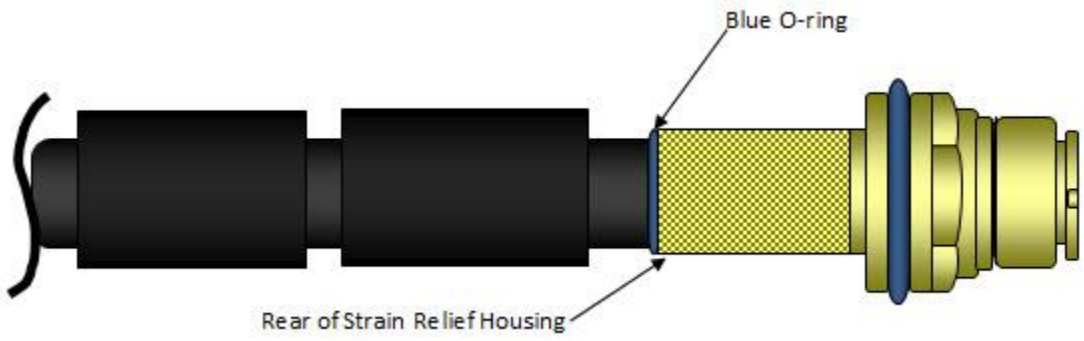


FIGURE 5A2-6. Placement of O-ring.

Step 12. For shell size 23 only, slide the 50-millimeter (2-inch) length of inner heat shrink tubing over the jacket until it butts up against the O-ring (see figure 5A2-7).

Starting at the cable end of the heat shrink tubing, hold the heat gun approximately 100 millimeters (4 inches) from the tubing and apply heat until the tubing shrinks to a tight fit and sealant is visible at the ends.

CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160 °C (320 °F) may damage the cable jacket. Discontinue heating of the tubing and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling or necking.

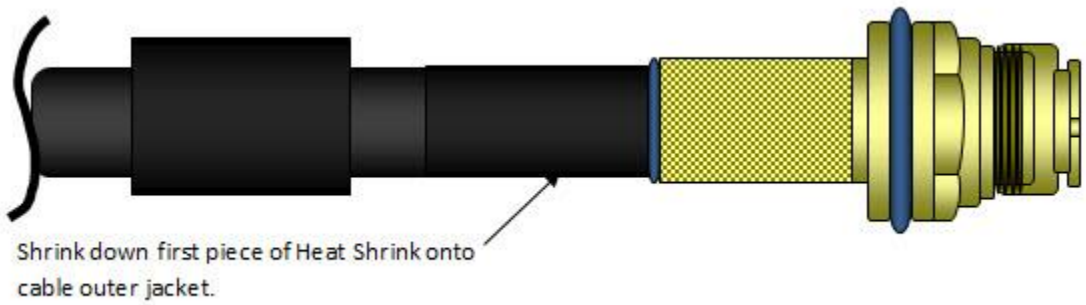


FIGURE 5A2-7. Application of inner heat shrink tubing.

Step 13. Slide the 50-millimeter (2-inch) length of outer heat shrink tubing over the O-ring and knurled end of the strain relief housing up to the shoulder (see figure 5A2-8).

Starting at the strain relief housing, hold the heat gun approximately 100 millimeters (4 inches) from the tubing and apply heat until the tubing shrinks to a tight fit and sealant is visible at the ends.

CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160 °C (320 °F) may damage the cable jacket. Discontinue heating of the tubing and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling or necking.

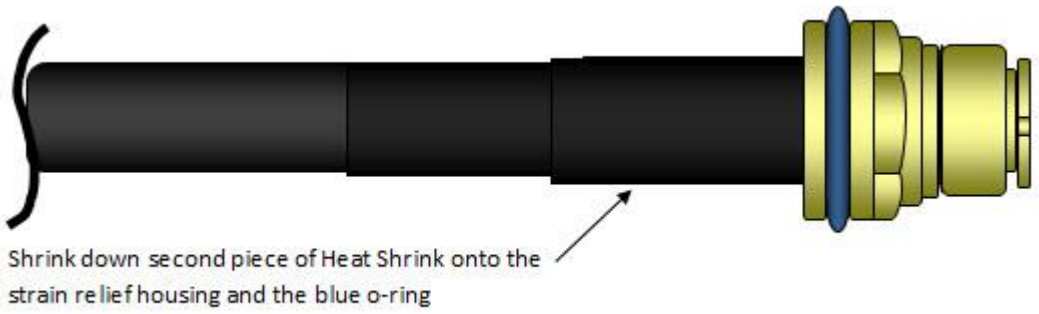


FIGURE 5A2-8. Application of outer heat shrink tubing.

Step 14. Proceed to fiber preparation (section 4.2.4).

4.2.2.2 Securing the strain relief (shell size 23 optional method). This method is useful when the multifiber cable pinout is different than the OFCC physical arrangement within the multifiber cable. The following steps shall be performed:

Step 1. Slide the strain relief onto the cable in the following order (see figure 5A2-9):

a. Compression nut.
b. Outer heat shrink tubing with a 200-millimeter (8-inch) minimum length.
c. O-ring and inner heat shrink tubing with a 50-millimeter (2-inch) length (supplied with connector).
d. Strain relief housing.
e. Inner cold shrink tubing with a 150-millimeter (6-inch) length.
f. Compression ring.

FIGURE 5A2-9. Strain relief parts on the cable.

Step 2. Mark the cable approximately 317 millimeters (12.5 inches) from the end and strip back the outer cable jacket using the cable jacket strip tool. Fold back the aramid yarn strength members and temporarily tape them to the cable outer jacket.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, optical fiber damage may occur.

Cut off the exposed central strength member and any fillers using the aramid yarn shears.

CAUTION: Do not cut or nick the OFCC jackets.

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

Step 4. Arrange the cable OFCCs so that the OFCCs are in the proper physical configuration for insertion into the connector insert once terminated. OFCCs can be gently woven or laced to accomplish this.

Step 5. Proceed with fiber preparation (see 4.2.4).

Step 6. Complete Method 5D1 for installation of termini onto fibers, polishing the fiber ends, and end face check before continuing this procedure.

Step 7. Remove the tape from the aramid yarn strength members and fold them forward. Slide the compression ring to the rear of the termini.

NOTE: The grooved side of the ring should face away from the termini.

Step 8. Slide the inner cold shrink tubing over the end of the cable jacket until it lies completely over the aramid yarn and OFCCs. Shrink the tubing down over the aramid yarn and OFCCs.

NOTE: There should not be a gap between the end of the cable jacket and the end of the inner cold shrink tubing. In addition, the inner shrink tubing should not overlap the end of the cable jacket.

Step 9. Slide the compression ring back over the aramid yarn until it is even with the end of the inner cold shrink tubing. Fold the aramid yarn strength members back over the compression ring and the cable in the direction of the strain relief housing.

Step 10. Remove the O-ring (taped to the backshell exterior) and apply O-ring lubricant. Place the O-ring on the O-ring installation tool by forcing the O-ring up the cone to the larger end of the tool.

Step 11. Slide the O-ring tool up the OFCCs (larger opening first) over the compression ring (and aramid yarn strength members) and force the O-ring over the compression ring onto the aramid yarn (see figure 5A2-10). Remove the O-ring tool.

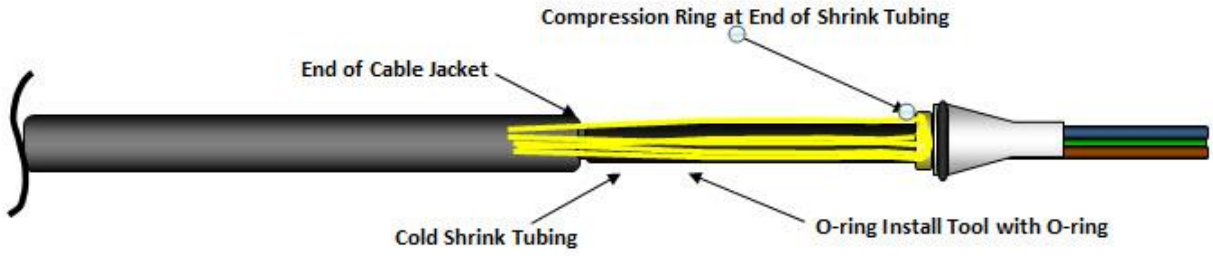


FIGURE 5A2-10. Installing the O-ring.

NOTE: The termini must be fed through the O-ring tool in groups of four to eight before the O-ring tool can slide up the OFCCs.

Step 12. Fold the aramid yarn strength members forward over the O-ring and the compression ring. Tape the aramid yarn members to the OFCCs to ease the installation of the aramid yarn compression nut.

Step 13. Slide the strain relief housing up the cable to the compression ring. Gently feed the OFCCs and aramid yarn through the aramid yarn compression nut and slide the nut up to the strain relief housing. Thread the compression nut onto the strain relief housing while pulling the aramid yarn taut.

NOTE: The termini must be fed through the compression nut in groups of four to eight before the compression nut can slide up to the strain relief housing.

Step 14. Tighten the aramid yarn compression nut to 2.75 newton-meters (25 inch-pounds) using the wrench, the strap wrench, and the torque tool. Remove the wrench and the other tools.

Step 15. Remove the tape and trim the aramid yarn down to the face of the aramid yarn compression nut using the aramid yarn shears.

Step 16. Slide the second O-ring over the jacket and inner shrink tubing until it butts up against the knurled end of the strain relief housing.

Step 17. Slide the 50-millimeter (2-inch) length of inner heat shrink tubing over the cold shrink tubing until it butts up against the O-ring. Starting at the cable end of the heat shrink tubing, hold the heat gun approximately 100 millimeters (4 inches) from the tubing and apply heat until the tubing shrinks to a tight fit and sealant is visible at the ends.

CAUTION: Do not overheat the cable. Prolonged exposure of the cold shrink tubing to temperatures above 160 °C (320 °F) may damage the cold shrink tubing. Discontinue heating of the heat shrink tubing and allow the cold shrink tubing to cool before reheating if the cold shrink tubing shows any signs of bubbling or necking.

Step 18. Slide the outer heat shrink tubing over the O-ring and knurled end of the strain relief housing up to the shoulder. Shrink the outer shrink tubing down over the strain relief housing, the O-ring, the inner shrink tubing, and the cable jacket.

Starting at the strain relief housing, hold the heat gun approximately 100 millimeters (4 inches) from the tubing and apply heat until the tubing shrinks to a tight fit and sealant is visible at the ends.

CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160 °C (320 °F) may damage the cable jacket. Discontinue heating of the tubing and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling or necking.

4.2.3 Securing the strain relief (BOF cable). The following steps shall be performed:

NOTE: If the number of fibers in the BOF tube exceeds the number of fibers to be terminated, the additional fibers should not be cut off until after the fibers to be terminated are successfully terminated.

Step 1.a. For shell size 15, proceed to step 2.

Step 1.b. For shell size 13, cut off the boot of the compression nut using a razor blade so that only the largest diameter boot section remains on the compression nut.

NOTE: This will allow the boot to slide onto the single tube-cable.

Step 2. Mark the cable approximately 305 millimeters (12.0 inches) from the end and strip back the outer cable jacket using the cable jacket strip tool. Fold back the aramid yarn strength members over the cable outer jacket.

CAUTION: Do not cut or nick the BOF tube when removing the cable jacket.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, BOF tube damage may occur.

Step 3. Remove any water blocking material and clean the BOF tube using a wipe dampened with alcohol and blow it dry with air.

Step 4. Pull the aramid yarn strength members forward over the BOF tube and tape them to the BOF tube. Slide the strain relief onto the cable in the following order (see figure 5A2-11):

a. Compression nut with boot.

b. Outer heat shrink tubing with a 50-millimeter (2-inch) length (supplied with connector).

c. Strain relief housing.

d. Compression ring.

NOTE: For shell size 13, the compression nut with boot and the outer heat shrink tubing will be the only parts that will go over the single-tube cable jacket. The strain relief housing and the compression ring will stop at the edge of the single-tube cable jacket.

FIGURE 5A2-11. Strain relief parts on the cable.

Step 5. Remove the tape from the aramid yarn strength members and fold them back over the compression ring and single tube-cable in the direction of the strain relief housing.

NOTE: The grooved side of the compression ring should face the strain relief housing.

Step 6. Cut the BOF tube at the front of the compression ring using a razor blade or tube cutter and remove the BOF tube.

CAUTION: Do not cut or nick the BOF fibers when cutting back the BOF tube.

Step 7. Remove the O-ring from the package and apply O-ring lubricant. Place the O-ring on the O-ring installation tool by forcing the O-ring up the cone to the larger end of the tool.

Step 8. Slide the O-ring tool up the BOF bundle or fibers (larger opening first) over the compression ring (and aramid yarn strength members) and force the O-ring over the compression ring onto the aramid yarn (see figure 5A2-12). Remove the O-ring tool.

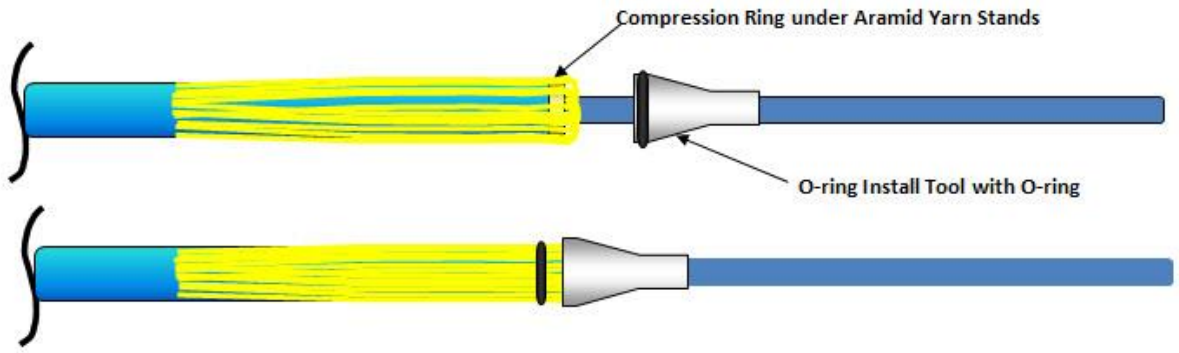


FIGURE 5A2-12. Installing the O-ring.

Step 9. For tubes containing BOF bundles only:

a. Place the appropriate tapered tube plug (see table 5A2-I) around the exposed bundle jacket approximately 12 millimeters (0.5 inch) from the end of the BOF tube.

b. Press the plug into the BOF tube.

NOTE: The tapered tube plug may be coated with silicone caulking compound before assembly into the tube for enhanced watertight sealing.

NOTE: Do not pull the slack fiber bundle out of the BOF tube before assembling the plug to the bundle jacket.

NOTE: The optical fiber bundle should now be fixed in the tapered tube plug and should not move into or out of the BOF tube during the connector assembly or fiber termination processes.

Step 10. For tubes containing individual BOF fibers only:

a. Work a small amount of sealant tape around the optical fibers approximately 12 millimeters (0.5 inch) from the end of the BOF tube.

b. Place the appropriate tapered tube plug (see table 5A2-I) around the optical fibers and sealant tape.

c. Press the plug into the BOF tube.

NOTE: The tapered tube plug may be coated with silicone caulking compound before assembly into the tube for enhanced watertight sealing.

NOTE: Do not pull slack fiber out of the BOF tube before assembling the plug to the fibers.

NOTE: The optical fibers should now be fixed in the tapered tube plug and should not move into or out of the BOF tube during the connector assembly or fiber termination processes.

Step 11. Fold the aramid yarn strength members forward over the O-ring and the compression ring. Tape the aramid yarn and BOF bundle or BOF fibers together at the end.

NOTE: Taping the aramid yarn and BOF bundle or BOF fibers together eases the installation of the aramid yarn compression nut.

NOTE: The aramid yarn should be uniformly arranged around the compression ring.

Step 12. For shell size 13, proceed to step 14.

Step 13. For shell size 15, gently feed the BOF bundle, or fibers, and aramid yarn through the flat washer and slide the washer up to the strain relief housing. Proceed to step 14.

Step 14. Gently feed the BOF bundle, or fibers, and aramid yarn through the aramid yarn compression nut and slide the nut up to the strain relief housing. Thread the compression nut onto the strain relief housing.

NOTE: If the compression nut cannot be threaded onto the strain relief housing because of the amount of aramid yarn in the single tube-cable, remove the compression nut and ring from the cable, trim back some of the cable aramid yarn to the cable jacket, and return to step 5. The amount of aramid yarn trimmed should be the minimum amount necessary to allow the compression nut to thread onto the strain relief housing. The aramid yarn should be trimmed uniformly around the circumference of the cable.

Step 15. Tighten the aramid yarn compression nut to 2.75 newton-meters (25 inch-pounds) using the wrench, the torque adapter, the hex adapter, and the torque tool (see figure 5A2-13). Remove the wrench and the other tools. Trim the excess aramid yarn even with the face of the aramid yarn compression nut using the aramid yarn shears.

CAUTION: Do not cut or nick the BOF fibers when cutting back the aramid yarn.

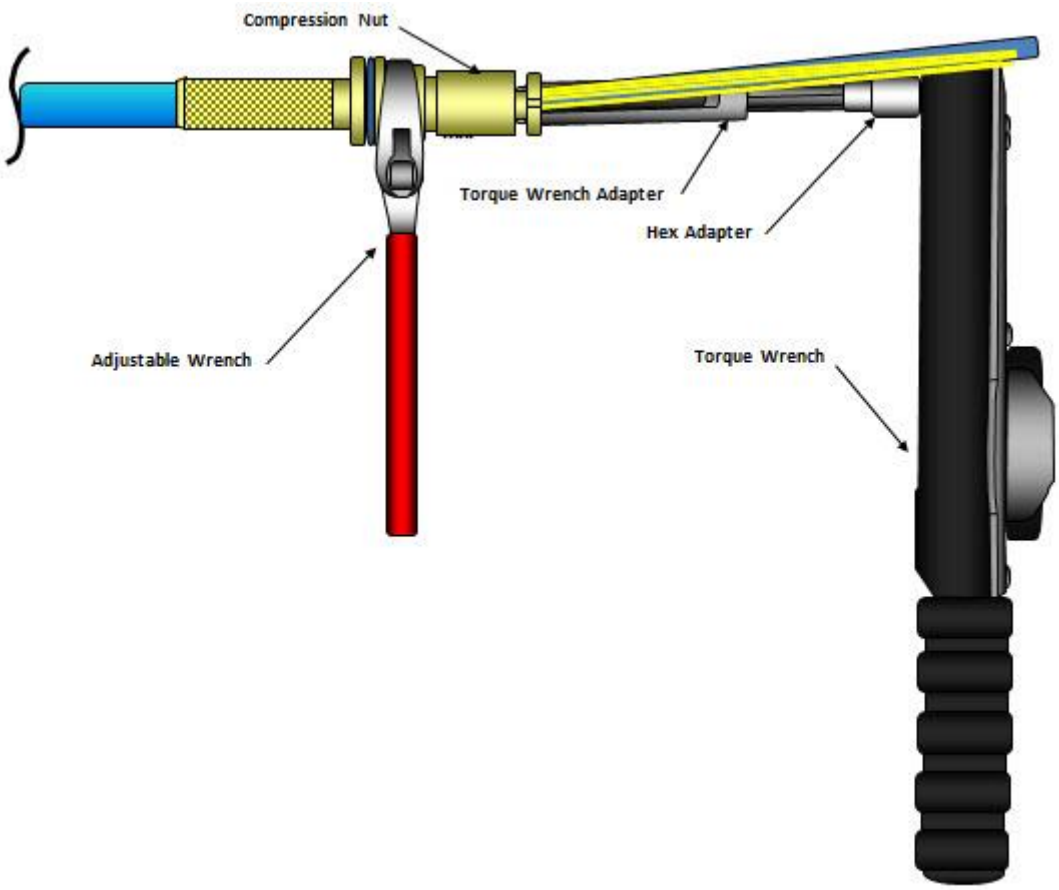


FIGURE 5A2-13. Tightening the aramid yarn compression nut.

NOTE: The following steps may be performed at this time or later in the connector assembly process before final assembly of the backshell (see 4.2.7).

Step 16. Slide the 50-millimeter (2-inch) length of outer heat shrink tubing over the knurled end of the strain relief housing up to the shoulder.

CAUTION: Do not overheat the cable. Prolonged exposure of the jacket to temperatures above 160 °C (320 °F) may damage the cable jacket. Discontinue heating of the tubing and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling or necking.

Step 17. Starting at the strain relief housing, hold the heat gun approximately 100 millimeters (4 inches) from the tubing and apply heat until the tubing shrinks to a tight fit and sealant is visible at the ends.

NOTE: Ensure that the heat shrink is properly sealed to the cable and connector. The heat shrink on the connector is an integral part of the BOF tube system watertight integrity.

Step 18. For tubes containing BOF bundles only, perform the following:

a. Using the bundle jacket stripper, remove the exposed bundle jacket in approximately 160-millimeter (6-inch) lengths until all of the exposed bundle jacket is removed.

NOTE: Once a short length of the bundle jacket has been removed, the remaining length can normally be torn off of the bundle by hand.

NOTE: For 18-fiber bundles, fibers of the same color are contained in each 6-fiber subunit. The sixth fiber color in each of the three 6-fiber subunits identifies the particular subunit. During the installation of the furcation unit, it is important to know the 6-fiber subunit that each fiber comes from (see MIL-STD-2042-2, table 2F2-II). If adequate fiber length exists, one method to uniquely mark the fibers of each 6-fiber subunit is to make the fibers of each subunit a slightly different length.

b. Using the clear jacket stripper, remove approximately 80 millimeters (3 inches) of the clear inner jacket from the end of the six-fiber subunit.

NOTE: If the clear jacket stripper does not bite into the clear inner jacket, position the clear jacket stripper at a 30- to 40-degree angle to increase its bite.

c. Find the ripcord from among the six fibers. Ensure that it is not crossed with any of the fibers. While holding the group of fibers in one hand, pull the ripcord along the bundle with the other hand. Pull the ripcord until it reaches the beginning of the bundle jacket.

NOTE: The ripcord and fibers spiral along the bundle length. Take care to follow the spiral when pulling the ripcord.

d. Starting at the end of the fiber bundle subunit, carefully pull the group of fibers from the clear inner jacket.

e. Using the scissors, carefully cut away the ripcord and the clear inner jacket.

f. Repeat steps b through e for each six-fiber subunit.

Step 19. Proceed to fiber preparation (see 4.2.4).

4.2.4 Fiber preparation. The following steps shall be performed:

Step 1. Feed each OFCC into a crimp sleeve and slide the sleeve back from the end of the OFCC.

NOTE: Only use crimp sleeves intended for termini. Do not use crimp sleeves intended for other types of connectors. The standard crimp sleeve for the terminus may be oriented in either direction.

NOTE: For termination of fiber with only a coating/buffer, a crimp sleeve is not utilized. Feed each fiber into a 6-millimeter (0.25-inch) length of 3-millimeter (0.12-inch) heat shrink tubing.

Step 2. Trim the OFCCs to the length (A + B + C) shown in table 5A2-II using the aramid yarn shears (see figure 5A2-14).

TABLE 5A2-II. Cable stripping dimensions.

Connector shell size	Backshell configuration	Dimensions mm (inch)		
		A	B	C
13	Straight	67 (2.64)	10 (0.39)	22 (0.87)
	45 degrees	85 (3.35)	10 (0.39)	22 (0.87)
	90 degrees	85 (3.35)	10 (0.39)	22 (0.87)
15	Straight	67 (2.64)	10 (0.39)	22 (0.87)
	45 degrees	105 (4.13)	10 (0.39)	22 (0.87)
	90 degrees	105 (4.13)	10 (0.39)	22 (0.87)
23	Straight	70 (2.75)	10 (0.39)	22 (0.87)
	45 degrees	108 (4.25)	10 (0.39)	22 (0.87)
	90 degrees	108 (4.25)	10 (0.39)	22 (0.87)

NOTES:

1. For BOF fiber, with only a coating/buffer, A + B should be used for the coated/buffered fiber length.
2. For the shell size 23 optional strain relief assembly procedure (see 4.2.2.2), the cable strip length (dimension A) used in the fiber preparation process should be increased by 163 millimeters (6.4 inches) due to the increased length of cable jacket removed in the procedure.
3. The tolerance on dimensions A and B is ±1 millimeter (±0.04 inch).
4. Shorter values for dimension C may be used.
5. For items approved after the date of publication, approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.

Step 3. For each OFCC, remove the OFCC jackets back to the dimension (B + C) shown in table 5A2-II using the OFCC stripper and trim the OFCC aramid yarn so that approximately 3 millimeters (0.12 inch) extend past the OFCC jacket (see figure 5A2-14).

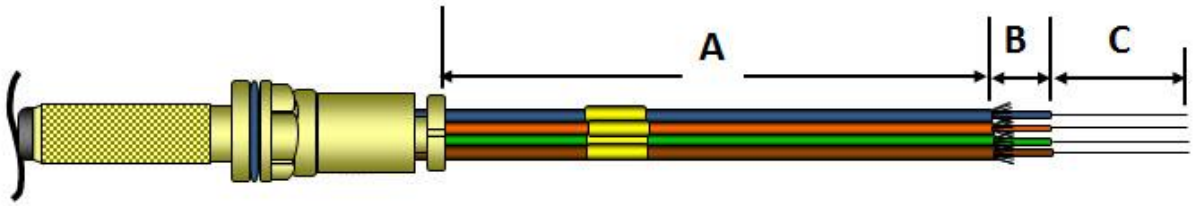


FIGURE 5A2-14. Cable stripping dimensions.

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

NOTE: This step does not apply when terminating BOF fiber with only a coating/buffer.

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

Step 4. For each OFCC, remove the fiber buffer and coating back to the dimension (C) shown in table 5A2-II using the buffer stripper (see figure 5A2-14). Remove the buffer and coating in small sections (approximately 6 millimeters [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 5. Remove any residual coating material from the bare fibers with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Breakage of any one fiber from this point until the connector is completely assembled will require repetition of this and the following steps in order to maintain approximately equal length of all the fibers in the cable.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.5 Construction, PC polishing, and end face inspection of termini. The following steps shall be performed:

Step 1. Proceed to Method 5D1 to construct, PC polish, and inspect M29504/14 and M29504/15 termini.

NOTE: Alternatively, if approved for this backshell configuration (see 6.4), a quick connect style termini can be constructed in accordance with the termini manufacturer's instructions.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to the termini insertion instructions (see 4.2.6).

4.2.6 Installation of the terminus into the connector insert. The following steps shall be performed:

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

NOTE: Proceed to step 1.a for straight (in-line) backshell connectors. Proceed to step 1.b for 45- or 90-degree backshell connectors.

Step 1.a. Fit the spacing shafts of the insert into the notches in the face of the strain relief until they snap into place (see figure 5A2-15). Proceed to step 2.

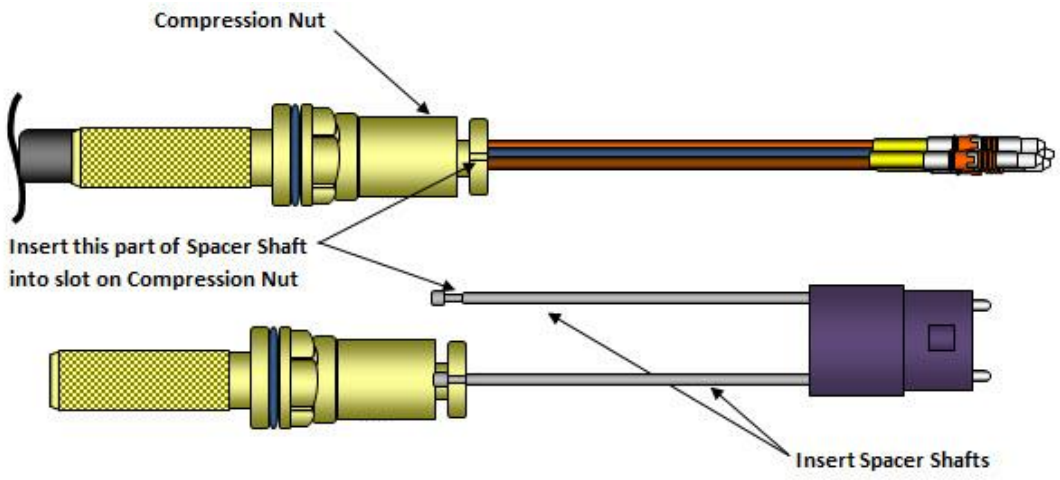


FIGURE 5A2-15. Installing the spacing shafts.

Step 1.b. Slide the strain relief/cable assembly into the backshell. When the strain relief assembly stops, rotate the backshell until the strain relief assembly aligns with the backshell. When they are aligned, fully seat the strain relief assembly by sliding it the rest of the way into the backshell. Proceed to step 2.

NOTE: A properly seated strain relief assembly should be recessed approximately 10 millimeters (0.4 inch) from the rear of the backshell.

Step 2. Insert termini in accordance with Method 5A6, Procedure I for pin termini, and Method 5A6, Procedure II for socket termini.

Step 3. When all termini have been successfully inserted into the connector, proceed to the backshell assembly instructions (see 4.2.7).

4.2.7 Assembly of the backshell. The following shall be performed:

NOTE: If the heat shrink was not applied to the connector strain relief during the initial strain relief assembly, complete steps 11, 12, and 13 of 4.2.2.1 before continuing.

NOTE: 45- and 90-degree backshells have two available clocking positions and are normally shipped with the backshell clocked at either 0 or 180 degrees, referenced to the master key. If other backshell clocking positions are required, the backshell adapter must be decoupled from the connector plug, rotated to the required clocking position, and then re-coupled to the plug. Thread locking compound is used on the plug and backshell adapter threads and must be replaced when re-coupling the backshell adapter to the plug at a torque of 8.6 newton-meters (75 inch-pounds).

4.2.7.1 Straight backshells. The following steps shall be performed:

Step 1. Slide the insert/strain relief/cable assembly into the backshell (see figure 5A2-16). When the insert stops, rotate the backshell until the key on the insert aligns with the keyway in the backshell. When they are aligned, fully seat the insert by sliding the insert/strain relief/cable assembly the rest of the way into the backshell.

NOTE: A properly seated insert should cause the strain relief assembly to be recessed approximately 10 millimeters (0.4 inch) from the rear of the backshell.

NOTE: While looking at the front of the integrated connector backshell, align the master key on the plug connector shell at the 12:00 position. While inserting the strain relief/insert assembly, from the opposite end of the integrated connector backshell, rotate the insert assembly until the alignment hole between number position 1 and 2 are entered between the master key of the plug connector shell (see figure 5A2-16).

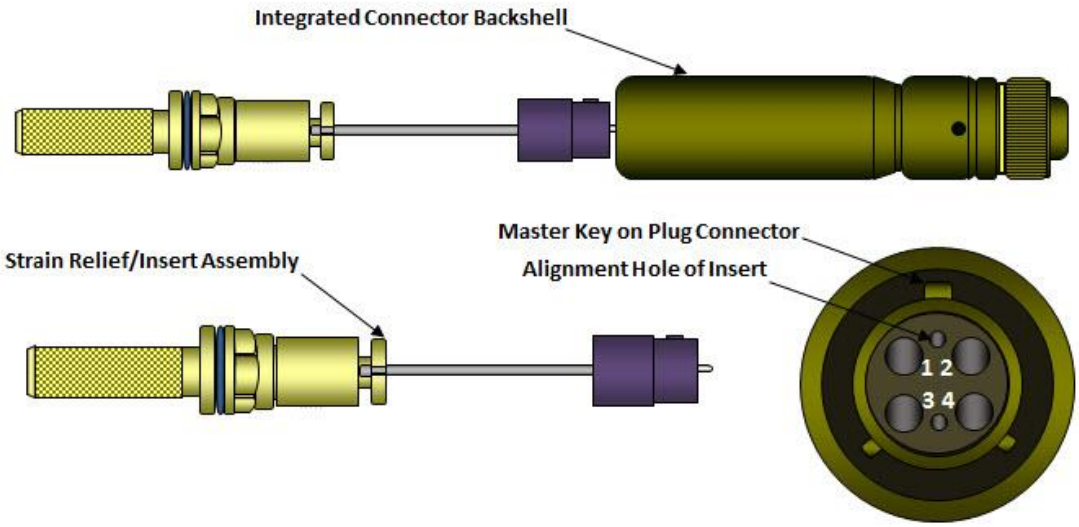


FIGURE 5A2-16. Assembling the backshell.

Step 2. Slide the compression nut up to the backshell, thread it into the backshell, and tighten it using the backshell wrench, torque wrench, and backshell grip to 6.6 newton-meters (60 inch-pounds). Use care to not nick or scratch the backshell coating during assembly.

CAUTION: Make sure that the insert key is properly aligned in the connector shell keyway and the insert is fully seated in the connector shell before threading the compression nut into the backshell. Failure to properly seat the insert in the connector shell will cause breakage of the spacer shafts when the compression nut is threaded into the connector shell.

NOTE: For assembly of backshells for BOF tube cables, ensure that the backshell is properly mated and tightened. The backshell and connector are integral parts of the BOF tube system watertight integrity.

NOTE: For shell size 23 backshells, use the strap wrench, torque wrench, and backshell grip to tighten the compression nut to the backshell.

Step 3. Install the plastic protective cap over the front of the connector.

4.2.7.2 45- and 90-degree backshells.

Step 1. Assemble the two backshell halves together using a screwdriver.

CAUTION: Make sure that the OFCCs will not be pinched between the two backshell halves before assembling the backshell halves.

Step 2. Slide the compression nut up to the backshell, thread it into the backshell, and tighten it using the backshell wrench, torque wrench, and backshell grip to 6.6 newton-meters (60 inch-pounds). Use care to not nick or scratch the backshell coating during assembly.

NOTE: For assembly of backshells for BOF tube cables, ensure that the backshell is properly mated and tightened. The backshell and connector are integral parts of the BOF tube system watertight integrity.

NOTE: For shell size 23 backshells, use the strap wrench, torque wrench, and backshell grip to tighten the compression nut to the backshell.

Step 3. Install the plastic protective cap over the front of the connector.

METHOD 5A3
MULTIPLE TERMINUS CONNECTOR (MIL-PRF-28876) INSTALLATION, CONNECTORS WITH INSERT RETENTION NUTS

1. SCOPE

1.1 Scope. This method describes a procedure for assembling connectors with part numbers M28876/1 and M28876/11 configured with insert retention nuts onto OFCCs.

1.2 Method dependencies. During execution of this method, the user will, at certain points, need to complete Method 5D1 and either Method 5A6, Procedure I or II. If the user is printing this method for reference, it is recommended to print Method 5D1 and Method 5A6, Procedure I or II as well.

2. DOCUMENTS APPLICABLE TO METHOD 5A3

2.1 General. The documents listed in this section are specified in Method 5A3 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A3 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876/1	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, Without Backshell, Environment Resisting
MIL-PRF-28876/11	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, Without Backshell, Environment Resisting
MIL-PRF-29504/14	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/15	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A3-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A3-I. Equipment and materials.

Reference #	Description	Quantity
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0046	Marking pen, permanent	1
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	As required
TL-0013	Canned air	As required
TL-0078	Strip tool, OFCC	1
TL-0045	Aramid yarn shears	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
	Dust covers	As required
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

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

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

4.2 Installation of connectors with insert retention nuts. The following shall be observed:

NOTE: This procedure is applicable in the installation of connector receptacles into equipment where the termination is accomplished on OFCCs. This procedure is not appropriate for the installation of plugs or receptacles onto multifiber cables.

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

4.2.1 Cable and fiber preparation. The following steps shall be performed:

Step 1. Ensure the OFCCs are the correct type as specified on the applicable cable diagram.

Step 2. Measure the OFCCs to the required length. Then add 80 millimeters (3.2 inches) to allow for at least two re-terminations.

Step 3. Clean the OFCC outer jackets with a wipe dampened with alcohol and blow them dry with air.

NOTE: Keep the OFCCs and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the part dry with air.

Step 4. Feed each OFCC into a crimp sleeve and slide the sleeve back from the end of the OFCC.

NOTE: Only use crimp sleeves intended for termini. Do not use crimp sleeves intended for other types of connectors. The standard crimp sleeve for the terminus may be oriented in either direction.

Step 5. For each OFCC, remove the OFCC jackets back 32 millimeters (1.26 inches) from the end of the fiber using the OFCC stripper and trim the OFCC aramid yarn using the aramid yarn shears so that approximately 3 millimeters (0.12 inch) extends past the OFCC jacket.

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

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

Step 6. For each OFCC, remove the fiber buffer and coating back 22 millimeters (0.87 inch) from the end of the fiber using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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 coating material from each of the bare fibers with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.2 Construction, PC polishing, and end face inspection of termini. The following steps shall be performed:

Step 1. Proceed to Method 5D1 to construct, PC polish, and inspect M29504/14 and M29504/15 termini.

NOTE: Alternatively, if approved for this backshell configuration (see 6.4), a quick connect style termini can be constructed in accordance with the termini manufacturer's instructions.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to the termini insertion instructions (see 4.2.3).

4.2.3 Installation of the terminus into the connector insert. The following steps shall be performed:

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

Step 1. Insert termini in accordance with Method 5A6, Procedure I for pin termini, and Method 5A6, Procedure II for socket termini.

Step 2. Install the plastic protective cap over the front of the connector.

METHOD 5A4
MIL-PRF-28876 CONNECTOR ASSEMBLY, SPLIT BACKSHELL

1. SCOPE

1.1 Scope. This method describes a procedure for installing connectors manufactured by Delphi Connection Systems with part numbers M28876/2, M28876/3, M28876/4, M28876/7, M28876/8, M28876/9, M28876/12, M28876/13, M28876/14, M28876/27, M28876/28, and M28876/29 onto fiber optic cables.

1.2 Method dependencies. During execution of this method, the user will, at certain points, need to complete Method 5D1 and Method 5A6, Procedure I or II. If the user is printing this method for reference, it is recommended to print Method 5D1 and Method 5A6, Procedure I or II as well.

2. DOCUMENTS APPLICABLE TO METHOD 5A4

2.1 General. The documents listed in this section are specified in Method 5A4 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A4 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for
MIL-PRF-28876/2	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With Straight Backshell, Environment Resisting
MIL-PRF-28876/3	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/4	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Wall Mounting, With 90-Degree Backshell, Environment Resisting
MIL-PRF-28876/7	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With Straight Backshell, Environment Resisting
MIL-PRF-28876/8	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/9	-	Connectors, Fiber Optic, Circular, Plug Style, Multiple Removable Termini, Screw Threads, With 90-Degree Backshell, Environment Resisting
MIL-PRF-28876/12	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting With Straight Backshell, Environment Resisting

MIL-PRF-28876/13	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting with 45-Degree Backshell, Environment Resisting
MIL-PRF-28876/14	-	Connectors, Fiber Optic, Circular, Receptacle Style, Multiple Removable Termini, Screw Threads, Jamnut Mounting, With 90-Degree Backshell, Environment Resisting
MIL-PRF-28876/27	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, Screw Threads, Straight Backshell, Environment Resisting
MIL-PRF-29504/14	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/15	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A4-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A4-I. Equipment and materials.

Reference #	Description	Quantity
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0046	Marking pen, permanent	1
TL-0013	Canned air	As required
TL-0012	Cable jacket stripping tool	1
	Masking tape	As required
TL-0091, TL-0092, or TL-0093	Dual-post, torque wrench adapter, shell sizes 11, 13, or 15	As required
TL-0070	Socket, socket wrench ¼" hex adapter for ⅜-drive	1
TL-0090	Torque wrench, $^{3}/_{8}$-inch drive	1
TL-0101	Heat gun	1
TL-0045	Aramid yarn cutting shears	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
TL-0078	Strip tool, OFCC	1
	Thread locking compound	1
	Razor blade	1
	Adjustable wrench	1
	Dust covers	As required
	Hex wrench	1
	Crow's foot wrench	1
	Open end wrench	1
	Micro torque driver	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

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

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

4.2 Installation of connectors with split backshells. The following shall be observed:

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

4.2.1 Cable and fiber preparation. The following steps shall be performed:

NOTE: The connector is received assembled with O-rings installed.

Step 1. Ensure that the cable is the correct type as specified on the applicable cable diagram.

Step 2. Measure the cable to the required length. Add 380 millimeters (15 inches) to allow for at least two re-terminations.

NOTE: If a BOF cable is being prepared, allow 610 millimeters (24 inches).

Step 3. Clean the outer cable jacket that will be in contact with the connector and backshell with a wipe dampened with alcohol and blow it dry with air.

NOTE: Keep the cable and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol, and blow the parts dry with air.

4.2.2 Backshell preparation. The following steps shall be performed:

Step 1. Disassemble the backshell by loosening the six socket head cap screws using the hex wrench. Remove the connector adapter and strain relief housing assembly (see figure 5A4-1).

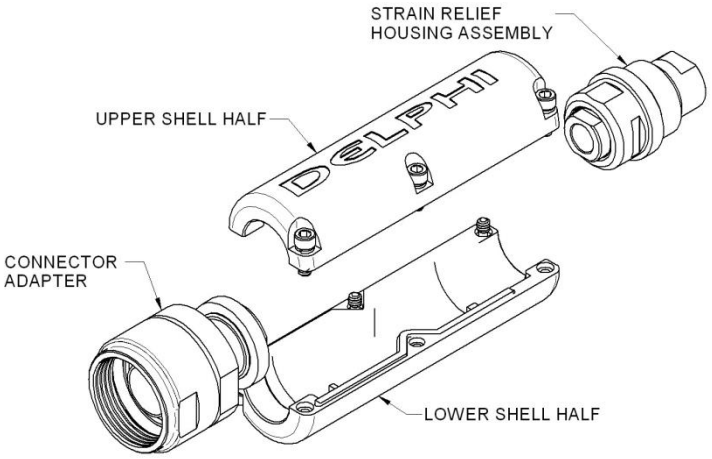


FIGURE 5A4-1. Assembling the backshell.

NOTE: An M28876/27 connector is shown on figure 5A4-1; 45- and 90-degree assemblies use the same connector adapter and strain relief housing assembly.

Step 2. Disassemble the strain relief housing by removing the strain relief nut and compression nut from the rear adapter (see figure 5A4-2).

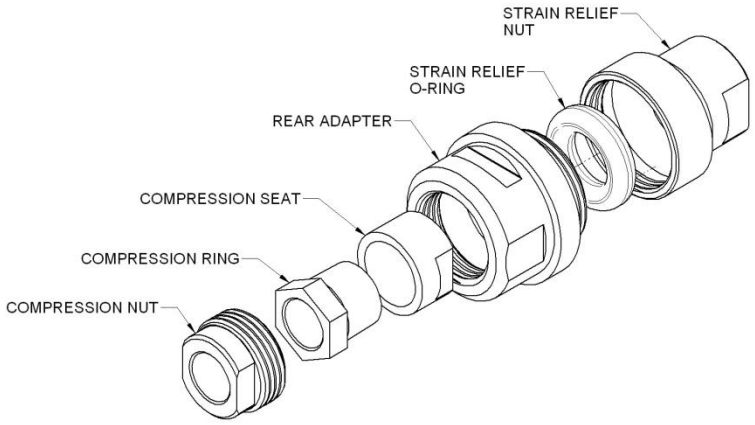


FIGURE 5A4-2. Strain relief assembly.

NOTE: Make sure to separate the compression ring from the compression seat. If they are slightly wedged together, use the wrench flats to turn them loose.

CAUTION: Do not cut or nick the OFCC jackets.

4.2.3 Securing the strain relief (conventional cable). The following steps shall be performed:

Step 1. Slide the strain relief assembly components onto the cable in the following order (see figure 5A4-3):

a. Strain relief nut.
b. Strain relief O-ring.
c. Rear adapter.
d. Compression seat.

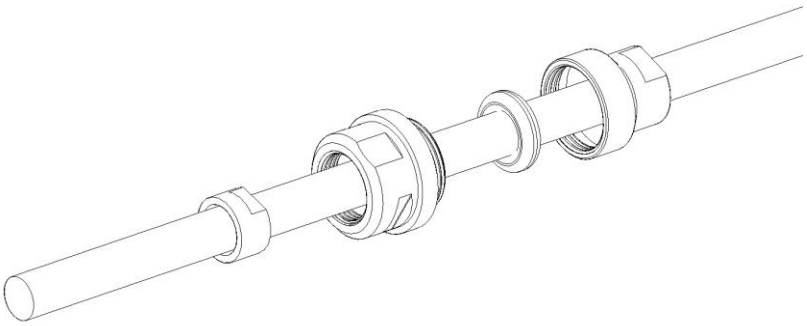


FIGURE 5A4-3. Strain relief parts on the cable.

NOTE: The wrench flat side of the compression seat should face the rear adapter. Leave at least 152.4 millimeters (6 inches) from the end of the cable to allow for cable stripping.

Step 2. Mark the cable approximately 127 millimeters (5 inches) from the end and strip back the outer cable jacket using the cable jacket strip tool. Cut off the exposed central strength member and any fillers using the aramid yarn shears.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, optical fiber damage may occur.

CAUTION: Do not cut or nick the OFCC jackets.

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

Step 4. Slide the compression seat to the end of the cable jacket. Fold the aramid yarn strength members back over the compression seat and the cable in the direction of the strain relief housing. Uniformly distribute the aramid yarn around the compression seat (figure 5A4-4).

NOTE: The wrench flats of the compression seat should face the strain relief housing.

Step 5. Press the compression ring onto the compression seat, wedging the aramid yarn between the compression seat and compression ring (figure 5A4-4). Firmly seat the compression ring onto the compression seat.

NOTE: Depending on the amount of aramid yarn on the cable, pliers may be required to firmly seat the compression ring onto the compression seat.

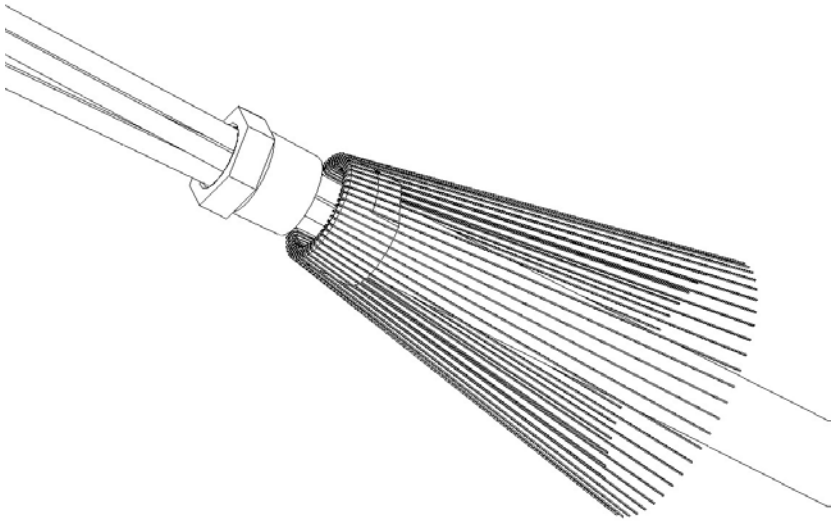


FIGURE 5A4-4. Installing the compression ring.

Step 6. Trim the excess aramid yarn.

NOTE: The aramid yarn should be uniformly arranged around the compression seat.

Step 7. Slide the rear adapter housing up the wedged compression seat and compression ring. Gently feed the OFCCs through the compression nut and hand-tighten the compression nut onto the rear adapter housing.

NOTE: If the compression nut cannot be threaded onto the rear adapter housing because of the amount of aramid yarn in the optical fiber cable, remove the compression nut, trim back some of the cable aramid yarn to the cable jacket, and return to step 4. The amount of aramid yarn trimmed should be the minimum amount necessary to allow the compression nut to thread onto the strain relief housing. The aramid yarn should be trimmed uniformly around the circumference of the cable.

Step 8. Tighten the aramid yarn compression nut to 2.75 newton-meters (25 inch-pounds) using the open end wrench, the crow's foot wrench, and the torque tool (see figure 5A4-5). Remove the wrench and the other tools.

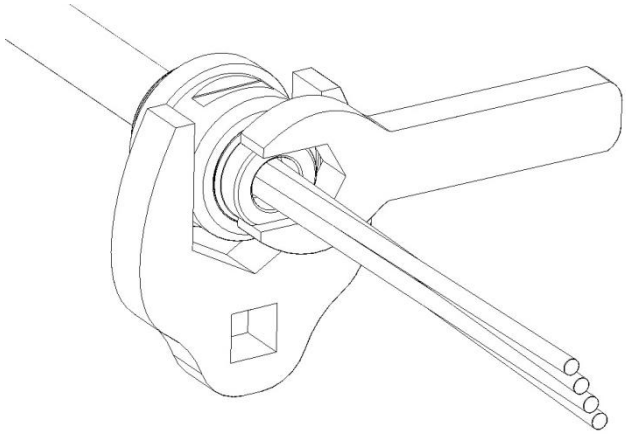


FIGURE 5A4-5. Tightening the aramid yarn compression nut.

Step 9. Slide the strain relief O-ring against the rear adapter housing and hand-tighten the strain relief nut onto the rear adapter (figure 5A4-6).

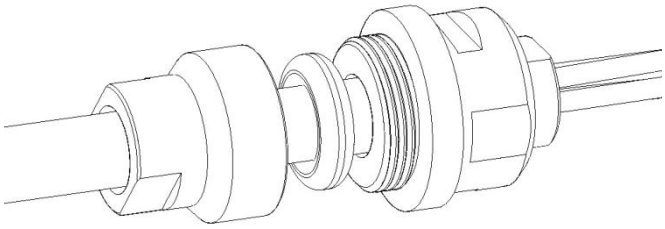


FIGURE 5A4-6. Positioning the strain relief O-ring.

NOTE: Thoroughly clean the cable jacket with alcohol in the area behind the rear adapter housing.

Step 10. Tighten the strain relief nut to 2.75 newton-meters (25 inch-pounds) using the open end wrench, the crow's foot wrench, and the torque tool (see figure 5A4-7). Remove the wrench and the other tools.

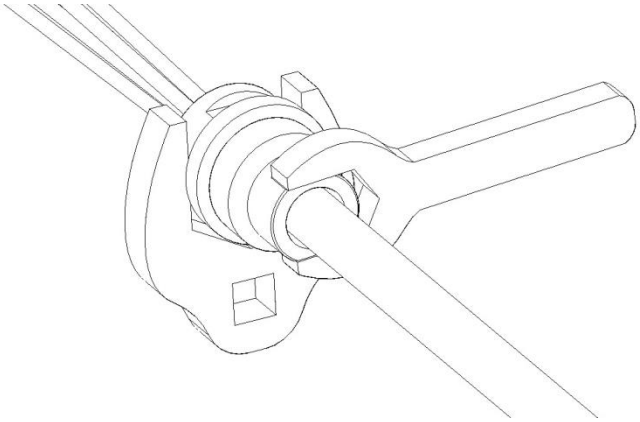


FIGURE 5A4-7. Tightening the strain relief nut.

4.2.4 Fiber preparation. The following steps shall be performed:

Step 1. Feed each OFCC into a crimp sleeve and slide the sleeve back from the end of the OFCC.

NOTE: For termination of fiber with only a coating/buffer, a crimp sleeve is not utilized. Feed each fiber into a 6-millimeter (0.24-inch) length of 3-millimeter (0.12-inch) heat shrink tubing.

Step 2. Trim the OFCCs to the length (A + B + C) shown in table 5A4-II using the aramid yarn shears (see figure 5A4-8).

FIGURE 5A4-8. Cable stripping dimensions.

TABLE 5A4-II. Cable stripping dimensions.

Connector shell size	Backshell configuration	Dimensions mm (inch)		
		A	B	C
13	Straight	66 (2.62)	10 (0.39)	22 (0.87)
	45 degrees	66 (2.62)	10 (0.39)	22 (0.87)
	90 degrees	66 (2.62)	10 (0.39)	22 (0.87)
15	Straight	70 (2.75)	10 (0.39)	22 (0.87)
	45 degrees	70 (2.75)	10 (0.39)	22 (0.87)
	90 degrees	70 (2.75)	10 (0.39)	22 (0.87)
23	Straight	TBD	10 (0.39)	22 (0.87)
	45 degrees	TBD	10 (0.39)	22 (0.87)
	90 degrees	TBD	10 (0.39)	22 (0.87)

NOTES:

1. For fiber with only a coating/buffer, A + B should be used for the coated/buffered fiber length.
2. The tolerance on dimensions A and B is ±1 millimeter (±0.04 inch).
3. Shorter values for dimension C may be used.
4. For items approved after the date of publication, approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.
5. Values for items listed as “TBD” were not available at time of publication; contact NSWCDD (see 6.4) or the manufacturer.

Step 3. For each OFCC, remove the OFCC jackets back to the dimension (B + C) shown in table 5A4-II using the OFCC stripper and trim the aramid yarn so that approximately 3 millimeters (0.12 inch) extend past the OFCC jacket.

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

NOTE: This step does not apply when terminating fiber with only a coating and buffer.

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

Step 4. For each OFCC, remove the fiber buffer and coating back to the dimension (C) shown in table 5A4-II using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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 5. Remove any residual coating material from the bare fibers with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care not to damage the fiber. Breakage of any one fiber from this point until the connector is completely assembled will require repetition of this and the following steps in order to maintain approximately equal length of all the fibers in the cable.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.5 Construction, PC polishing, and end face inspection of termini. The following steps shall be performed:

Step 1. Proceed to Method 5D1 to construct, PC polish, and inspect M29504/14 and M29504/15 termini.

NOTE: Alternatively, if approved for this backshell configuration (see 6.4), a quick connect style termini can be constructed per the termini manufacturer's instructions.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to 4.2.6 for installation of the connector adapter on M28876/27, M28876/28, and M28876/29 backshells; otherwise, proceed to the termini insertion instructions (see 4.2.7).

4.2.6 Installation of the terminus into the connector insert. The following steps shall be performed:

Step 1. Install O-ring supplied with backshell onto rear of M28876 connector (plug shown) in region between spline feature and threads (see figure 5A4-9).

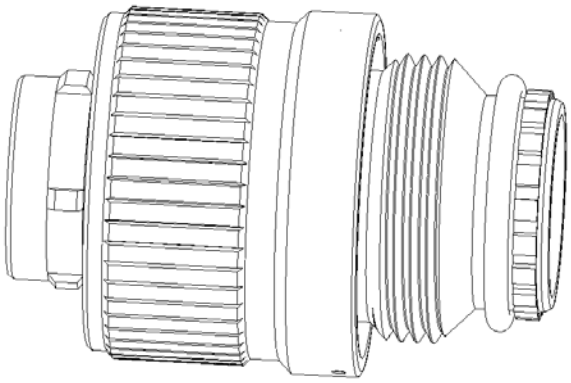


FIGURE 5A4-9. Installing O-ring on connector.

Step 2. Apply a light film of thread locking compound on the rear accessory threads of the M28876 connector. Align the coupling adapter to the M28876 connector and hand-tighten the coupling adapter to the M28876 connector. As you tighten the coupling adapter you will feel the spline of the connector and the adapter engaging, preventing the connector from spinning within the adapter. The pressure sleeve will push on the rear of the connector insert, locking it in place (see figure 5A4-10).

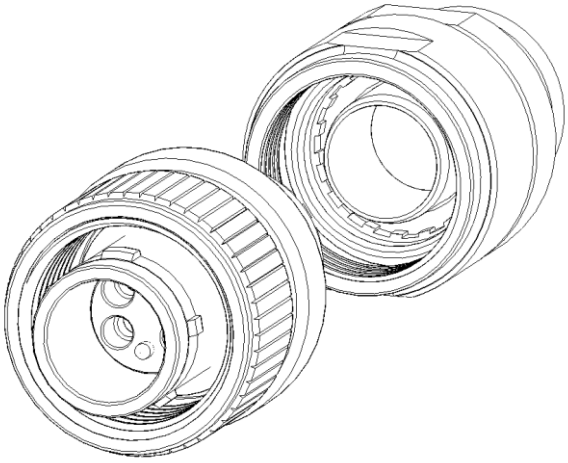


FIGURE 5A4-10. Aligning the connector and connector adapter.

NOTE: Make sure the insert is locked in position, preventing it from floating towards the adapter. If it is moving, it is likely that the splines of the connector and adapter are not properly engaged. Disassemble the adapter from the connector and repeat step 2.

NOTE: 45- and 90-degree backshells have two available clocking positions and are normally shipped with the backshell clocked at either 0 or 180 degrees referenced to the master key. If other backshell clocking positions are required, the backshell front adapter must be rotated to the required clocking position and then coupled to the plug.

Step 3. Use the wrench flats on the connector adapter to hold the assembly to tighten the connector adapter coupling ring to a torque of 3.4 newton-meters (30 inch-pounds).

4.2.7 Installation of the terminus into the connector insert. The following steps shall be performed:

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

Step 1. Insert termini in accordance with Method 5A6, Procedure I for pin termini, and Method 5A6, Procedure II for socket termini.

Step 2. When all termini have been successfully inserted into the connector, proceed to the backshell assembly instructions (see 4.2.8).

4.2.8 Assembly of the backshell. The following steps shall be performed:

NOTE: 45- and 90-degree backshells have two available clocking positions and are normally shipped with the backshell clocked at either 0 or 180 degrees referenced to the master key. If other backshell clocking positions are required, the backshell front adapter must be decoupled from the connector plug, rotated to the required clocking position, and then re-coupled to the plug. Thread locking compound is used on the plug and backshell adapter threads and must be replaced when re-coupling the backshell adapter to the plug at a torque of 3.4 newton-meters (30 inch-pounds).

NOTE: 45- and 90-degree backshells are assembled following the same steps as the straight backshell.

Step 1. Place the strain relief assembly onto the bottom shell by aligning the locating flats on the rear adapter to the flats on the bottom shell. Place the front adapter into its position using the locating flats on the front adapter and the shell (see figure 5A4-11).

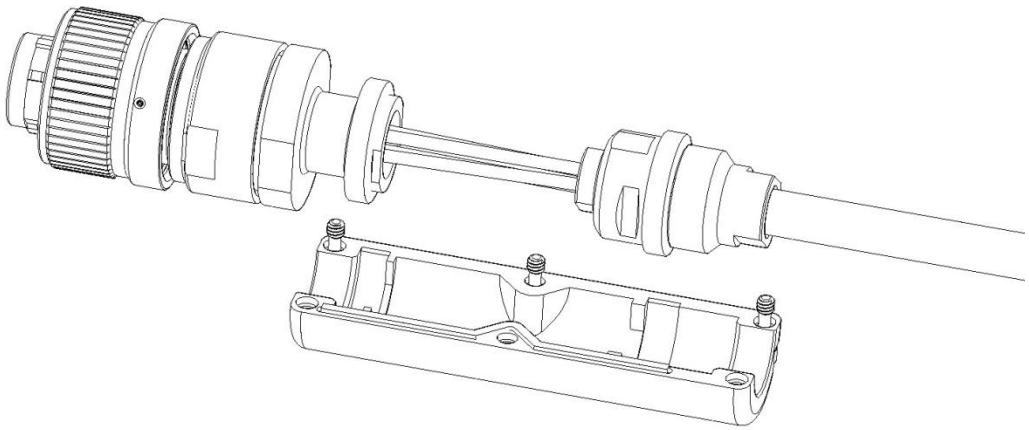


FIGURE 5A4-11. Assembling the backshell, bottom half.

NOTE: Make sure the gasket strip seal stays in its groove.

Step 2. Place the upper shell directly above the bottom shell, hold it firmly together, and begin threading the screws (see figure 5A4-12).

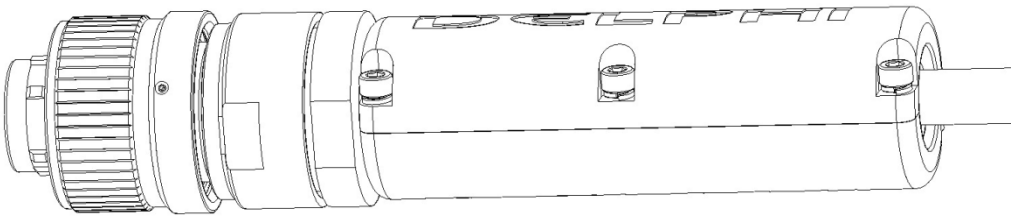


FIGURE 5A4-12. Assembling the backshell, top half.

Step 3. Hand-tighten the backshells together, beginning with the 2 screws in the middle of the backshell.

Step 4. Assemble the two backshell halves together by tightening the screws to 0.45 newton-meters (4 inch-pounds).

NOTE: Apply torque on screws farthest from each other to ensure that the shells are closing evenly.

Step 5. Install the plastic protective cap over the front of the connector.

METHOD 5A5
M64266/18 CONNECTOR ASSEMBLY, SPLIT BACKSHELL WITH MULTIPLE FIBER CABLE

1. SCOPE

1.1 Scope. This method describes a procedure for assembling multiple termini connectors in accordance with M64266/18 on the ends of fiber optic cable in which there is more than one optical fiber within the cable.

1.2 Method dependencies. During execution of this method, the user will, at certain points, need to complete either Method 5D1 or Method 5D2 and Method 5A6, Procedure III. If the user is printing this method for reference, it is recommended to print Method 5D1 or Method 5D2 and Method 5A6, Procedure III as well.

2. DOCUMENTS APPLICABLE TO METHOD 5A5

2.1 General. The documents listed in this section are specified in Method 5A5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59474	-	Insulation Tape, Electrical; High Temperature, Polytetrafluoroethylene, Pressure-Sensitive

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29504/18	-	Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-PRF-29504/20	-	Termini, Fiber Optic, Keyed, Connector, Removable, Environment Resisting, Genderless Terminus, Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-PRF-64266	-	Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for
MIL-PRF-64266/18	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Screw Threads, Backshell, Split, Multiple Fiber Cables, Strength Member Capture and Bend Limiting Interface, Environment Resisting

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

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

SAE INTERNATIONAL

SAE-AMS-DTL-23053 - Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for

SAE-AS-85049 - Connector Accessories, Electrical General Specification for

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A5-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A5-I. Equipment and materials.

Reference #	Description	Quantity
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0046	Marking pen, permanent	1
TL-0013	Canned air	As required
TL-0012	Cable jacket stripping	1
	Masking tape	As required
TL-0128	Torque wrench, 0 to 22.6 nm (0 to 200 in-lbs), $^{3}/_{8}$-inch square drive socket	As required
TL-0070	Socket, socket wrench ¼-inch hex adapter for $^{3}/_{8}$-inch drive	1
TL-0101	Heat gun	1
TL-0045	Aramid yarn cutting shears	1
TL-0110	Banding adapter tool, hand operated, ¼-inch banding straps	1
TL-0111	Banding strap, tie down for backshell sleeve, stainless steel, in accordance with SAE-AS-85049/128 (14.25 inches long × ¼ inch wide)	As required
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1

TABLE 5A5-I. Equipment and materials – Continued.

Reference #	Description	Quantity
	Adjustable wrench	1
	Dust covers	As required
	Heat shrinkable insulation sleeving, SAE-AMS-DTL-23053/5 electrical, polyolefin, flexible, crosslinked	As required
TL-0077	Strap wrench	1
TL-0104	Adapter tool, plug holder only, shell size 11, MIL-PRF-64266, all 12 keying positions	1
TL-0078	Strip Tool, OFCC	1
TL-0105	Adapter tool, plug holder only, shell size 13, MIL-PRF-64266, all 12 keying positions	1
TL-0106	Adapter tool, plug holder only, shell size 15, MIL-PRF-64266, all 12 keying positions	1
TL-0107	Adapter tool, plug holder only, shell size 23, MIL-PRF-64266, all 12 keying positions	1
TL-0127	T-handle, 3/8-inch square drive socket	1
	3/8-inch hex wrench	As required
	3/8-inch hex wrench on ¼-inch or 3/8-inch square drive socket	As required
	7/64-inch hex wrench	As required
	7/64-inch hex wrench on ¼-inch or 3/8-inch square drive socket	As required
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

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

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

4.2 Installation of M64266/18 connectors with split backshells. The following shall be observed:

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

NOTE: Backshell selection includes consideration of cable diameter and cable entry angle occurring at the backshell cable entrance end. Backshell configurations include those with a specific range of allowed cable diameters and with an orientation of straight, 45-degree, and 90-degree cable entry angles (straight, 45-degree, and 90-degree backshells) (see figure 5A5-1).

FIGURE 5A5-1. Backshell configurations for cable entry angle, banding rear adapter.

4.2.1 Backshell preparation. The following steps shall be performed:

Step 1. Ensure cable is the correct type as specified on the applicable cable diagram.

Step 2. Measure the length of each multiple fiber cable to verify that it is the required length.

Step 3. Clean the portion of each fiber optic cable jacket that will be in contact with the connector and backshell with a wipe dampened with alcohol and blow it dry with air.

NOTE: Keep the cable and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol, and blow the part dry with air.

Step 4. Slide the backshell parts (see figure 5A5-2) onto the cable in the following order:

a. Heat shrink sleeve.

b. Rear adapter (ensure correct orientation on cable).

c. Heat shrink sleeve.

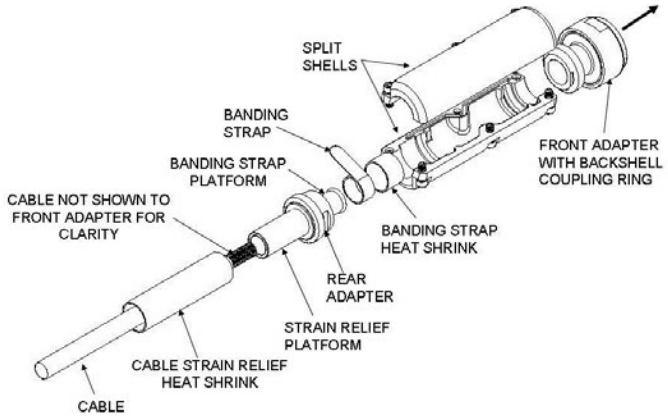


FIGURE 5A5-2. Exploded view of connector parts.

4.2.2 Cable preparation. The following steps shall be performed:

Step 1. Mark the cable jacket approximately 190 millimeters (7.5 inches) from the end and strip back the outer cable jacket to the mark using the cable stripper.

CAUTION: Do not cut or nick OFCC jackets.

NOTE: The cable core should not be bent beyond the minimum bend diameter when removing the cable jacket. If the cable core is bent beyond the minimum bend diameter during cable jacket removal, optical fiber damage may occur.

Step 2. Cut off the exposed central strength member and any fillers using the aramid yarn shears.

Step 3. Remove any water blocking material, clean the OFCCs (each single fiber cable) using a wipe dampened with alcohol, and blow them dry with air.

Step 4. Fold back the aramid yarn strength members and temporarily tape them to the cable outer jacket past the banding platform on the rear adapter.

NOTE: Length of aramid yarn must be a minimum of 88.9 millimeters (3.5 inches) to tape back onto the banding platform on the rear adapter.

Step 4. Trim the OFCCs to the dimension (D) in table 5A5-II using the aramid yarn shears (see figure 5A5-3).

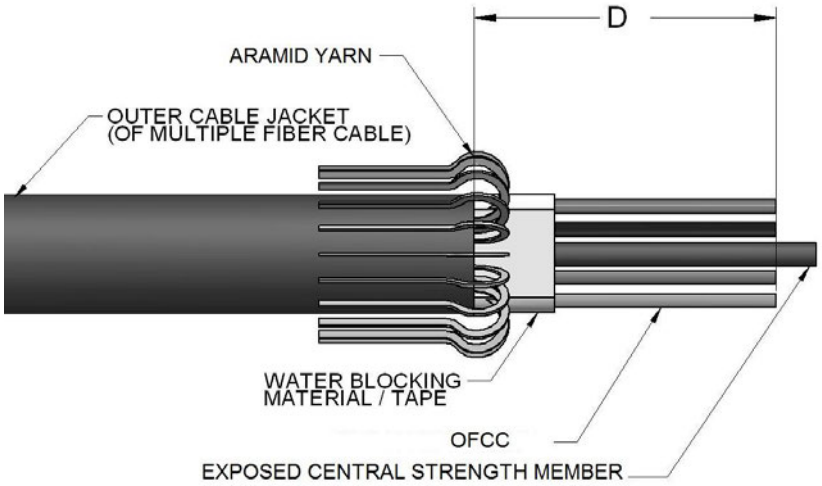


FIGURE 5A5-3. Cable stripping dimensions.

TABLE 5A5-II. Cable stripping dimensions.

Connector shell size	Terminus type	Stripping dimension D	
		mm	inches
11	M29504/18	TBD	TBD
13	M29504/18	TBD	TBD
15	M29504/18	TBD	TBD
23	M29504/18	TBD	TBD

NOTES:
1. Cable jacket stripping dimensions are the same for backshells with straight, 45-degree, and 90-degree cable entry angles.
2. For items approved after the date of publication, approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.
3. Values for items listed as “TBD” were not available at time of publication; contact NSWCDD (see 6.4) or the manufacturer.

4.2.3 Fiber preparation. The following steps shall be performed:

Step 1. Feed each OFCC into the supplied crimp sleeve that is packaged with the M29504/18 or M29504/20 termini, and slide the crimp sleeve back from the end of the OFCC.

NOTE: Only use the crimp sleeve that is supplied with the M29504/18 or M29504/20 termini, respectively, for the aramid yarn capture/strain relief mechanism.

Step 2. Mark the OFCC outer jacket to the dimensions (A and B) in table 5A5-III and figure 5A5-4.

TABLE 5A5-III. Fiber stripping dimensions.

Dimensions mm (inch)					
M29504/18 terminus			**M29504/20 terminus**		
A	**B**	**C**	**A**	**B**	**C**
43.2 (1.71)	4.5 (0.18)	21.7 (0.85)	43.2 (1.71)	4.5 (0.18)	21.7 (0.85)
NOTE: Tolerances on all dimensions are ±0.8 millimeter (0.03 inch). Where feasible, use vendor preferred tolerance of ±0.5 millimeter (0.02 inch).					

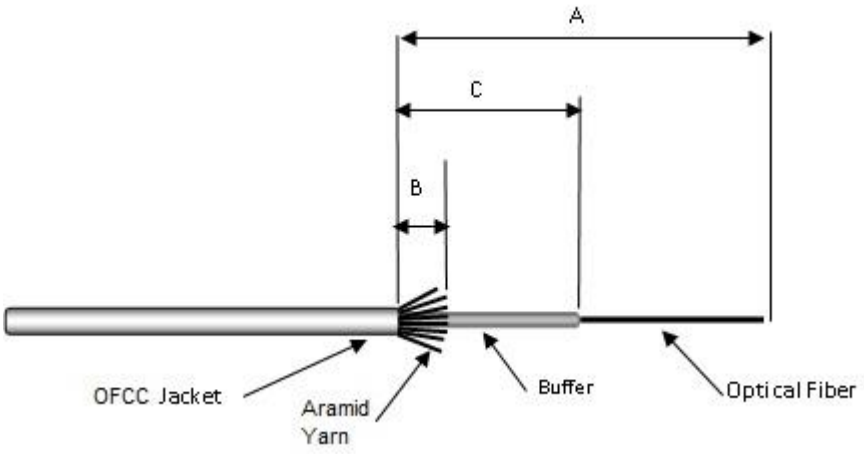


FIGURE 5A5-4. Fiber stripping dimensions.

Step 3. Remove the OFCC jacket back to the dimension B mark. Trim the aramid yarn back until even with the OFCC jacket.

NOTE: The optimum way to remove the OFCC jacket is to ring cut the jacket with the OFCC cable stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held cable stripper can lead to fiber breakage.

Step 4. Next remove the OFCC jacket back to the dimension A mark using the cable stripper. This step will expose the aramid yarn to the appropriate length.

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

Step 5. Remove the fiber buffer and coating back to the dimension C in table 5A5-III using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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 6. Remove any residual coating material from the bare fibers with a wipe dampened with alcohol. Wipe only once from the end of the buffer towards the end of the fiber.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

CAUTION: The uncoated/bare (or polyimide coated) fiber is in its most vulnerable state. Take extreme care not to damage the fiber.

4.2.4 Construction, PC polishing, and end face inspection of termini.

Step 1. Proceed to Method 5D1 to construct, PC polish, and inspect for PC polish of M29504/18 termini. Proceed to Method 5D2 to construct, polish, and inspect for APC polish of M29504/20 termini.

Step 2. When all termini have been successfully constructed, polished, and inspected, proceed to the assembly instructions (see 4.2.5).

4.2.5 Assembly of banding strap platform, banding rear adapter.

NOTE: Take care to not pinch or twist the single fiber cables during this part of the backshell installation.

Step 1. Distribute the aramid yarn evenly around the banding platform.

Step 2. Place the banding strap around the outer jacket aramid yarn at the backshell rear adapter banding platform (see figures 5A5-5 and 5A5-6).

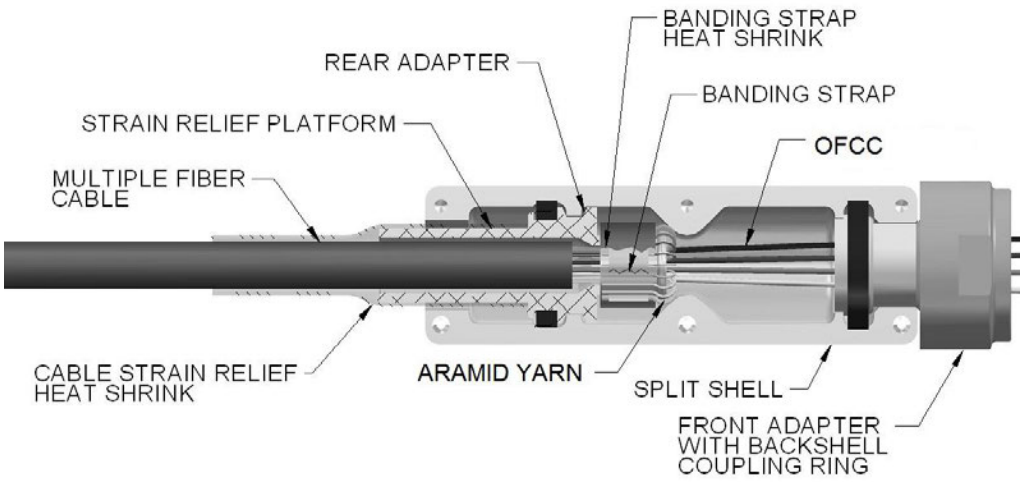


FIGURE 5A5-5. Sectional view of backshell assembly, banding rear adapter.

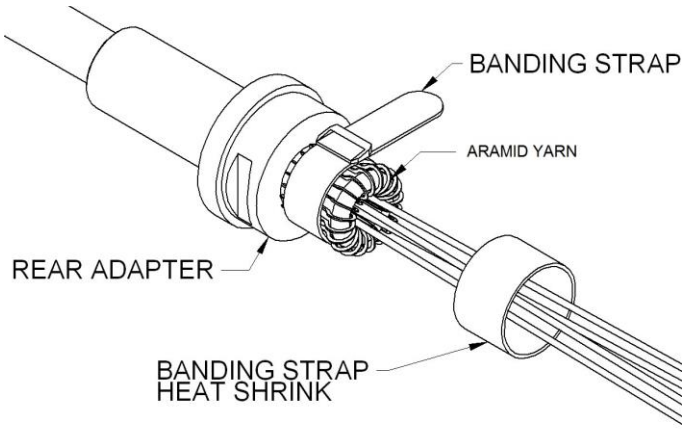


FIGURE 5A5-6. View of assembled parts on rear adapter banding platform.

Step 3. Obtain and locate the tail length indicator on a banding strap.

Step 4. Roll tail length indicator mark through buckle slot twice (see figure 5A5-7).

NOTE: Failure to roll end of band (to tail length indicator mark) through the buckle slot twice is the most common user error in connector assemblies involving a band strap. Banding strap buckle is designed for two wraps of the banding strap, not one wrap. With only one wrap, large potential for loosening or unwinding of the banding strap to occur under vibration.

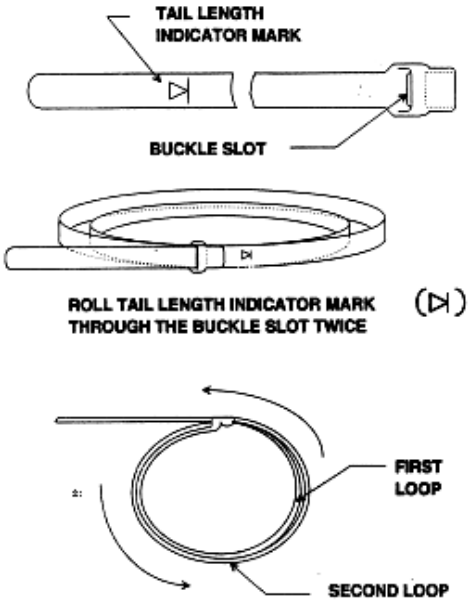


FIGURE 5A5-7. Assemble banding strap.

Step 5. Pull on the banding strap until indicator mark is 25.4 millimeters (1 inch) through buckle slot.

Step 6. Unlock the banding adapter tool handles by separating the pull-up handle from tool body by pulling away.

Step 7. Push the release lever forward and insert the prepared banding strap into the front end opening of banding adapter tool (see figure 5A5-8).

NOTE: The circular portion of looped band strap must face buckle downward. Placement of the looped band strap facing the buckle upper into tool can result in breakage of the banding adapter tool.

NOTE: The release lever may be on the opposite side of the banding adapter tool than shown on figure 5A5-8 (i.e., on the same side as the pull-up handle instead of the cut-off handle).

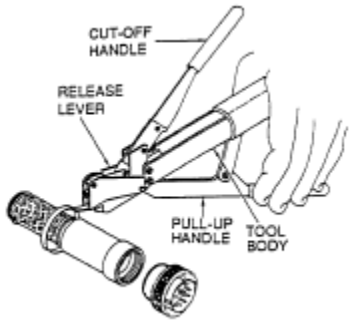


FIGURE 5A5-8. Installing banding strap.

Step 8. Align the banding strap and the banding adapter tool with the backshell rear adapter banding platform.

Step 9. Push the release lever in the back position. Tighten the banding strap by compressing the pull-up handle until handle locks in place against the tool body which indicates the band is compressed to the banding adapter tool preset tension.

NOTE: The pull-up handle is compressed in short strokes until it locks in place against the tool body.

NOTE: If the aramid yarn is not properly seated under the banding strap, then tension on the banding strap is relaxed by pushing on the release lever on the top of the banding adapter tool. Make adjustments to the aramid yarn, then repeat step 9.

NOTE: The technique of pulling down (seating) the aramid yarn completely by partial strokes of the tool until the band is firmly seated, and then accomplishing the lock with a full stroke of the handle is very important. Many potential problems in applications have been avoided with the explanation of this technique.

NOTE: Allow the pull-up handle to return to its original position between strokes. If the pull-up handle locks part way between strokes, then push it back down to obtain a full stroke.

NOTE: Do not squeeze the cut-off handle while performing this step.

Step 10. Complete the clamping process by lifting the tool forward and squeezing the cut-off handle.

Step 11. With the cut-off handle locked, remove the excess portion of the banding strap by pulling it through and discarding.

Step 12. Inspect to verify that the banding strap is secured on the rear adapter (see figure 5A5-6).

Step 13. Seat the heat shrink on the rear adapter banding platform (see figure 5A5-6).

NOTE: Tape may be wrapped over the banding strap in lieu of heat shrink. If tape is used, then skip step 14.

Step 14. Apply heat to collapse the heat shrink to the rear adapter banding platform and to the cabling.

Step 15. Trim any excess aramid yarn.

4.2.6 Assembly of strain relief platform, banding rear adapter. The following steps shall be performed:

NOTE: In some cases, the outer cable jacket may need to be built up to ensure proper attachment of the heat shrink. Use A-A-59474, Type I Teflon tape (NSN 5970-01-012-4280), or equal (see 4.8), for wrapping operations. This tape has a silicone adhesive that will not leave a residue on the termini.

Step 1. Seat the heat shrink on the rear adapter strain relief platform (see figure 5A5-5).

Step 2. Apply heat to collapse the heat shrink to the rear adapter strain relief platform and to the cabling (see figure 5A5-6).

4.2.7 Installation of the terminus into the connector insert. The following steps shall be performed:

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

Step 1. Feed the terminated fibers into backshell front adapter.

Step 2. Verify that no cable has crossed over another.

NOTE: Crossing of a cable over another may be more likely to occur with backshells having entry angles of 45 and 90 degrees versus straight backshells. Pay particular attention to ensure no crossing of cabling occurs.

Step 3. Insert termini in accordance with Method 5A6, Procedure III.

Step 4. When all termini have been successfully inserted into the connector, proceed to the backshell assembly instructions (see 4.2.8).

4.2.8 Assembly of backshell connector end. The following steps shall be performed:

NOTE: This process is to be performed after the termini have been installed in the connector insert.

NOTE: Take care to not pinch or twist the OFCCs during this connector installation.

Step 1. Slide the backshell front adapter forward and screw the backshell body coupling nut onto the connector until tight (see figure 5A5-9).

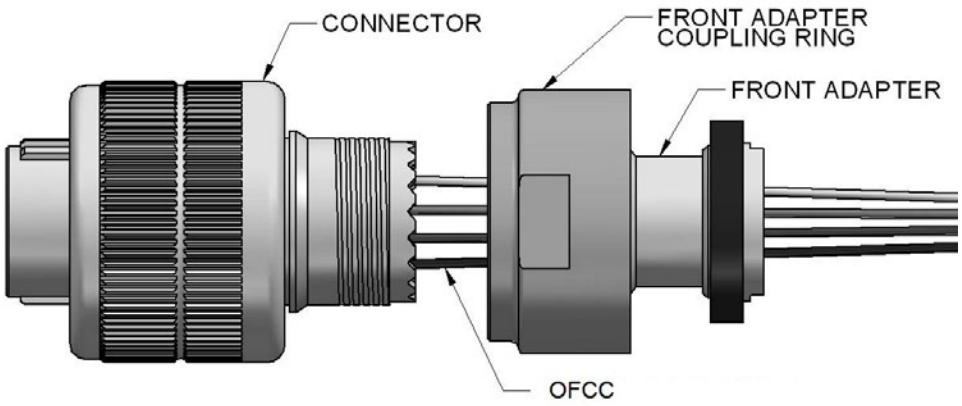


FIGURE 5A5-9. Orientation of backshell adapter relative to connector.

Step 2. Select the proper adapter tool for the M64266 receptacle or plug, shell size, and keying position (see table 5A5-IV).

TABLE 5A5-IV. M64266 adapter tool selection.

Shell size	Color coding	Keying position	Individual tool part number 1/ (or equal [see 4.8])	Cage code
11	No	All 12	CM642-11	11851
13	No	All 12	CM642-13	11851
15	No	All 12	CM642-15	11851
23	No	All 12	CM642-23	11851

NOTE:
1/ Parts from Commercial and Government Entity (CAGE) Code 11851 are for plug holder adapter tools only.

Step 3. Place the adapter tool onto the connector (see figure 5A5-10).

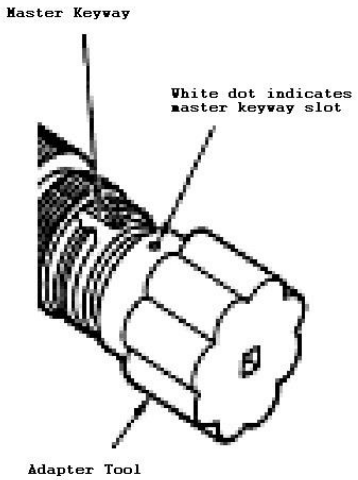


FIGURE 5A5-10. Adapter tool placement on connector.

NOTE: Spinning the adapter tool on the connector plug will cause damage to the connector or connector plating. Rotate adapter tool carefully onto or into the connector.

NOTE: Some adapter tools have a white dot at the master key. If present, then this white dot on the adapter tool aligns with the master keyway on the connector.

Step 4. Place the torque wrench into the ¼- or ⅜-inch drive on the adapter tool.

NOTE: Perform step 5 only for backshells with a 45- or 90-degree cable entry end (i.e., a 45- or 90-degree backshell). The 45- or 90-degree backshell has the cable entry end on a 45- or 90-degree angle relative to the connector entry end or in lieu of a straight backshell (where connector entry and cable entry ends are 180 degrees apart).

Step 5. Determine the correct radial position or clocking of the backshell cable entry end relative to the connector.

NOTE: Observe the main master key in the connector plug and verify that the cable entry end of the mating 45- or 90-degree backshell is orientated at the angle specified in the platform specific maintenance manual. For instance, when specified at the 12 o'clock position, the cable entry end is pointed at the same angle as the main master key (0 degrees or cabling entry from the 12 o'clock, top or upward position). For instance, when specified at the 6 o'clock position, the cable entry end is pointed in the opposite direction with a 180-degree angle from the main master key (cabling entry from the 6 o'clock, bottom or downward position).

Step 6. Place a wrench or an adjustable wrench on the coupling nut flats. Verify the backshell is in the correct clocking orientation relative to the connector for 45- or 90-degree backshells.

Step 7. Tighten the backshell body onto the connector applying a clockwise torque as viewed from the connector rear (connector interface with backshell). Keep the torque wrench stationary while tightening the backshell coupling nut with the wrench (or adjustable wrench, as applicable). Tighten to the torque value specified in table 5A5-V.

TABLE 5A5-V. Torque value for connector-to-backshell (±56.4 N-cm [±5 in-lbs]).

Shell size	MIL-PRF-64266 N-cm (inch-lbs)			
	Composite		Metal	
	N-cm	inch-lbs	N-cm	inch-lbs
11	452	40	904	80
13	452	40	1356	120
15	452	40	1356	120
23	904	80	1582	140

Step 8. Remove the torque wrench from the adapter tool. Keep adapter tool on the connector.

4.2.9 Assembly of split shell halves. The following steps shall be performed:

NOTE: This process shall be performed after the backshell rear adapter has been assembled and the front adapter has been installed onto the connector.

NOTE: Take care to not pinch or twist the OFCCs during this part of the backshell installation.

NOTE: Take care to not nick or scratch the backshell coating during assembly.

Step 1. Obtain one of the two split shell halves (referred to here as “the lower split shell half” for better clarity during this assembly).

NOTE: The two split shell halves are symmetrical. Either shell half can be used as either the upper or the lower split shell half.

Step 2. Place the rear adapter into the lower split shell half (see figure 5A5-2).

NOTE: Ensure that the keys for the rear adapter and cable strain relief boot are aligned with the grooves in the lower split shell half.

Step 3. Place the front adapter into the lower split shell half (see figure 5A5-5).

NOTE: Ensure that the keys for the front adapter are aligned with the grooves in the lower split shell half.

Step 4. Verify that no OFCC has crossed over another.

Step 5. Place the upper split shell half onto the lower split shell half.

NOTE: Ensure that the keys for the front adapter and rear adapter are aligned with the grooves in the upper split shell half.

Step 6. Install the hex fitting onto the torque wrench. Select the hex fitting size in table 5A5-VI for the appropriate shell size.

TABLE 5A5-VI. Hex wrench size selection.

Shell size	Hex fitting size (inch)
11	3/32
13	3/32
15	3/32
23	7/64

Step 7. Hand-tighten the three exposed screws on the upper shell half using the correct hex size for the shell size of the backshell being assembled.

Step 8. Turn the backshell shell half over and hand-tighten the three exposed screws on the lower shell half.

Step 9. Torque the six hex screws on the backshell shell halves to 57±5 newton-centimeters (5±0.5 inch-pounds). The torque value is applicable for all shell sizes of the backshell.

Step 10. Remove the adapter tool from the connector.

Step 11. Install the metal dust cover over the front of the connector.

METHOD 5A6
MIL-PRF-28876 AND MIL-PRF-64266 TERMINUS INSERTION AND REMOVAL FROM CONNECTOR

1. SCOPE

1.1 Scope. This method describes procedures for inserting and removing termini for connectors in accordance with MIL-PRF-28876 and MIL-PRF-64266.

2. DOCUMENTS APPLICABLE TO METHOD 5A6

2.1 General. The documents listed in this section are specified in Method 5A6 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5A6 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for
MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29504/14	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/15	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/18	-	Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-PRF-29504/20	-	Termini, Fiber Optic, Keyed, Connector, Removable, Environment Resisting, Genderless Terminus, Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-PRF-64266	-	Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5A6-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5A6-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0071	Safety glasses	1
TL-0041	Insertion tool, terminus	1
TL-0039	Insertion tool, 90 degree	1
TL-0125	Removal tool, for M29504/18 and /20	1
TL-0108	ASR assembly tool for alignment sleeve, for M29504/18 and /20	1
TL-0066	Removal tool, M29504/14 and /15	1
	Loctite 222, or equal (see 4.8)	As required
	20-gauge needle tip	1
	Terminus retention tester (Daniels MFG Corp HT260-2N, or equal [see 4.8])	1
TL-0042	Insertion/removal tool, M29504/14 and /15	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

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

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

4.2 Procedure I: Terminus insertion instructions for M29504/14 pin termini into M28876 connectors. The following steps shall be performed:

NOTE: The termini may be installed before or after the connector backshell has been assembled onto the connector shell. If the connector backshell has been assembled to the connector shell, the backshell sheath must be removed in order to install the termini.

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

Step 1. Place the end of the terminus insertion tool at the rear of the crimp sleeve with the OFCC laid in the tool channel (see figure 5A6-1).

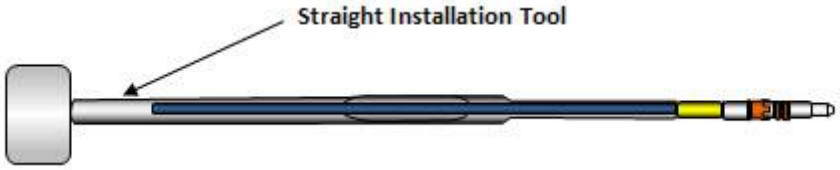


FIGURE 5A6-1. Placing the terminus in the insertion tool.

Step 2. If the connector has a removable insert and it has not already been installed, install the insert into the connector shell.

Step 3. Place the terminus in the proper cavity in the rear of the connector insert. Apply pressure with the insertion tool until the terminus snaps into place (see figure 5A6-2). Remove the tool by pulling straight back.

NOTE: Make sure that the insert key is properly aligned in the connector shell keyway before installing the insert.

NOTE: The termini may be tested for proper insertion by gently pulling on the fiber or by using a terminus retention tester.

NOTE: A properly inserted terminus will have some axial "play" within the insert cavity.

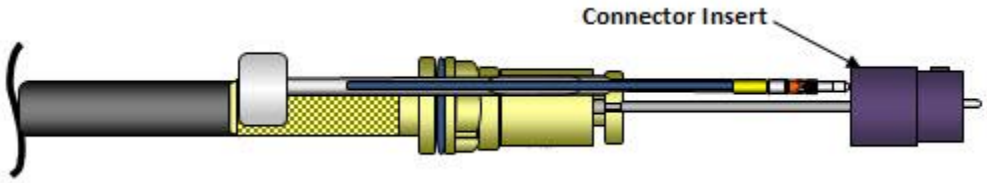


FIGURE 5A6-2. Installing the terminus in the insert.

Step 4. Repeat steps 1 through 3 for the rest of the termini.

Step 5. Return to the original connector installation method.

4.3 Procedure II: Terminus insertion instructions for M29504/15 socket termini into M28876 connectors. The following steps shall be performed:

NOTE: The termini may be installed before or after the connector backshell has been assembled onto the connector shell. If the connector backshell has been assembled to the connector shell, the backshell sheath must be removed in order to install the termini.

NOTE: Inspect the connector insert for dirt or other debris before installing termini into the insert. Clean dirty inserts prior to installing termini.

Step 1. Place the end of the terminus insertion tool at the rear of the crimp sleeve with the OFCC laid in the tool channel (see figure 5A6-1).

Step 2. If it has not already been done, install the insert into the connector shell. Place the terminus in the proper cavity in the rear of the connector insert. Apply pressure with the insertion tool until the terminus snaps into place (see figure 5A6-2). Remove the tool by pulling straight back.

NOTE: Make sure that the insert key is properly aligned in the connector shell keyway before installing the insert.

NOTE: The termini may be tested for proper insertion by gently pulling on the fiber or by using a terminus retention tester.

NOTE: A properly inserted terminus will have some axial "play" within the insert cavity.

Step 3. Place the end of the socket terminus alignment sleeve installation and removal tool into the solid end of the alignment sleeve, depress the plunger to grasp the alignment sleeve, and place the sleeve into the socket terminus cavity in the face of the insert (see figure 5A6-3). Release the plunger and press until the sleeve snaps onto the groove on the ceramic terminus body. Remove the tool by pulling straight back.

CAUTION: Do not rotate the tool after the sleeve is installed in the insert.

CAUTION: Do not press the sleeve into place with the plunger depressed. This may cause damage to the inner ceramic tube.

CAUTION: The alignment sleeve must be oriented in the correct position before installation on the socket terminus. The pronged side of the alignment sleeve must face the socket terminus when installing the alignment sleeve.

CAUTION: Do not depress the plunger too much as damage to the tool may result. Only depress the plunger enough to grab the alignment sleeve.

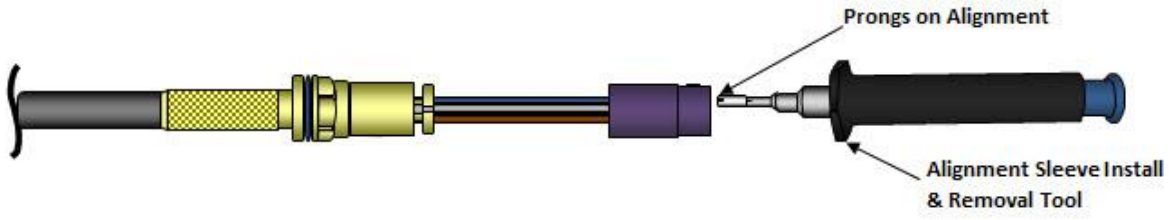


FIGURE 5A6-3. Installing the alignment sleeve.

Step 4. Repeat steps 1 through 3 for all socket termini.

Step 5. Return to the original connector installation method.

4.4 Procedure III: Terminus insertion instructions for M29504/18 and M29504/20 termini into M64266 connectors. The following steps shall be performed:

CAUTION: Do not install a terminus into the connector if the alignment sleeve retainer (ASR) is affixed to the connector. If affixed, remove ASR prior to installation of a terminus. Do not remove the alignment sleeve from the ASR.

NOTE: Any connector fitting adapter must be installed onto the cable prior to the installation of the termini into the connector.

NOTE: Ensure that the tube on the insertion tool is not bent. A bent tube could cut the terminus O-ring (pressure seal) during terminus removal from the connector.

NOTE: Before using the terminus insertion tool, inspect the tool for damage to the tip (such as cracking or chipping).

NOTE: The termini must be installed after the connector backshell components have been placed onto the connector shell. If the connector backshell has been assembled to the connector shell, the backshell sheath must be removed in order to install the termini.

Step 1. Place the end of the terminus insertion tool at the rear of the crimp sleeve with the OFCC laid in the tool channel (see figure 5A6-4).

Step 2. Slip the blade of the insertion tool over the OFCC's outer jacket and slide down into the connector until it bottoms out on the termini.

Step 3. Press the OFCC's outer jacket against the insertion/removal tool to prevent the cable from moving.

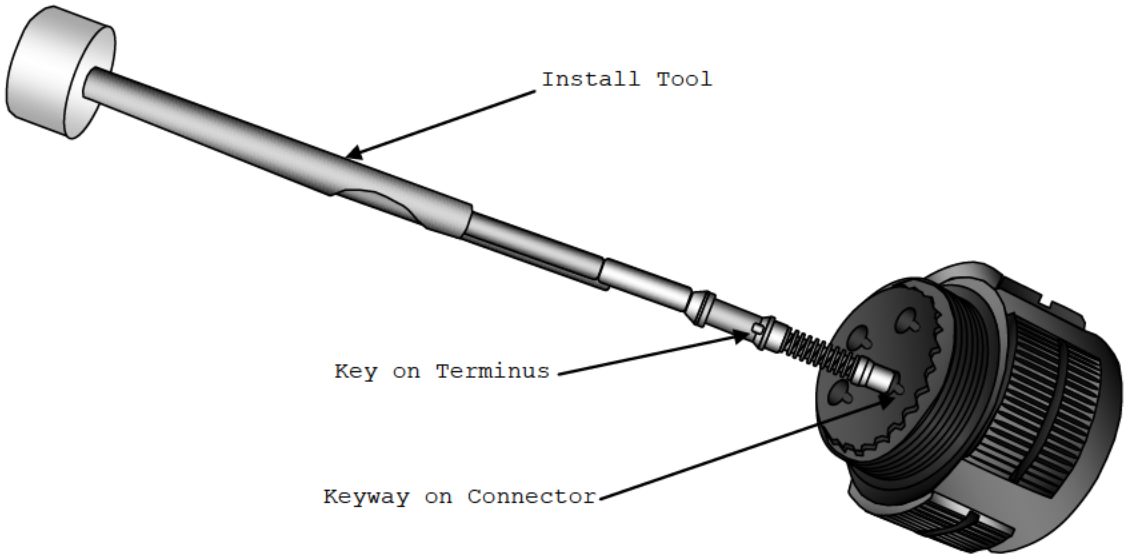


FIGURE 5A6-4. Installing the terminus in the connector insert.

Step 4. If the connector has a removable insert (to which the ASR can be affixed, but which is not the ASR) and it has not already been installed, install the insert into the connector shell. Otherwise, proceed to step 5. Make sure that the insert key is properly aligned in the connector shell keyway before installing the insert.

Step 5. Place the terminus in the proper cavity in the rear of the connector insert.

Step 6. Apply pressure with the insertion tool until the terminus snaps into place (see figure 5A6-4).

Step 7. Remove the tool by pulling straight back. A properly inserted terminus will have some axial "play" within the insert cavity.

NOTE: The termini may be tested for proper insertion by gently pulling on the fiber or by using a terminus retention tester.

Step 8. Repeat steps 1 through 7 for all of the termini.

4.4.1 Assembly of the ASR with alignment sleeves. The following steps shall be performed:

NOTE: During assembly of the ASR, take care not to over tighten the ASR assembly posts. These posts should only be tightened to a snug fit.

Step 1. Verify that an alignment sleeve is inserted into each cavity (channel) of the ASR.

Step 2. Put the halves of the ASR together carefully.

NOTE: Install a 20-gauge needle tip onto the Loctite 222 bottle, or equal (see 4.8), to apply the Loctite to the threads of the ASR assembly post.

Step 3. Apply a drop of Loctite 222, or equal (see 4.8), to the threads on the ASR assembly posts (see figure 5A6-5).

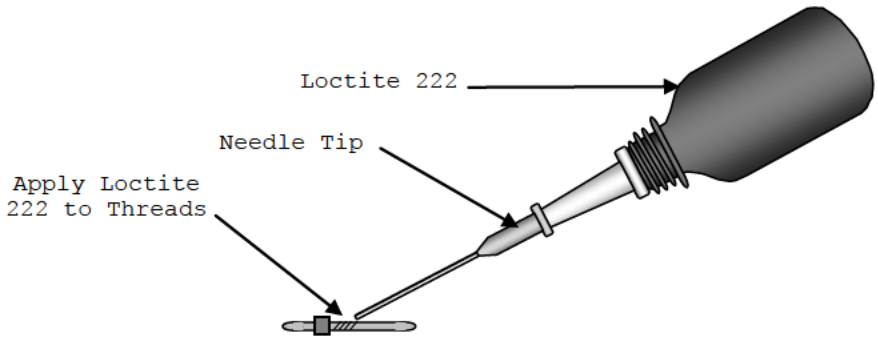


FIGURE 5A6-5. Loctite ASR assembly post.

Step 4. Hold the ASR halves firmly together while tightening the ASR assembly posts into both halves of the ASR.

4.5 Procedure IV: Removal of the termini from the M28876 connector insert. The following steps shall be performed:

NOTE: Perform this procedure only if the termini are to be removed from the connector.

NOTE: Proceed to step 1 for socket termini. Proceed to step 2 for pin termini.

Step 1. Remove the alignment sleeves from the socket termini using the terminus alignment sleeve installation and removal tool by inserting the tool end into the alignment sleeve and depressing the plunger so that the tool grasps the sleeve. Pull the sleeve straight back (see figure 5A6-6).

CAUTION: Do not rotate the tool while the sleeve is in the insert.

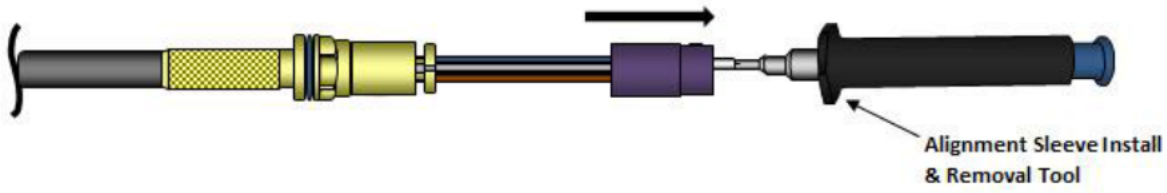


FIGURE 5A6-6. Removal of alignment sleeve.

Step 2. Insert the terminus removal tool into the terminus cavity from the front of the insert and press on the hilt of the tool until it snaps into place (see figure 5A6-7). Depress the plunger and pull the removal tool straight back to slide the terminus out the rear of the insert.

NOTE: Make sure that the removal tool is clean before inserting the tool into the terminus cavity.

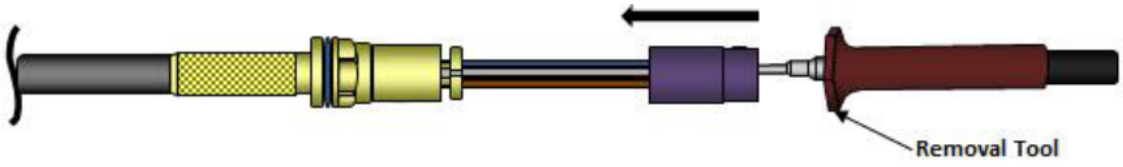


FIGURE 5A6-7. Removing the terminus from the insert.

Step 3. Repeat steps 1 and 2 for all of the termini that need to be removed.

4.6 Procedure V: Removal of the M29504/18 or M29504/20 termini from the M64266 connector insert. The following steps shall be performed:

CAUTION: Do not remove a terminus from the connector if the ASR is affixed to the connector. If affixed, remove the ASR prior to removal of a terminus. Do not disassemble the ASR or try to remove the alignment sleeves.

NOTE: Ensure that the tube on the removal tool is not bent. A bent tube could cut the terminus O-ring (pressure seal) during terminus removal from the connector.

NOTE: Perform this procedure only if the termini are to be removed from the connector.

Step 1. To open the termini removal tool, squeeze the center section of the termini removal tool.

Step 2. Insert the terminus removal tool around the section of OFCC exiting the terminus and allow it to close around the OFCC.

Step 3. Rotate the removal tool until you feel it drop down between the terminus rear shoulder and the terminus retention clip.

Step 4. Squeeze the center section of the removal tool to open up the terminus retention clip and pull straight back on the OFCC to remove the terminus from the connector (see figure 5A6-8).

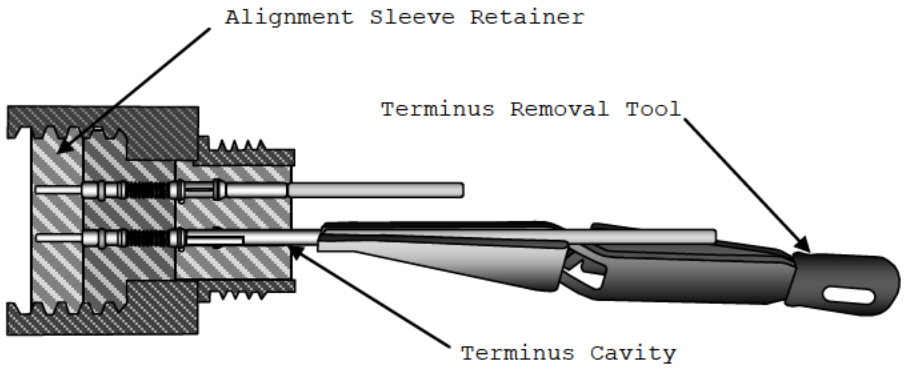


FIGURE 5A6-8. Removing the terminus from the insert.

Step 5. Pull the removal tool straight back.

Step 6. Slide the terminus out the rear of the insert.

Step 7. Repeat steps 1 through 6 for all of the termini.

METHOD 5B1
SINGLE FERRULE CONNECTOR INSTALLATION, ST

1. SCOPE

1.1 Scope. This method describes a procedure for installing single terminus (light duty) connectors in accordance with MIL-DTL-83522 onto OFCCs.

1.2 Method dependencies. During execution of this method, the user will need to complete Method 5D3. If the user is printing this method for reference, it is recommended to print Method 5D3 as well.

2. DOCUMENTS APPLICABLE TO METHOD 5B1

2.1 General. The documents listed in this section are specified in Method 5B1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5B1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24792	-	Adhesive, Epoxy, Two Part, Fiber Optics
MIL-DTL-83522	-	Connectors, Fiber Optic, Single Terminus, General Specification for
MIL-DTL-83522/16	-	Connector, Fiber Optic, Single Terminus, Plug, Bayonet Coupling (ST Style), 2.5 Millimeters Diameter Ferrule, Epoxy

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5B1-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5B1-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0013	Canned air	As required
TL-0078	Strip tool, OFCC	1
TL-0045	Aramid yarn shears	1
TL-0071	Safety glasses	1
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0046	Marking pen, permanent	1
TL-0079	Strip tool, buffer	1
	Cleaning wire	As required
	Epoxy (MIL-PRF-24792)	As required
	3-mm syringe with 20 gauge dispensing needles	As required
TL-0024	Cure adapter (MIL-DTL-83522)	As required
TL-0021	Crimper	1
TL-0023	Single die set (for crimper 0.090 and 0.105 indent ring and 0.190 hex) (MIL-DTL-83522)	1
TL-0101	Heat gun	1
TL-0027	Curing oven assembly (MIL-DTL-83522)	1
	Holder block	As required
TL-0014	Cleaver	1
	Dust covers	As required
TL-0051	Boot ring tool (MIL-DTL-83522)	1

NOTES:

1. Verify that the epoxy shelf life has not expired. Do not use epoxy with an expiration date that has passed. Refer to MIL-PRF-24792 for additional information on shelf life or contact the epoxy vendor or NSWCDD (see 6.4) for additional information.
2. Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).

4. PROCEDURE

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2 Procedure.

4.2.1 Cable and fiber preparation. The following steps shall be performed:

NOTE: If the cable jacket has not been removed, refer to MIL-STD-2042-2, Methods 2A1 and 2B1.

NOTE: Keep the OFCCs and connector parts free from oil, dirt, and grease throughout the installation procedure. If cleaning is necessary, use a wipe dampened with alcohol and blow the part dry with air.

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

NOTE: This procedure utilizes heat shrink tubing (with identification markings) for the identification of individual OFCCs. Other permanent methods of identification may be used with authorized approval (see 6.4).

NOTE: The curing oven may be turned on at this time to allow proper warm up (approximately 30 minutes) before the connector is placed into it.

Step 1. Measure the OFCCs to the required length (see MIL-STD-2042-2, Method 2C1). Add 80 millimeters (3.2 inches) to allow for at least two re-terminations.

Step 2. Slip the heat shrink tubing (with the fiber identification), the connector boot ring (AFSI connectors only), the connector boot, the crimp sleeve, and the cup washer (Delphi locking boot only) or three locking washers (OCC [AOS] connector) over the OFCC (see figure 5B1-1 for non-locking connectors; see figure 5B1-2 for locking connectors).

NOTE: The cup washer is supplied only with the locking boot connectors (i.e., M83522/16-ANX and ANY). Locking boots are marked “LOCKING”.

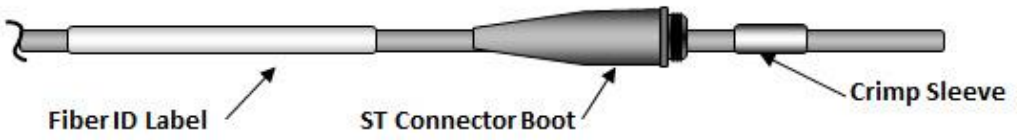
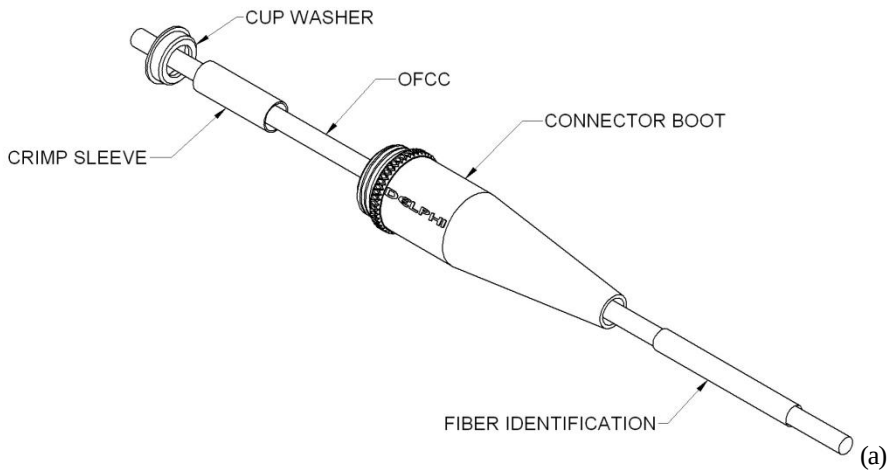


FIGURE 5B1-1. Installing the identification sleeve and connector boot (non-locking type typical).



(a)

(b)

NOTES:

1. "(a)" shows the installation of the crimp sleeve and connector boot (locking type, Delphi).
2. "(b)" shows the installation of the crimp sleeve, locking washers, and connector boot (locking type, OCC).

FIGURE 5B1-2. Installing the identification sleeve and connector boot (locking type).

TABLE 5B1-II. Cable stripping dimensions.

Vendor	**Dimensions mm (inch)**		
	A	**B**	**C**
OFS/COMMSCOPE (ST II Style)	30 (1.20)	6 (0.24)	13 (0.51)
Delphi	33.3 (1.31)	8 (0.31)	19.3 (0.76)
AFSI, OCC, STRAN	34 (1.34)	6.0 (0.24)	17 (0.67)

NOTES:

1. Tolerances on all dimensions are ±1 mm (0.04 inch).
2. For items approved after the date of publication, approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.
3. ST II Style template should be used for previously approved AT&T, Lucent, Avaya, and Systimax connectors.

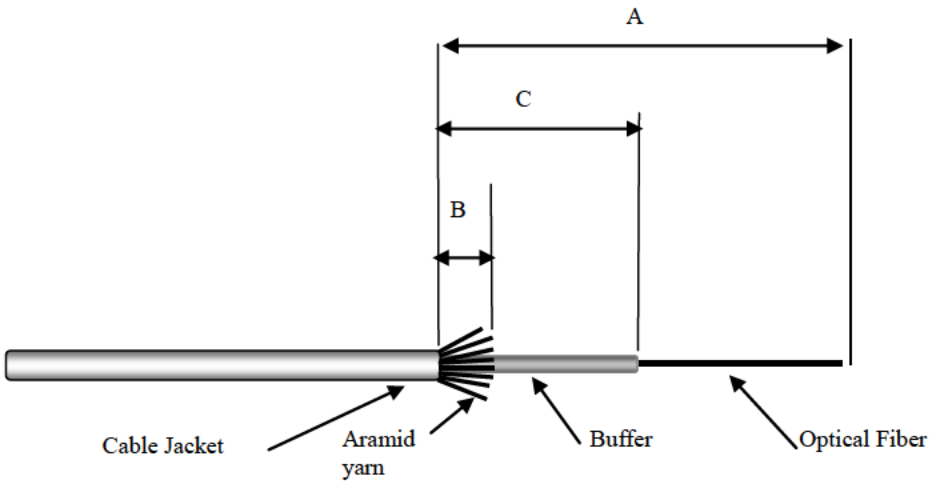


FIGURE 5B1-3. Cable stripping dimensions.

Step 3. Mark the OFCC outer jacket to dimension A and to dimension B for the appropriate connector type listed in table 5B1-II.

Step 4. Remove the OFCC outer jacket back to the dimension B mark using the OFCC cable stripper and trim the aramid yarn using the aramid yarn cutting shears so that it is even with the cable jacket.

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

Step 5. Remove the OFCC outer jacket back to the dimension A mark using the OFCC cable stripper. This step will expose the aramid yarn to the appropriate length.

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

Step 6. Remove the fiber buffer and coating back to dimension C (see table 5B1-II) using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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.

CAUTION: The uncoated/bare fiber is in its most vulnerable state. Take extreme care not to damage the fiber.

Step 7. Remove any residual coating material 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.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

4.2.2 Installation of the connector onto the fiber. The following steps shall be performed:

Step 1. Inspect the connector and verify that the ferrule hole is free and clear of dirt. This can be accomplished by holding the front of the connector up to a light and verifying that the light is visible from the rear of the connector. If light cannot be seen through the connector, push cleaning wire through the ferrule hole to clear it. Then blow dry air through the hole to remove any debris.

Step 2. Remove the divider from a two-part epoxy package and mix the two parts together until the epoxy is a smooth uniform color (see figure 5B1-4). The epoxy can be mixed by either repeatedly rolling or gently sliding the divider over the package.

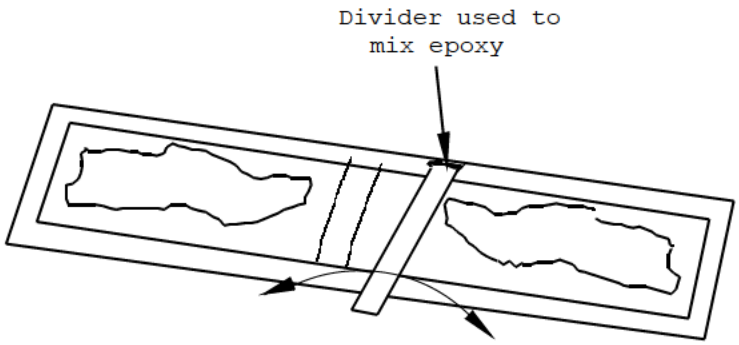


FIGURE 5B1-4. Mixing the epoxy.

NOTE: Alternatively, the epoxy may be mixed by massaging the epoxy package by hand.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

Step 3. Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

WARNING: Wear safety glasses while dispensing the epoxy to avoid possible eye injury.

Step 4. Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

Step 5. Slide the connector, rear first, onto the syringe tip (see figure 5B1-5). Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the connector until it escapes out of the ferrule, forming a very small bead.

NOTE: Do not overfill. Be extremely careful not to get epoxy on the connector spring or other connector moving parts.

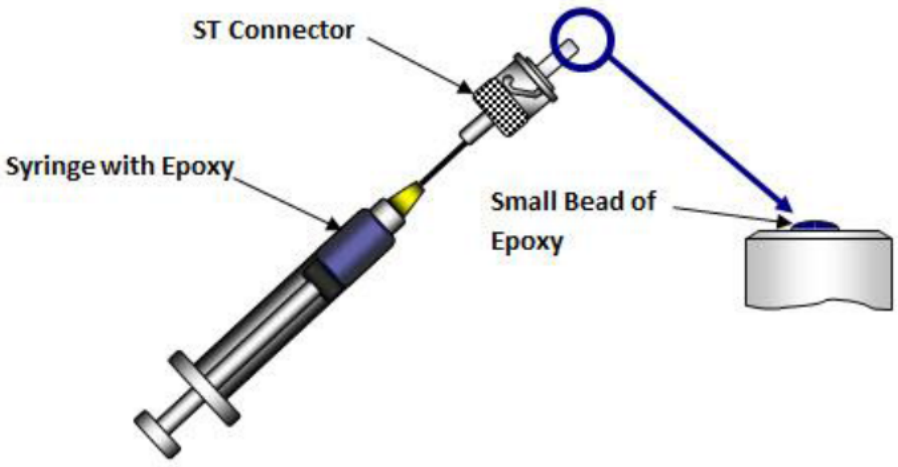


FIGURE 5B1-5. Injecting epoxy into the connector.

Step 6. Withdraw the syringe from the connector. Maintain some pressure on the plunger as the syringe is withdrawn so that the connector is completely filled with epoxy. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of the ferrule without disturbing the epoxy bead.

NOTE: Alternatively, the connector may be completely filled by maintaining a light pressure on the syringe plunger and allowing the epoxy to push the connector off of the syringe tip.

NOTE: Alternatively, when wiping away epoxy on the ferrule, the entire surface of the ferrule may be cleaned, including the epoxy bead; however, this will significantly reduce the overall epoxy bead size. Reduced epoxy bead size will increase probability of improper cleaves, resulting in fiber damage that may not be addressed through the polishing process and could require complete re-termination.

Step 7. Apply a very thin coating of epoxy to the aramid yarn strands and the buffer.

Step 8. Apply a very thin band of epoxy to approximately 3 millimeters (0.12 inch) of the connector barrel (see figure 5B1-6).

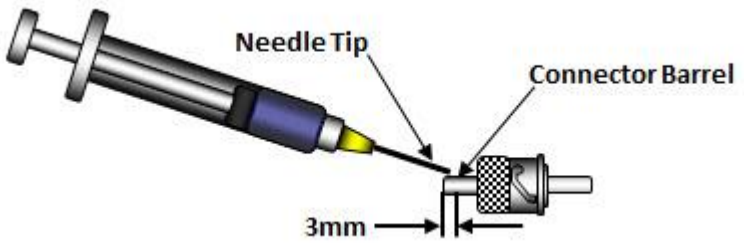


FIGURE 5B1-6. Applying epoxy to the connector barrel.

NOTE: At this point, the connector may be inserted into the cure adapter. Refer to step 10 for insertion of the connector into the cure adapter.

Step 9. Feather the aramid yarn evenly around the fiber and insert the fiber into the rear of the connector (see figure 5B1-7). Slide the crimp sleeve up to the end of the OFCC next to the aramid yarn. Gently work the fiber through the connector until the buffer seats against the rear of the ferrule (the connector should be rotated around the fiber as the fiber is inserted). The OFCC jacket should come up to the rear of the connector barrel and the aramid yarn should surround the rear of the connector barrel. Do not allow aramid yarn to enter the rear of the connector. Once inserted, do not allow the fiber to slip back.

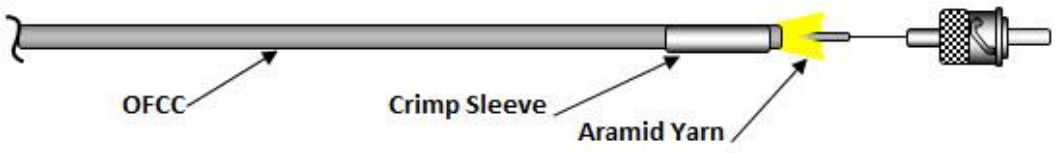


FIGURE 5B1-7. Inserting the fiber into the connector.

Step 10.a. For Delphi connectors with locking boots, if the cure adapter was not previously installed onto the connector, carefully place the cure adapter over the fiber and mate it to the connector so that the connector barrel is at maximum extension from the rear of the connector (place the cure adapter nub at end of the connector ramp, just before the normal mated position). Slide the cup washer to the rear of the connector. Slide the crimp sleeve over the OFCC jacket and aramid yarn onto the connector barrel (see figure 5B1-8).

NOTE: Maintain the same orientation of the cup washer with outer rim towards connector (see figure 5B1-2).

NOTE: The fiber must not protrude beyond the end of the cure adapter. If it does, trim the fiber end so it does not.

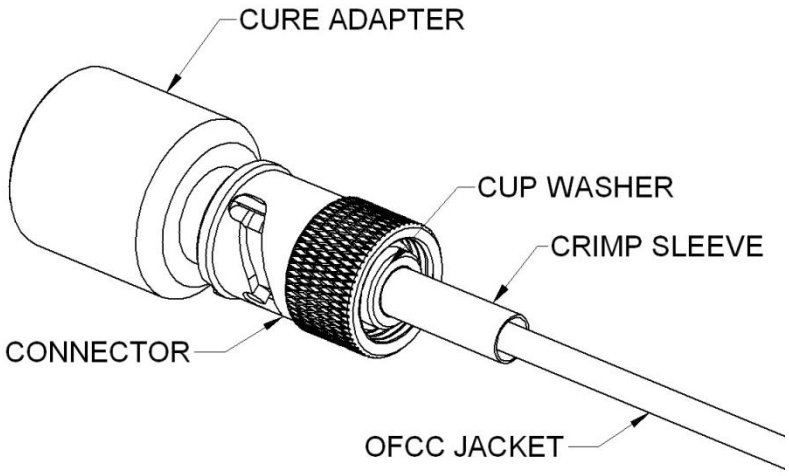


FIGURE 5B1-8. Sliding the crimp sleeve over the connector barrel (locking boot).

Step 10.b. For all other connectors, if the cure adapter was not previously installed onto the connector, carefully place the cure adapter over the fiber and mate it to the connector so that the connector barrel is at maximum extension from the rear of the connector (place the cure adapter nub at end of the connector ramp, just before the normal mated position). Slide the crimp sleeve over the OFCC jacket and aramid yarn onto the connector barrel (see figure 5B1-9).

NOTE: The fiber must not protrude beyond the end of the cure adapter. If it does, trim the fiber end so it does not.

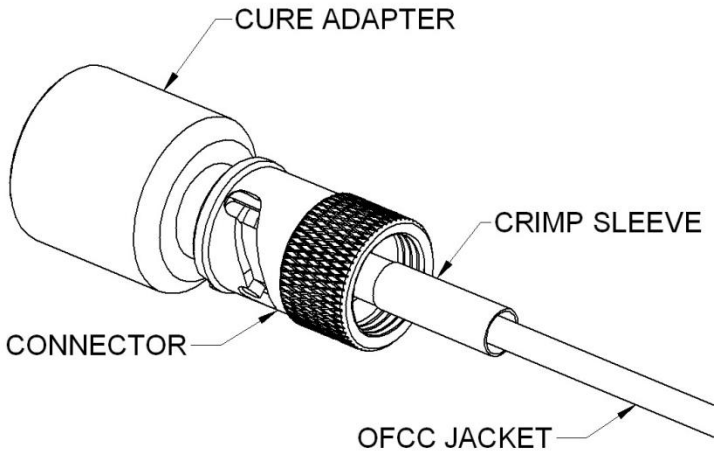


FIGURE 5B1-9. Sliding the crimp sleeve over the connector barrel (non-locking boot).

Step 11. Place the crimping tool over the crimp sleeve and crimp it against the connector barrel using the 0.105 indent ring cavity. Rotate the connector 90 degrees and crimp it again (see figure 5B1-10).

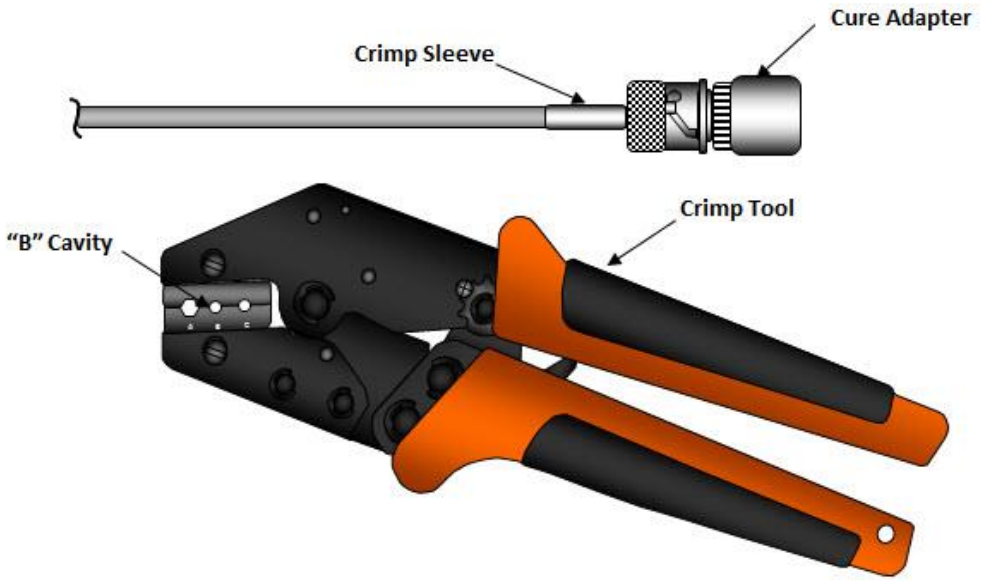


FIGURE 5B1-10. Crimping the connector.

NOTE: The cure adapter may be removed from the connector to perform steps 12 and 13.

Step 12. Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the ferrule tip, carefully add a small amount of epoxy around the fiber.

NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause the fiber to crack. If there is no small bead of epoxy on the ferrule tip, it may cause the fiber to crack.

Step 13. Using a wipe dampened with alcohol, carefully wipe away any epoxy on the fiber that is more than 2 millimeters (0.1 inch) from the ferrule surface.

NOTE: If the cure adapter was removed to perform steps 12 and 13, it should be re-mated to the connector at this time.

Step 14.a. For threaded connectors (non-locking) only: apply a drop of epoxy onto the boot threads, slip the boot over the crimped sleeve, and screw it onto the connector body.

Step 14.b. For non-threaded connectors only: slip the boot over the crimped sleeve onto the connector body until it snaps into the groove (at the rear of the connector body). Using the boot ring tool, slide the boot ring up the boot until it snaps into the same groove on the connector body.

NOTE: The boot ring can also be pushed up the boot by hand.

CAUTION: Do not apply epoxy to threads of a locking boot connector, or the connector will be disabled and must be replaced.

Step 14.c. For locking boot connectors only: slip the boot over the crimped sleeve and screw it onto the connector body.

Step 15. Slide the fiber identification tubing up the OFCC to near the connector boot and shrink it over the OFCC using a heat gun.

CAUTION: Do not overheat the OFCC. Prolonged exposure of the OFCC to temperatures above 160 °C (320 °F) may damage the OFCC jacket. Discontinue heating of the tubing and allow the jacket to cool before reheating if the jacket shows any signs of bubbling.

4.2.3 Curing the epoxy. The following steps shall be performed:

Step 1. Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 30 minutes).

NOTE: The oven may be turned on early in the connector assembly process so that it is already at the proper temperature.

Step 2. Place the cure adapter with the connector in the curing oven, and position the OFCC vertically over the oven. Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120 °C (248 °F). Ensure that the cure adapter and heater block configuration in use allow the connector to be within the heater block with little or no portion of the crimp sleeve exposed above the top surface of the block.

NOTE: When the OFCC is positioned above the connector, make sure that no bends are placed in the OFCC. The OFCC should enter the connector parallel to the connector axis.

NOTE: Alternate cure schedules may be used with approval of NSWCDD (see 6.4).

Step 3. Turn the curing oven off, remove the connector and cure adapter from the curing oven, and place them on a cure adapter holder block or non-flammable surface. Allow the cure adapter and connector to cool for approximately 4 minutes.

4.2.4 Polishing the fiber ends. The following step shall be performed:

Step 1. Proceed to Method 5D3 to polish and inspect the connector.

METHOD 5B2
SINGLE FERRULE CONNECTOR INSTALLATION, LC

1. SCOPE

1.1 Scope. This method describes a procedure for installing LC connectors onto the ends of OFCCs.

1.2 Method dependencies. During execution of this method, the user will need to complete Method 5D3. If the user is printing this method for reference, it is recommended to print Method 5D3 as well.

2. DOCUMENTS APPLICABLE TO METHOD 5B2

2.1 General. The documents listed in this section are specified in Method 5B2 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5B2 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24792 - Adhesive, Epoxy, Two Part, Fiber Optics

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

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

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-604-10 - Fiber Optic Connector Intermateability Standard, Type LC

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS.

3.1 Equipment and materials. The equipment and materials in table 5B2-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5B2-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0013	Canned air	As required
TL-0078	Strip tool, OFCC	1
TL-0045	Aramid yarn cutting shears	1
TL-0071	Safety glasses	1
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0079	Strip tool, buffer	1
	125-micron cleaning wire (499-6872811-24)	As required
	Epoxy (MIL-PRF-24792)	As required
	3-mm syringe	As required
	Dispensing (syringe) tip (needle), twist on, 20-gauge, 25.4 mm (1 inch) long, blunt end, for epoxy injection into non-pull proof LC connectors	As required
	Loctite 222, or equal (see 4.8)	As required
TL-0117	Cure adapters, LC connector (TIA-604-10)	As required
TL-0116	Crimp tool for LC connector	1
TL-0118	Die for crimp tool for LC connector	1
TL-0101	Heat gun	1
TL-0027	Curing oven assembly (MIL-DTL-83522)	1
	Holder block	As required
TL-0014	Cleaver	1
	Dust covers	As required

NOTES:

1. Verify that the epoxy shelf life has not expired. Do not use epoxy with an expiration date that has passed. Refer to MIL-PRF-24792 for additional information on shelf life or contact the epoxy vendor or NSWCDD (see 6.4) for additional information.
2. Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).

4. PROCEDURE

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2 Procedure.

NOTE: The curing oven may be turned on at this time to allow proper warm up (approximately 30 minutes) before the connector is placed into it.

4.2.1 Cable and fiber preparation. The following steps shall be performed:

Step 1. Install the following items onto the OFCC(s): wire marker sleeve, strain relief boot, and shrink tube with attached crimp sleeve (see figure 5B2-1), and slide them back from the end of the OFCC.

NOTE: Only use the crimp sleeve that is supplied with the LC connector for the aramid yarn capture/strain relief mechanism.

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

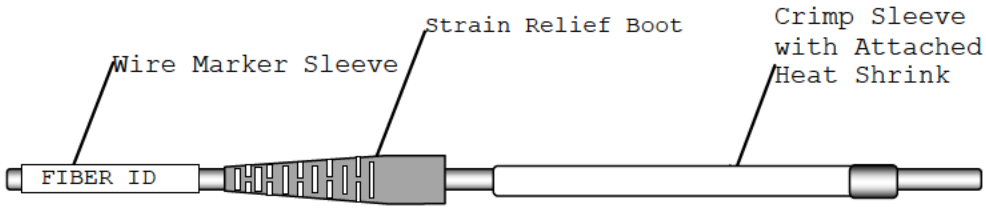


FIGURE 5B2-1. Pre-installed cable components.

NOTE: See table 5B2-II and figure 5B2-2 for cable stripping dimensions.

TABLE 5B2-II. Cable stripping dimensions.

Vendor (CAGE Code)	Dimensions		
	A mm (inch)	B mm (inch)	C mm (inch)
OFS (1YK91)	34.9 (1.38)	6.4 (0.25)	20.8 (0.82)
TYCO (0PJN9)	36.5 (1.44)	4.6 (0.18)	20.6 (0.81)

NOTES:
1. Tolerances on all dimensions are ±1.6 mm (0.06 inch).
2. For items approved after the date of publication, approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.

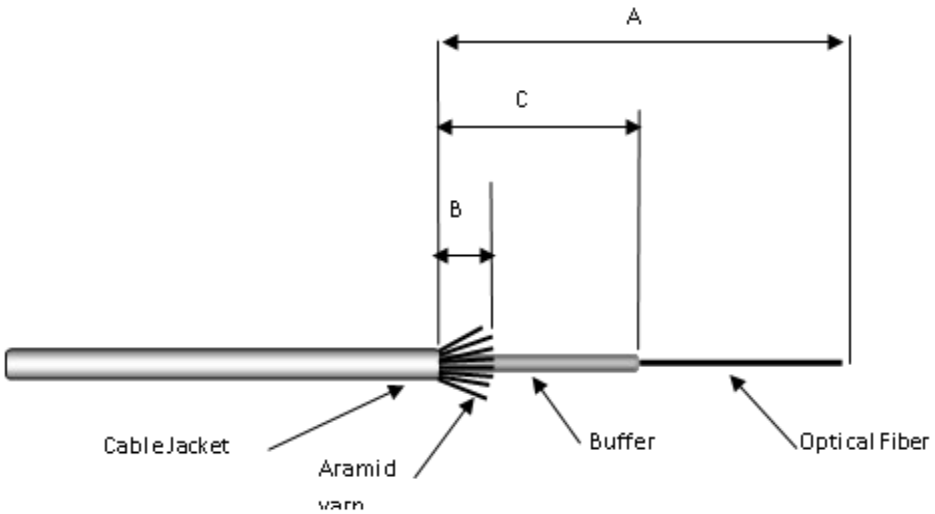


FIGURE 5B2-2. Cable stripping dimensions.

Step 2. Mark the OFCC outer jacket to dimension A and to dimension B for the appropriate connector type listed in table 5B2-II.

Step 3. Remove the OFCC outer jacket back to the dimension B mark using the OFCC cable stripper and trim the aramid yarn using the aramid yarn cutting shears so that it is even with the cable jacket.

NOTE: The optimum way to remove the OFCC jackets is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing off the OFCC jacket with a tightly held OFCC stripper can lead to fiber breakage.

Step 4. Remove the OFCC outer jacket back to the dimension A mark using the OFCC cable stripper. This step will expose the aramid yarn to the appropriate length.

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

Step 5. Remove the fiber buffer and coating back to dimension C (see table 5B2-II) using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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.

CAUTION: The uncoated/bare fiber is in its most vulnerable state. Take extreme care not to damage the fiber.

Step 6. Remove any residual coating material 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.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

NOTE: Do not dampen the aramid yarn strength member while cleaning the fiber. Alcohol will contaminate the epoxy and compromise the bond of the strength member to the LC connector.

4.2.2 Installation of the connector onto the fiber. The following steps shall be performed:

NOTE: There are two types of LC connectors, pull proof and non-pull proof. The following contains instructions for both types of connectors. Pay close attention to steps that call out specific pull proof or non-pull proof instructions.

NOTE: If it is not clear which type of LC connector has been provided, verify the part number. If part number is not available, then before fiber installation, push on the ferrule and observe the movement of the crimp body at the back of the connector. If the entire crimp body moves when the ferrule is depressed, it is a non-pull proof connector. If the external portion of the crimp body remains still, it is a pull proof connector.

Step 1. Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 30 minutes).

Step 2. Inspect the LC connector and verify that the ferrule hole is free and clean of dirt. This can be accomplished by holding the front of the LC connector up to a light and verifying that the light is visible from the rear of the LC connector. If light cannot be seen through the LC connector, push cleaning wire through the LC connector hole to clear it. Then blow dry air through the hole to remove any debris.

NOTE: Do not use cleaning wire that is oxidized or rusted.

NOTE: For some applications, there may be a tight ferrule hole tolerance requirement. If the application requires a tight ferrule hole tolerance, then several LC connectors with different ferrule hole diameters will need to be kept on hand. Dry fit the LC connector onto the fiber to ensure proper ferrule hole clearance before injecting epoxy into the LC connector. Try the smaller ferrule hole diameter first; if the LC connector will not fit, then proceed to the next larger ferrule hole diameter.

Step 3. Remove the divider from a two-part epoxy package and slowly mix the two parts together until the epoxy is a smooth uniform color (see figure 5B2-3). The epoxy can be mixed by either repeatedly rolling the divider over the package or gently sliding the divider over the package.

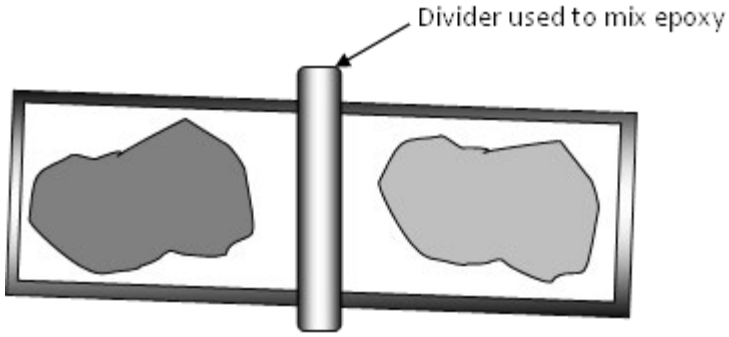


FIGURE 5B2-3. Mixing the epoxy.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Mix the epoxy slowly to minimize the introduction of air bubbles. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

NOTE: Alternatively, the epoxy may be mixed by slowly massaging the epoxy package by hand.

Step 4. Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

Step 5. Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

Step 6. Slide the connector, rear first, onto the syringe tip (see figure 5B2-4). Insert the syringe tip completely. Push and hold the LC connector against the syringe tip to prevent the connector from lifting off of the syringe tip.

Step 7. Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the LC connector. Pressure on the syringe plunger is applied until an epoxy bead appears on the ferrule end face (at least half the ferrule diameter). Retract the syringe tip slightly (approximately 1 millimeter) and hold for 1 second. Discontinue pressure on the syringe plunger and withdraw the syringe tip quickly without injecting more adhesive.

CAUTION: Do not completely backfill an LC connector. A complete backfill of epoxy can result a locked spring (inability of plunger feature to function) or bonded fiber (inability of fiber to push back in the tube/jacket).

NOTE: Be extremely careful not to get epoxy on the spring or other LC connector moving parts.

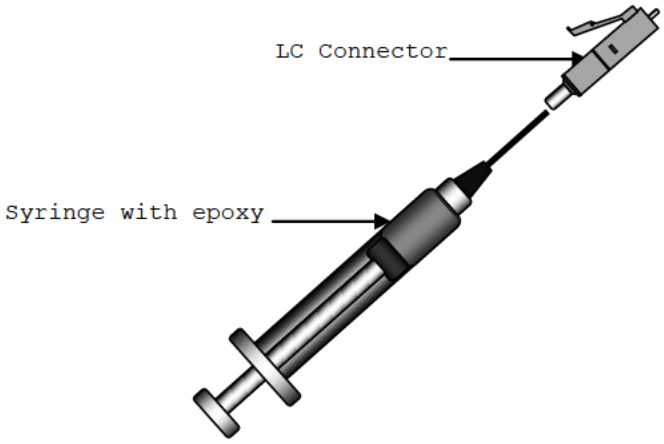


FIGURE 5B2-4. Injecting epoxy into the LC connector.

Step 8. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of ferrule without disturbing the epoxy bead.

NOTE: Alternatively, when wiping away epoxy on the ferrule, the entire surface of the ferrule may be cleaned, including the epoxy bead; however, this will significantly reduce the overall epoxy bead size. Reduced epoxy bead size will increase probability of improper cleaves, resulting in fiber damage that may not be addressed through the polishing process and could require complete re-termination.

Step 9. Feather the aramid yarn evenly around the fiber and insert the fiber into the rear of the LC connector (see figure 5B2-5). Gently work the fiber through the LC connector until the fiber fully seats inside the LC connector. (The LC connector should be rotated around the fiber as the fiber is inserted.) The aramid yarn should surround the rear of the LC connector. Once inserted, do not allow the fiber to slip back.

NOTE: Wetting the fiber with a thin layer of epoxy before inserting into the LC connector reduces the chance of entrapping air (being "dragged" next to the fiber) during LC connector insertion.

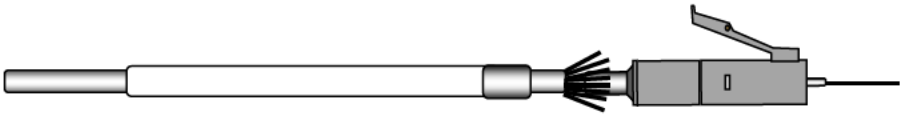


FIGURE 5B2-5. Distribute aramid yarn evenly around area of crimp.

Step 10. Insert the LC connector into the cure adapter until it rests against the housing or against the barrel behind the ceramic ferrule (see figure 5B2-6).

Step 11. Slide the crimp sleeve over the aramid yarn. Place the LC connector into the crimp die. Position the LC connector so that the top of the crimp sleeve seats even with the front face of the crimp die and then crimp the LC connector crimp sleeve (see figure 5B2-6).

NOTE: A small amount of epoxy may be added on the aramid yarn near the rear of the LC connector before the crimp sleeve is installed.

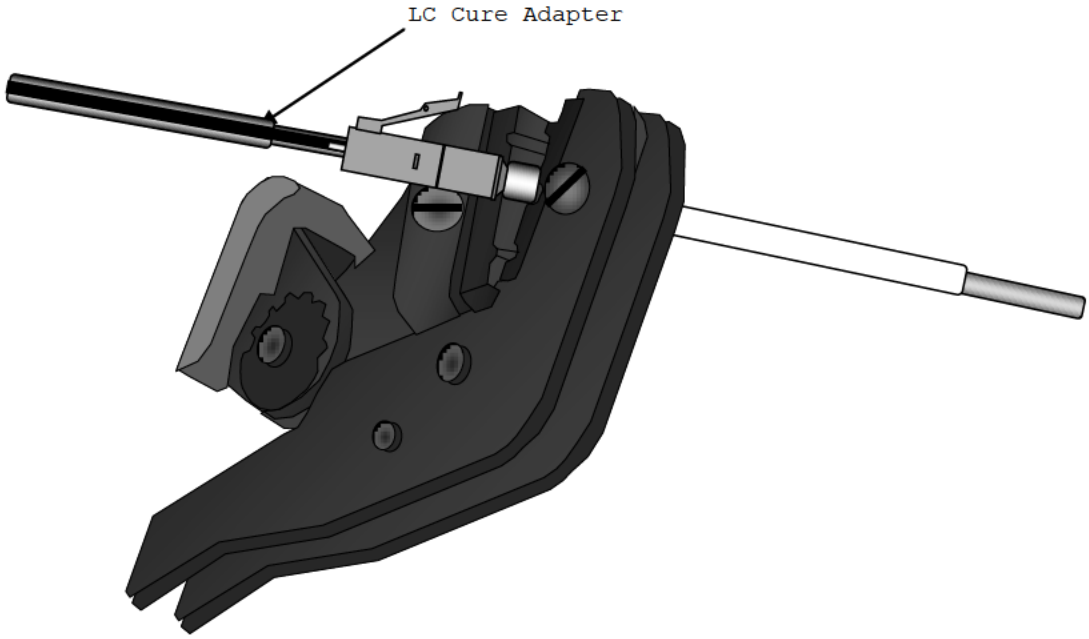


FIGURE 5B2-6. Crimp tool operation.

Step 12. Verify that the aramid yarn does not protrude excessively from under the crimp sleeve. Excessive aramid yarn protrusion will cause the LC connector to not seat properly in the finished connector. If excessive aramid yarn protrudes from under the crimp sleeve, trim it back using aramid yarn cutting shears.

NOTE: Ideally, no aramid yarn should be visible. Verify that the cable is bottomed in the LC connector.

Step 13. Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the LC connector tip, carefully add a small amount of epoxy around the fiber.

NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause damage to the optical glass fiber. If there is no small bead of epoxy on the ferrule tip, it may cause the fiber to crack.

WARNING: Do not get epoxy on the outside of the ceramic ferrule of the LC connector. Wipe off any excess epoxy on the outside of the ceramic ferrule using a lint-free cloth.

Step 14. Use a wipe dampened with alcohol to carefully wipe away any excess epoxy on the fiber that is more than 2 millimeters (0.1 inch) from the ferrule tip surface.

NOTE: Ensure that no epoxy gets onto the spring on the LC connector. If epoxy does get onto the spring, then remove and replace the LC connector.

Step 15. Repeat steps 2 through 14 for each fiber to be terminated.

4.2.3 Curing the epoxy. The following steps shall be performed:

Step 1. Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 30 minutes).

NOTE: The oven may be turned on early in the connector assembly process so that it is already at the proper temperature.

Step 2. Place the cure adapter with the connector in the curing oven, and position the OFCC vertically over the oven. Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120 °C (248 °F). Ensure that the cure adapter and heater block configuration in use allow the connector to be within the heater block with little or no portion of the crimp sleeve exposed above the top surface of the block.

NOTE: When the OFCC is positioned above the connector, make sure that no bends are placed in the OFCC. The OFCC should enter the connector parallel to the connector axis.

NOTE: Alternate cure schedules may be used with approval of the NSWCDD (see 6.4).

Step 3. Turn the curing oven off, remove the connector and cure adapter from the curing oven, and place them on a cure adapter holder block or non-flammable surface. Allow the cure adapter and connector to cool for approximately 4 minutes.

4.2.4 Polishing the fiber ends. The following steps shall be performed:

Step 1. Proceed to Method 5D3 to polish and inspect the connector.

Step 2. When all connectors have been successfully constructed, polished, and inspected, proceed to the final assembly instructions (see 4.2.5).

4.2.5 Final assembly. The following steps shall be performed:

Step 1. Apply heat evenly over the length on the heat shrink portion of the crimp sleeve to collapse the heat shrink to the OFCC jacket (see figure 5B2-1).

CAUTION: Do not overheat. Overheating the OFCC while collapsing the heat shrink can result in either inducing high optical loss in or breakage of the optical fiber.

Step 2. Push the strain relief boot up to the base of the LC connector. Ensure that the exposed crimp sleeve is fully covered (see figure 5B2-7).

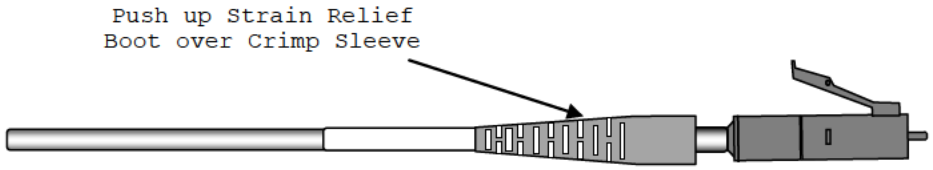


FIGURE 5B2-7. Installing the strain relief boot.

Step 3. Install the LC connector into the duplex connector clip. Identify the channel "A" connector position and locate the "A" position on the duplex clip. Center the LC connector between one of the openings in the clip. Next, insert the LC connector into the cavity.

NOTE: Correct placement is denoted by an audible "click" sound (see figure 5B2-8).

Step 4. Repeat step 3 for Channel "B".

NOTE: The duplex clip contains a rib feature, which corresponds with a recess in the LC connector housing (body). For correct installation, the rib must mate with the recess. In addition, there is an arrow on the clip that should point toward the front on the LC connector.

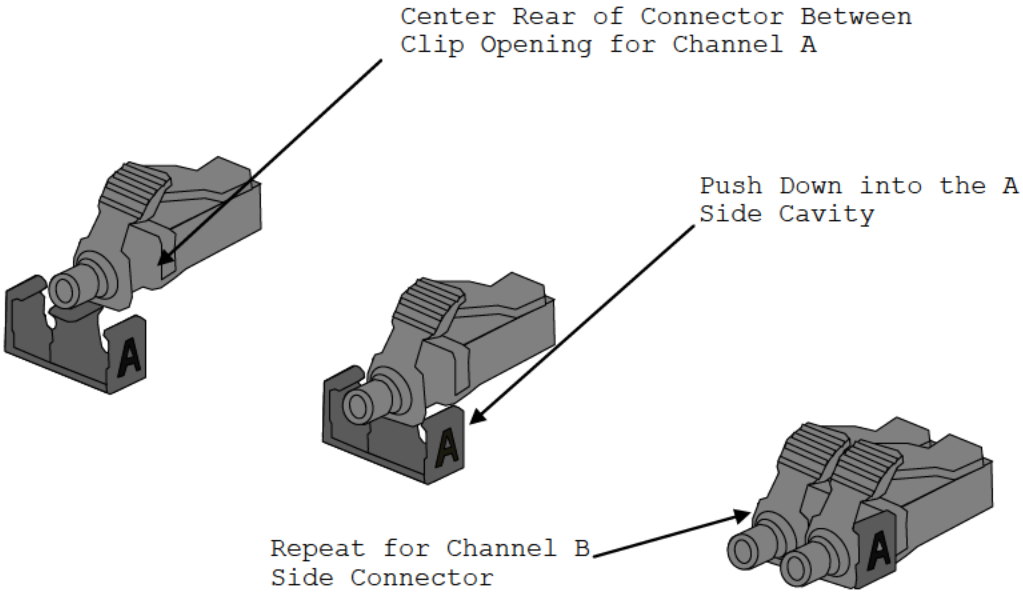


FIGURE 5B2-8. Installing the duplex clip.

Step 5. Place dust cover over end of LC connector ferrule to protect the ferrule end face of each LC connector until it is installed into the system.

METHOD 5B3
SINGLE FERRULE CONNECTOR INSTALLATION, SC

1. SCOPE

1.1 Scope. This method describes a procedure for installing SC connectors onto the ends of OFCCs.

1.2 Method dependencies. During execution of this method, the user will need to complete Method 5D3. If the user is printing this method for reference, it is recommended to print Method 5D3 as well.

2. DOCUMENTS APPLICABLE TO METHOD 5B3

2.1 General. The documents listed in this section are specified in Method 5B3 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5B3 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24792 - Adhesive, Epoxy, Two Part, Fiber Optics

(Copies of this document are available online at http://quicksearch.dla.mil/.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-604-3 - Fiber Optic Connector Intermateability Standard, Type SC

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

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5B3-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5B3-I. Equipment and materials.

Reference #	Description	Quantity
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TL-0013	Canned air	As required
TL-0078	Strip tool, OFCC	1
TL-0045	Aramid yarn cutting shears	1
TL-0071	Safety glasses	1
TL-0046	Marking pen, permanent	1
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0079	Strip tool, buffer	1
	125 micron cleaning wire	As required
	Epoxy (MIL-PRF-24792)	As required
	3 millimeter syringe	As required
	Dispensing (syringe) tip (needle), twist on, 18-gauge, 12.7 mm (0.5 inch) long, blunt end, for epoxy injection into pull proof SC connectors	As required
TL-0025	Cure adapter (TIA-604-3)	As required
TL-0021	Crimper	1
TL-0119	Die set, for SC connector, 3-mm fiber	As required
TL-0120	Die set, for SC connector, 2-mm fiber	1
TL-0027	Curing oven	1
	Holder block	As required
TL-0014	Cleaver	1
TL-0101	Heat gun	1
	Dust covers	As required

NOTES:

1. Verify that the epoxy shelf life has not expired. Do not use epoxy with an expiration date that has passed. Refer to MIL-PRF-24792 for additional information on shelf life or contact the epoxy vendor or NSWCDD (see 6.4) for additional information.
2. Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).

4. PROCEDURE

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2 Procedure.

NOTE: The curing oven may be turned on at this time to allow proper warm up (approximately 30 minutes) before the connector is placed into it.

4.2.1 Cable and fiber preparation. The following steps shall be performed:

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

Step 1. Install the following items onto the OFCC(s): wire marker sleeve, strain relief boot and crimp sleeve with attached heat shrink (see figure 5B3-1), and slide them back from the end of the OFCC.

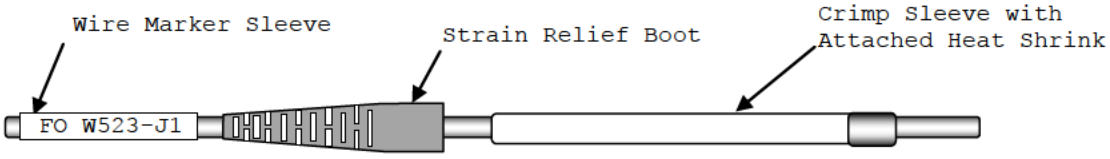

FIGURE 5B3-1. Pre-installed SC cable components.

NOTE: See table 5B3-II and figure 5B3-2 for cable stripping dimensions.

NOTE: If it is not clear which type of SC connector has been provided, verify the part number. If part number is not available, then before fiber installation push on the ferrule and observe if the movement of the crimp body at the back of the connector. If the entire crimp body moves when the ferrule is depressed, it is a non-pull proof connector. If the external portion of the crimp body remains still, it is a pull proof connector.

TABLE 5B3-II. Cable stripping dimensions.

Vendor	Dimensions mm (inch)		
	A	B	C
TYCO (Non-Pull Proof)	35.09 (1.38)	4.06 (0.16)	22.09 (0.87)
TYCO (Pull proof)	34.29 (1.35)	6.35 (0.25)	16.00 (0.63)

NOTES:
1. Tolerances on all dimensions are ±1.6 mm (0.06 inch).
2. For items approved after the date of publication approved strip templates may be obtained from NSWCDD (see 6.4) or the manufacturer.

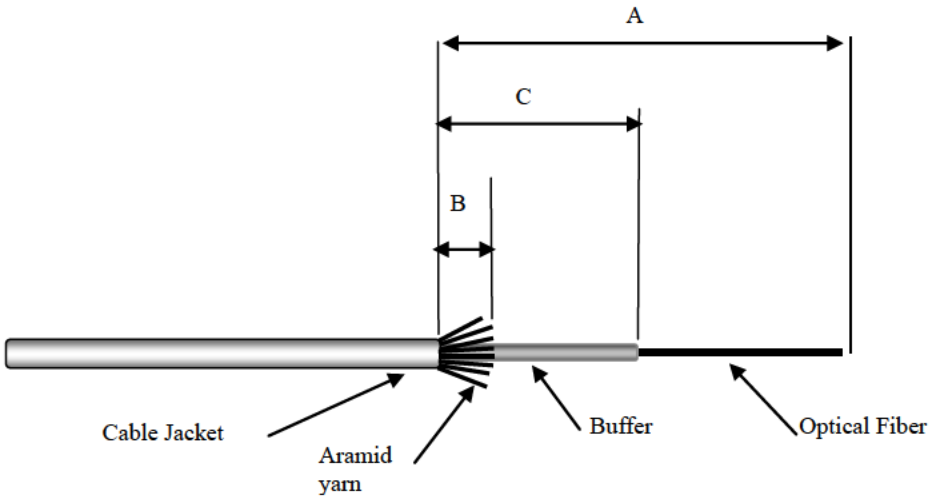

FIGURE 5B3-2. Cable stripping dimensions.

Step 2. Mark the OFCC jacket to dimension A and to dimension B (see table 5B3-II).

Step 3. Remove the OFCC outer jacket back to the dimension B mark using the OFCC cable stripper and trim the aramid yarn, using the aramid yarn cutting shears, so that it is even with the cable jacket.

NOTE: The optimum way to remove the OFCC jacket is to ring cut the jacket with the OFCC stripper and pull the jacket off by hand. Pushing the OFCC jacket off with a tightly held OFCC stripper can lead to fiber breakage.

Step 4. Remove the OFCC outer jacket back to the dimension A mark using the OFCC cable stripper. This step will expose the aramid yarn to the appropriate length.

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

Step 5. Remove the fiber buffer and coating back to dimension C (see table 5B3-II) using the buffer stripper. Remove the buffer and coating in small sections (approximately 6 millimeters [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.

CAUTION: The uncoated/bare fiber is in its most vulnerable state. Take extreme care not to damage the fiber.

Step 6. Remove any residual coating material 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.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

NOTE: Do not dampen the aramid yarn strength member while cleaning the fiber. Alcohol will contaminate the epoxy and compromise the bond of the strength member to the SC connector.

4.2.2 Installation of the connector onto the fiber. The following steps shall be performed:

Step 1. Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 30 minutes).

Step 2. Inspect the SC connector and verify that the ferrule hole is free and clear of dirt. This can be accomplished by holding the front of the SC connector up to a light and verifying that the light is visible from the rear of the SC connector. If light cannot be seen through the SC connector, push cleaning wire through the SC connector hole to clear it. Then blow dry air through the hole to remove any debris.

NOTE: Do not use cleaning wire that is oxidized or rusted.

NOTE: For some applications, there may be a tight ferrule hole tolerance requirement. If the application requires a tight ferrule hole tolerance, then several SC connectors with different ferrule hole diameters will need to be kept on hand. Dry fit the SC connector onto the fiber, to ensure proper ferrule hole clearance, before injecting epoxy into the SC connector. Try the smaller ferrule hole diameter first; if the SC connector will not fit, then proceed to the next larger ferrule hole diameter.

Step 3. Remove the divider from a two-part epoxy package and slowly mix the two parts together until the epoxy is a smooth uniform color (see figure 5B3-3). The epoxy can be mixed by either repeatedly rolling the divider over the package or gently sliding the divider over the package.

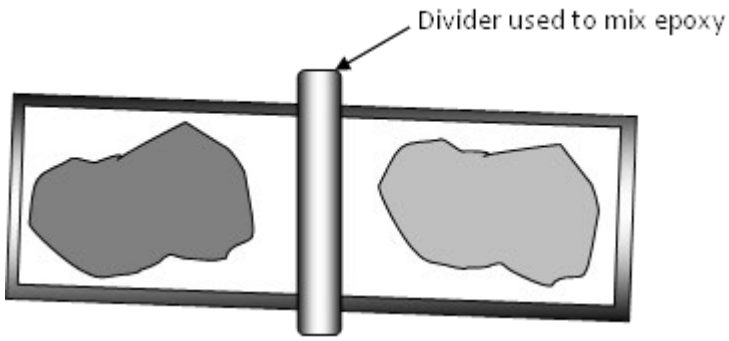

FIGURE 5B3-3. Mixing the epoxy.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Mix the epoxy slowly to minimize the introduction of air bubbles. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

NOTE: Alternatively, the epoxy may be mixed by slowly massaging the epoxy package by hand.

Step 4. Use an 18-gauge syringe tip. Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

NOTE: The gauge of the syringe tip is critical to successful completion of this method. Do not use the 20-gauge tips that are used for ST or LC termination.

NOTE: To ensure successful termination of a pull proof connector onto tight buffer cable, do not completely backfill the connector barrel cavity.

Step 5. Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

Step 6. Slide the SC connector, rear first, onto the syringe tip (see figure 5B3-4). Push and hold the SC connector against the syringe tip. This applied pressure will prevent the SC connector lifting off the tip before the SC connector is filled.

Step 7. Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the SC connector. The syringe tip is inserted completely. Pressure on the syringe plunger is applied until an epoxy bead appears on the ferrule end face (at least half the ferrule diameter). The correct volume of epoxy is injected once the epoxy bead appears. Discontinue pressure on the syringe plunger and withdraw the syringe tip from the SC connector without further injection of epoxy.

CAUTION: Do not completely backfill an SC connector when terminating to tight buffer cabling.

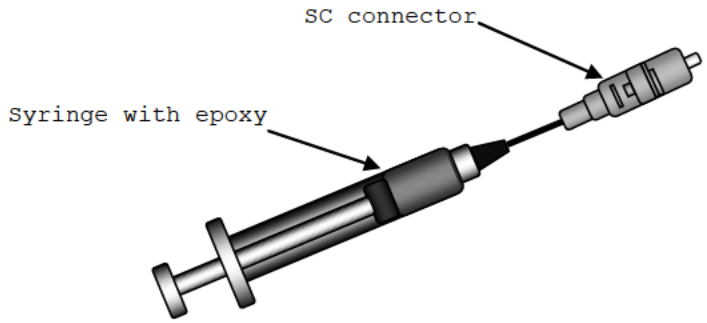

FIGURE 5B3-4. Injecting epoxy into the SC connector.

NOTE: Be extremely careful not to get epoxy on the spring or other SC connector moving parts.

Step 8. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of ferrule without disturbing the epoxy bead.

NOTE: Alternatively, when wiping away epoxy on the ferrule, the entire surface of the ferrule may be cleaned including the epoxy bead. However, this will significantly reduce the overall epoxy bead size. Reduced epoxy bead size will increase probability of improper cleaves, resulting in fiber damage that may not be addressed through the polishing process and could require complete re-termination.

Step 9. Feather the aramid yarn evenly around the fiber and insert the fiber into the rear of the SC connector (see figure 5B3-5). Gently work the fiber through the SC connector until the fiber fully seats inside the SC connector. The SC connector should be rotated around the fiber as the fiber is inserted. The aramid yarn should surround the rear of the SC connector. Once inserted, do not allow the fiber to slip back.

NOTE: Wetting the fiber with a thin layer of epoxy before inserting into the SC connector reduces the chance of entrapping air (being "dragged" next to the fiber) during SC connector insertion.

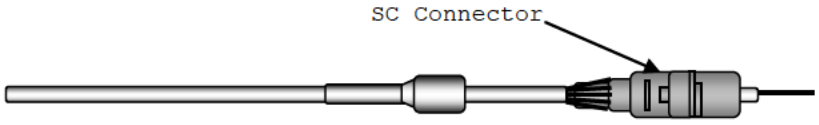

FIGURE 5B3-5. Distribute aramid yarn evenly around area of crimp.

Step 10. Slide the crimp sleeve with the attached white heat shrink up over the aramid yarn until it bottoms out on the rear section of the SC connector. Install the SC cure adapter over the ceramic ferrule until it is secure on the ferrule (see figure 5B3-6).

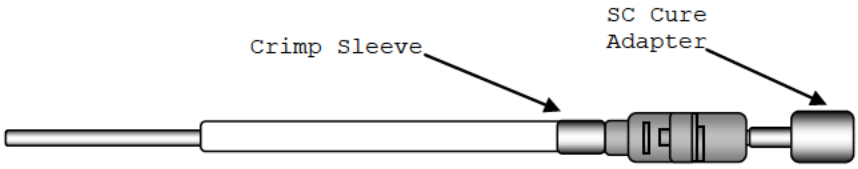

FIGURE 5B3-6. Install SC cure adapter.

Step 11. Position the SC connector so that the crimp sleeve is seated in the 2-millimeter (0.078-inch) cavity of the crimp die and crimp using the crimp tool.

NOTE: A small amount of epoxy may be added on the aramid yarn near the rear of the SC connector before the crimp sleeve is installed.

NOTE: If installing the 3-millimeter OFCC version of the SC connector, a different crimp sleeve and crimp die are necessary (see figure 5B3-7). The small area of the crimp sleeve should be crimped first using the 2-millimeter cavity, followed by crimping the larger section of the crimp sleeve in the 2/2.5/3-millimeter cavity.

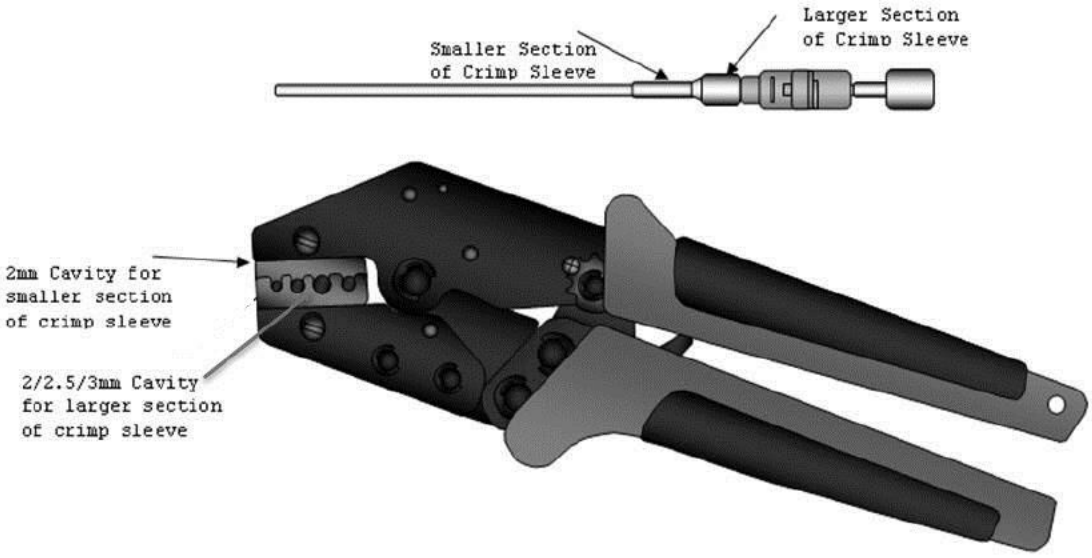

FIGURE 5B3-7. Crimp sleeve and crimp tool operation for SC connector installed on a 3 millimeter OFCC.

Step 12. Verify that the aramid yarn does not protrude excessively from under the crimp sleeve. Excessive aramid yarn protrusion will cause the SC connector to not seat properly in the finished connector. If excessive aramid yarn protrudes from under the crimp sleeve, trim it back using aramid yarn cutting shears.

NOTE: Ideally, no aramid yarn should be visible. Verify that the cable is bottomed in the SC connector.

Step 13. Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the SC connector tip, carefully add a small amount of epoxy around the fiber. If there is no small bead of epoxy on the ferrule tip, it may cause the fiber to crack.

NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause damage to the optical glass fiber.

WARNING: Do not get epoxy on the outside of the ceramic ferrule of the SC connector. Wipe off any excess epoxy on the outside of the ceramic ferrule using a lint-free cloth.

Step 14. Use a wipe dampened with alcohol to carefully wipe away any excess epoxy on the fiber that is more than 2 millimeters (0.1 inch) from the ferrule tip surface.

NOTE: Ensure that no epoxy gets onto the spring on the SC connector. If epoxy does get onto the spring, remove and replace the SC connector.

Step 15. Repeat steps 2 through 14 for each fiber to be terminated.

Step 16. Place the cure adapters in the curing oven, and position the cable vertically over the oven using the cable stand.

4.2.3 Curing the epoxy. The following steps shall be performed:

Step 1. Turn on the curing oven so that it attains the proper temperature before the connector is placed within it (approximately 30 minutes).

NOTE: The oven may be turned on early in the connector assembly process so that it is already at the proper temperature.

Step 2. Place the cure adapter with the connector in the curing oven, and position the OFCC vertically over the oven. Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120 °C (248 °F). Ensure that the cure adapter and heater block configuration in use allow the connector to be within the heater block with little or no portion of the crimp sleeve exposed above the top surface of the block.

NOTE: When the OFCC is positioned above the connector, make sure that no bends are placed in the OFCC. The OFCC should enter the connector parallel to the connector axis.

NOTE: Alternate cure schedules may be used with approval of the NSWCDD (see 6.4).

Step 3. Turn the curing oven off, remove the connector and cure adapter from the curing oven, and place them on a cure adapter holder block or non-flammable surface. Allow the cure adapter and connector to cool for approximately 4 minutes.

4.2.4 Polishing the fiber ends. The following steps shall be performed:

Step 1. Proceed to Method 5D3 to PC polish and inspect the connector.

Step 2. When all connectors have been successfully constructed, PC polished, and inspected, proceed to the final assembly instructions (see 4.2.5).

4.2.5 Final assembly. The following steps shall be performed:

NOTE: Only the pull proof SC connector has the heat shrink sleeve attached to the crimp sleeve that will need to be shrunk down during final assembly.

Step 1. Apply heat evenly over the length on the heat shrink portion of the crimp sleeve to collapse the heat shrink to the OFCC jacket (see figure 5B3-8).

CAUTION: Do not overheat. Overheating the OFCC while collapsing the heat shrink can result in either inducing high optical loss in or breakage of the optical fiber.

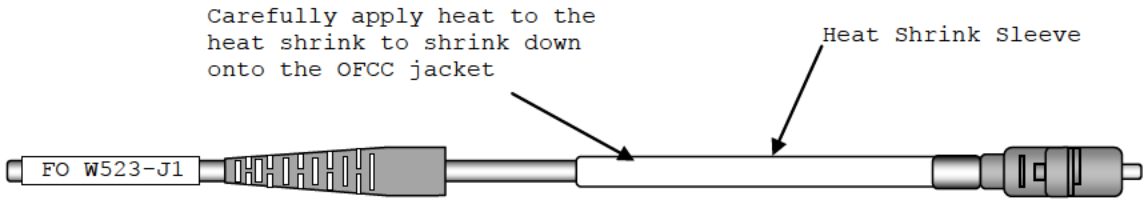

FIGURE 5B3-8. Location of heat shrink sleeve.

Step 2. Push the strain relief boot up to the base of the SC connector. Ensure that the exposed crimp sleeve is fully covered (see figure 5B3-9).

NOTE: Do not push the strain relief boot all the way up over the crimp sleeve. When the outer SC housing is installed, this will allow the strain relief boot to be fully seated.

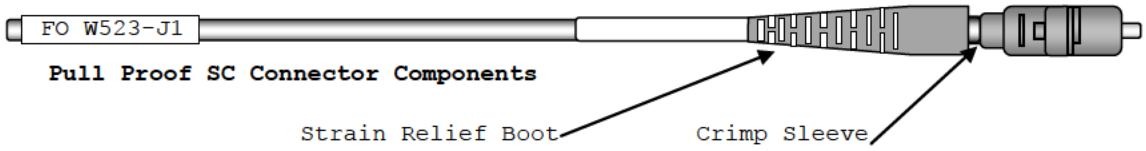

FIGURE 5B3-9. Installing the strain relief boot.

Step 3. Verify the proper orientation of the SC housing in relationship to the SC connector and install the SC housing over the SC connector. Push onto the SC connector until an audible click sound is heard.

NOTE: Correct orientation is achieved by aligning the dog eared corners of the housing with the dog eared corners of the SC connector (see figure 5B3-10).

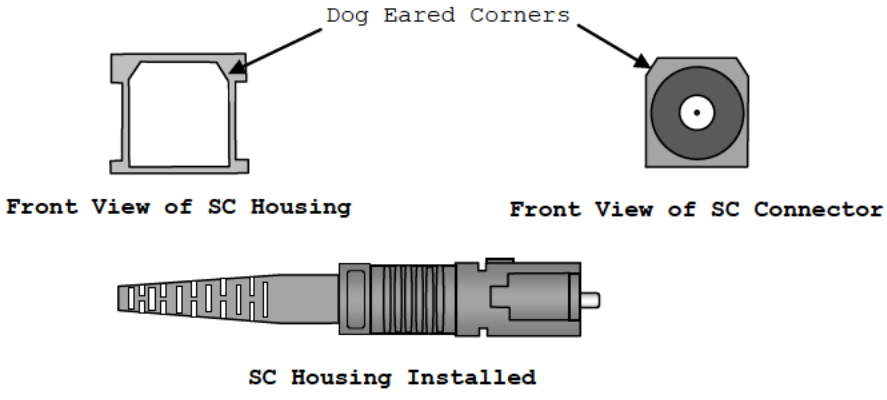

FIGURE 5B3-10. Installing the SC housing over the SC connector.

METHOD 5C1
MECHANICAL SPLICE FERRULE INSTALLATION

This method is obsolete for new design. The method details can be found in MIL-STD-2042B.

METHOD 5C2
FUSION SPLICING

1. SCOPE

1.1 Scope. This method describes a procedure for the fusion splicing of two optical fibers with a fusion splicer in accordance with A-A-59799. The resultant splice will be in accordance with MIL-PRF-24623/6, with 250, 500, or 900 micron protective jacket (buffered fiber).

2. DOCUMENTS APPLICABLE TO METHOD 5C2

2.1 General. The documents listed in this section are specified in Method 5C2 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5C2 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

COMMERCIAL ITEM DESCRIPTIONS

A-A-59799 - Fusion Splicer and Cleaver, Optical Fiber

DEPARTMENT OF DEFENSE STANDARDS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24623/6 - Splice, Fusion, Fiber Optic Protector

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5C2-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5C2-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0078	Strip tool, OFCC	1
TL-0071	Safety glasses	1
TL-0069	Scale, 15.24 cm (6 inches)	1
TL-0079	Strip tool, buffer	1
	Fusion splice protectors (MIL-PRF-24623/6)	As required
TL-0137	Fusion splicing kit including high precision cleaver (A-A-59799)	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers.

b. Do not touch the ends of bare fiber. Wash hands thoroughly after handling bare fibers.

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

d. Observe warnings and cautions on equipment and materials.

4.2. Procedure.

4.2.1. Fusion splicer preparation. The following steps shall be performed:

Step 1. Turn the splicer on.

CAUTION: Throughout the fabrication process, cleanliness is critical to obtaining a high quality optical connection. Make sure that your hands and the work area are as clean as possible to minimize the ingress of dirt into the splices.

NOTE: To mitigate dirt ingress, keep the cover of the splicer closed whenever not loading or unloading fibers or removing completed splices.

Step 2. Select the splicing program and parameters that are needed to splice the fibers being used. Refer to the manufacturer's operational manual, applicable to the fusion splicer being used, for additional guidance.

NOTE: Step 3 may be splicer manufacturer specific. Refer to the manufacturer's operational manual for exact operation and setup.

NOTE: If an additional visual inspection of the splice is desired during the splicing process, refer to the manufacturer's operational manual in order to activate arc pause features.

Step 3. Perform an arc test using same cable type to be spliced.

NOTE: Arc check/calibration/test should be performed each day prior to initial use of the machine, when high splice losses are observed, or when moving the fusion splicer location. Refer to the manufacturer's operational manual, applicable to the fusion splicer being used, for additional guidance. Arc power, arc duration, and arc center are adjusted based on environmental conditions, the type of fiber being spliced, and electrode wear.

NOTE: Arc test may be performed using approximately 1 foot of the same fiber type as being spliced. Typically a piece of fiber waste trimmed from a section to be spliced is used. Follow the same fiber preparation as identified in steps 3 through 5 of 4.2.2 of this method. Perform arc test instead of complete fusing.

4.2.2 Fiber preparation. The following steps shall be performed:

Step 1. Choose a fiber out of set "A" to be spliced.

Step 2. Slip the heat shrink splice protector over the fiber (250, 500, or 900 micron buffered fiber) (see figure 5C2-1).

NOTE: The splice protector can be placed on either set "A" or set "B".

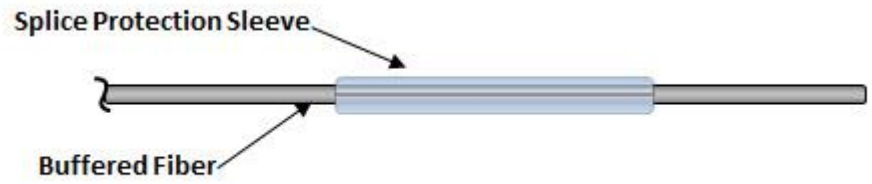

FIGURE 5C2-1. Splice protector installation.

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

Step 3. Strip (remove) approximately 30 millimeters (1.2 inches) of the buffer from the end of the fiber using the buffer strip tool. Remove the buffer and coating in small sections approximately 6.35 millimeters (0.25 inch) at a time. Strip the fiber down to the bare glass (see figure 5C2-2).

CAUTION: The uncoated fiber is in its most vulnerable state. Take extreme care to not damage the fiber.

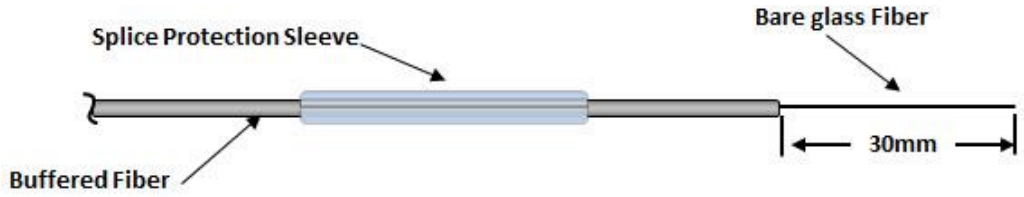

FIGURE 5C2-2. Fiber stripping.

Step 4. Clean the bare fiber with a lint-free gauze pad moistened with pure alcohol and wipe 1 to 2 times to remove any coating residue.

NOTE: Do not repeatedly wipe the bare fiber, as this will weaken the fiber.

Step 5. Use the precision cleaving tool provided with the fusion splicer to cleave the fiber. The maximum cleave length is 12 millimeters (0.472 inch). For recommended cleaving procedures, refer to the manufacturer's operational manual. Deposit the waste fiber in a fiber scrap container or on a piece of electrical tape if not collected by the cleaving tool.

NOTE: Do not let the end face of the bare fiber come into contact with any surface.

NOTE: Do not clean or touch the bare fiber after it has been cleaved.

Step 6. Insert the optical fiber into the splicer in accordance with the insertion procedure of the splicer. Refer to the manufacturer's operational manual for additional guidance.

NOTE: Ensure that, during the insertion process, the end face of the fiber does not contact any surfaces. Avoid plowing or pushing the fiber end face through the V-groove of the splicer.

NOTE: If an additional visual inspection of the splice is desired during the splicing process, refer to the manufacturer's operational manual in order to activate arc pause features.

Step 7. Repeat steps 2 through 6 with set "B" fiber of same splice.

4.2.3 Fusion splicing. The following steps shall be performed:

Step 1. Following the specific manufacturer's splice procedure, splice the two fibers together.

NOTE: If the fibers fail inspection for cleave criteria (maximum 12 millimeters [0.472 inch]), repeat steps 3 through 5 of 4.2.2 of this method.

Step 2. Before removing the splice from fusion splicer, inspect the completed splice to ensure that there are no physical flaws (bubbles, cracks, dark lines, or other splice defects) as seen on the LCD screen. A small or faint white vertical line at the splice joint, perpendicular to the fiber, is permitted. If physical flaws are observed, break the splice and repeat steps 2 through 6 of 4.2.2 of this method.

NOTE: Ensure that the estimated loss from the LCD screen of the splicer is less than 0.03 decibels (dB). Note that the final criteria (insertion loss) over a fusion spliced fiber is 0.2 decibels (dB).

Step 3. After the splice has been successfully completed, perform a tension test in accordance with the fusion splicer operational manual.

NOTE: Tension test is performed by the splicer unit.

Step 4. Slide the heat shrink splice protector close to the splice area and, in accordance with the fusion splicer operational manual, remove the splice from the fusion splicer, ensuring not to damage the exposed glass.

NOTE: Maintain slight tension on the splice to ensure the spliced region is not bent or bowed.

Step 5. Slide the heat shrink splice protector over the spliced region and center. Insert the splice and splice protector in the heater attached to the splicer. Activate the heater assembly and shrink the sleeve down (see operational manual of heater).

NOTE: Ensure splice protector is properly centered on the splice region by utilizing the splice protector gauge on the splicer unit (see splicer operational manual for this feature).

Step 6. Visually inspect the splice protector after the shrinking process is complete to ensure that the entire length of the splice protector has shrunk and there are no bubbles or other detrimental defects (see figure 5C2-3).

NOTE: The heater cycle in step 5 may be repeated if the splice protector was not completely shrunk on the first attempt.

NOTE: Additional fibers can be spliced before placing in the splice tray.

NOTE: Allow splice protector to cool before inserting splice into splice holder. Splice protectors may be damaged or deformed if inserted into the splice holder while still hot.

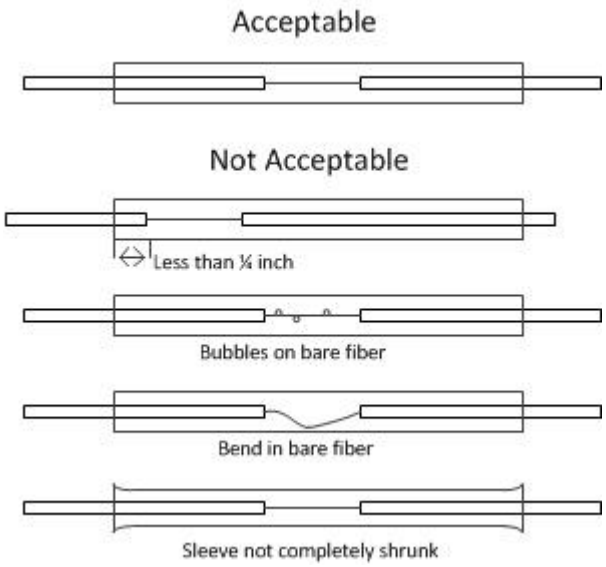

Figure 5C2-3. Acceptable and non-acceptable splice sleeve conditions.

Step 7. Repeat steps 1 through 6 for each additional fiber pair (set “A” and set “B”) to be spliced.

Step 8. Return to MIL-STD-2042-2, Methods 2K1 (7-inch splice trays) or 2K2 (10-inch splice trays) to complete fusion splice tray installation.

METHOD 5D1
TERMINI INSTALLATION FOR M29504/14, M29504/15, M29504/18, M29504/20 PC POLISH

1. SCOPE

1.1 Scope. This method describes a procedure for inserting fiber, polishing, and inspection of M29504/14, M29504/15, M29504/18, and M29504/20 termini. The polishing in this method is a PC polish.

2. DOCUMENTS APPLICABLE TO METHOD 5D1

2.1 General. The documents listed in this section are specified in Method 5D1 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5D1 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1678-5	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements) (Part 5 of 6 Parts)
MIL-STD-1678-6	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 6: Parts and Support Equipment Commonality and Standardization Requirements, Cable Harness Configurations) (Part 6 of 6 Parts)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24792	-	Adhesive, Epoxy, Two Part, Fiber Optics
MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29504/14	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Pin Terminus, Front Release Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/15	-	Termini, Fiber Optic, Connector, Removable, Environment Resisting, Socket Terminus, Front Release, Ceramic Ferrule, (for MIL-C-28876 Connectors)
MIL-PRF-29504/18	-	Termini, Fiber Optic, Non-Keyed, Connector, Removable, Environment Resisting, Genderless Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-PRF-29504/20	-	Termini, Fiber Optic, Keyed, Connector, Removable, Environment Resisting, Genderless Terminus, Rear Insert/Rear Release, 1.25 MM Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-DTL-83522	-	Connectors, Fiber Optic, Single Terminus, General Specification for

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5D1-I shall be used to perform these procedures. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5D1-I. Equipment and materials.

Reference #	Description	Quantity
TL-0013	Canned air	As required
TL-0012	Cable jacket stripping tool	1
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0045	Aramid yarn cutting shears	1
TL-0078	Strip tool, OFCC	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
	125 micron cleaning wire	As required
	Epoxy (MIL-PRF-24792)	As required
	3-mm syringe with 20 gauge dispensing needles	As required
TL-0069	Scale, 15.24 cm (6 inches)	1
	Razor blade	1
TL-0028	Curing oven assembly IAW MIL-PRF-29504 and MIL-DTL-83522. Includes cable stand, cable stand ring, cable clips, cure adapters.	1
TL-0014	Cleaver	1
TL-0058	Polishing paper (5 um aluminum oxide, foam backed)	As required
TL-0064	Polishing tool ceramic termini	1
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0062	Glass polishing plate	1
TL-0033	7× eye loupe	1
TL-0057	Polishing paper (1 um aluminum oxide, Mylar backed)	As required
TL-0097	Water bottle, 4 oz squeeze with cap	1
TS-0007	Optical microscope, 400×	1
TL-0060	Polishing paper (0.1 um diamond, mylar backed)	As required
TL-0067	Resilient pad, 70 to 90 durometer, 127 × 127 mm (5.5 × 5.5 inches), minimum	1
TL-0121	1.25-mm ferrule size polishing tool (for M29504/18 and /20)	1
TL-0061	Polishing paper (ultrafine, mylar backed)	As required
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2 Installation of the termini onto the fibers. The following steps shall be performed:

NOTE: This procedure describes the process for installing ceramic termini onto either multimode or single mode fibers. The termini use epoxy to secure the fiber and a crimp sleeve to capture the aramid yarn strength members of the OFCCs.

Step 1. Turn on the curing oven so that it attains the proper temperature before the termini are placed within it (approximately 30 minutes).

Step 2. Inspect the terminus and verify that the ferrule hole is free and clear of dirt. This can be accomplished by holding the front of the terminus up to a light and verifying that the light is visible from the rear of the terminus. If light cannot be seen through the terminus, push clean cleaning wire through the terminus hole to clear it. Then blow dry air through the hole to remove any debris.

Step 3. Remove the divider from a two-part epoxy package and mix the two parts together until the epoxy is a smooth uniform color (see figure 5D1-1). The epoxy can be mixed by either repeatedly rolling or gently sliding the divider over the package.

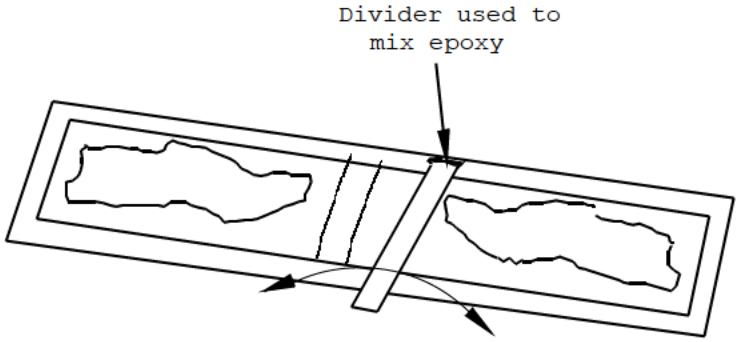

FIGURE 5D1-1. Mixing the epoxy.

NOTE: Alternatively, the epoxy may be mixed by massaging the epoxy package by hand.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

Step 4. Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

Step 5. Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

WARNING: Wear safety glasses while dispensing the epoxy to avoid possible eye injury.

Step 6. Slide the terminus, rear first, onto the syringe tip (see figure 5D1-2). Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the terminus until it escapes out of the ferrule, forming a very small bead. Do not overfill.

NOTE: Be extremely careful not to get epoxy on the pin spring or other terminus moving parts.

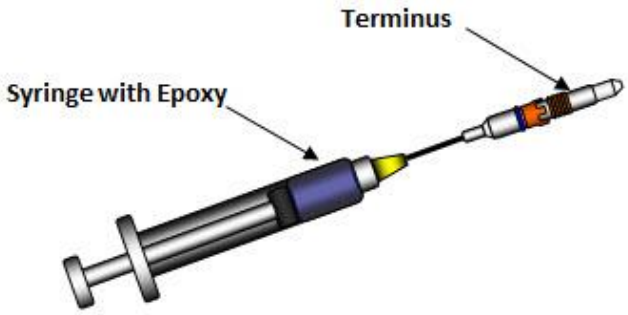

FIGURE 5D1-2. Injecting epoxy into the terminus.

Step 7. Withdraw the syringe from the terminus. Maintain some pressure on the plunger as the syringe is withdrawn so that the terminus is completely filled with epoxy. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of the ferrule without disturbing the epoxy bead. For terminating OFCCs, proceed to step 8; otherwise skip to step 9.

NOTE: Avoid trapping air in the epoxy during syringe tip removal. Keep the syringe tip in the epoxy while filling the remainder of the terminus.

NOTE: Alternatively, when wiping away epoxy on the ferrule, the entire surface of the ferrule may be cleaned including the epoxy bead. However, this will significantly reduce the overall epoxy bead size. Reduced epoxy bead size will increase probability of improper cleaves resulting in fiber damage that may not be addressed through the polishing process and could require complete re-termination. If there is no small bead of epoxy on the ferrule tip it may cause the fiber to crack.

NOTE: Alternatively, the terminus may be completely filled by maintaining a light pressure on the syringe plunger and allowing the epoxy to push the terminus off of the syringe tip.

Step 8. For termination of OFCCs only, feather the aramid yarn evenly around the fiber and insert the fiber into the rear of the terminus (see figure 5D1-3). Gently work the fiber through the terminus until the buffer seats against the rear of the ferrule. (The terminus should be rotated around the fiber as the fiber is inserted.) The OFCC jacket should come up to the rear of the terminus and the aramid yarn should surround the rear of the terminus. Do not allow aramid yarn to enter the rear of the terminus. Once inserted, do not allow the fiber to slip back. Skip to step 10.

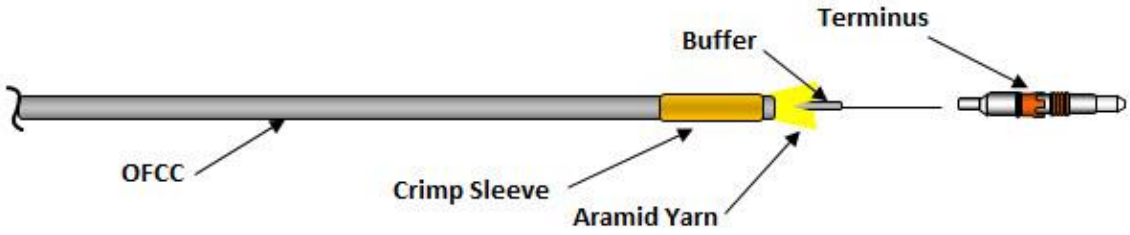

FIGURE 5D1-3. Inserting the fiber into the terminus.

Step 9. For termination of fiber with only a coating/buffer, gently work the fiber through the terminus until the buffer seats against the rear of the ferrule. (The terminus should be rotated around the fiber as the fiber is inserted.) Once inserted, do not allow the fiber to slip back. Skip to step 11.

Step 10. For termination of OFCCs only, slide the crimp sleeve over the aramid yarn and crimp it to the rear of the terminus using the crimp tool. Skip to step 12.

NOTE: A small amount of epoxy may be added on the aramid yarn near the rear of the terminus before the crimp sleeve is installed. However, no epoxy should be visible once the crimp sleeve is installed.

NOTE: If small wings are visible on the sides of the crimp sleeve after crimping, rotate the terminus 60 degrees in the crimp tool and crimp the terminus a second time.

Step 11. For termination of fiber with only a coating/buffer, work a small bead of sealant tape around the fiber at the rear of the terminus. Slide the heat shrink tube over sealant tape and the rear of the terminus. Skip to step 13.

Step 12. For termination of OFCCs only, verify that the aramid yarn does not protrude excessively from under the crimp sleeve. Excessive aramid yarn protrusion will cause the terminus to not seat properly in the finished connector. If excessive aramid yarn protrudes from under the crimp sleeve, trim it back using a razor blade.

Step 13. Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule. If it is found that there is no small bead of epoxy on the terminus tip, carefully add a small amount of epoxy around the fiber.

NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause the fiber to crack.

Step 14. Using a wipe dampened with alcohol, carefully wipe away any excess epoxy on the fiber that is more than 2 millimeters (0.1 inch) from the ferrule tip surface.

Step 15. Insert the terminus into the cure adapter until it snaps into place (see figure 5D1-4).

FIGURE 5D1-4. Inserting a terminus into a cure adapter.

Step 16. Repeat steps 2 through 15 for each fiber to be terminated.

Step 17. Place the cure adapters in the curing oven and position the cable vertically over the oven using the cable stand, cable stand ring, and cable clip (see figure 5D1-5). Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120 °C (248 °F). Ensure that the cure adapter and heater block configuration in use allow the connector to be within the heater block with little or no portion of the crimp sleeve exposed above the top surface of the block.

NOTE: When the cable is positioned above the terminus, make sure that no bends are placed in the OFCCs. Each OFCC should enter the terminus parallel to the terminus.

NOTE: To ensure proper epoxy cure, the heater block shall be in the configuration depicted on figure 5D1-5 with the small circular cutout patterns face up.

NOTE: Alternate cure schedules may be used with approval of the NSWCDD (see 6.4).

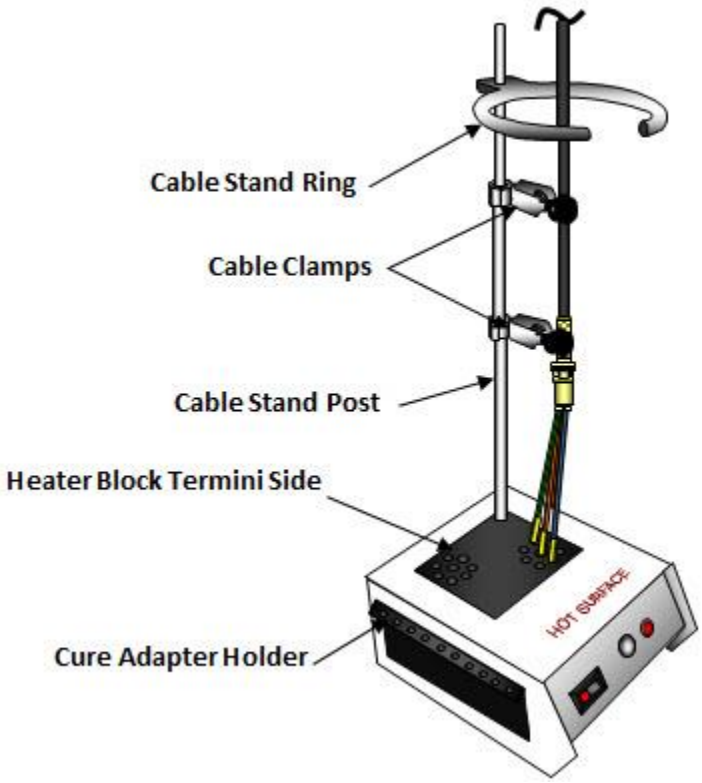

FIGURE 5D1-5. Termini in the curing oven.

Step 18. Turn the curing oven off, remove the cure adapters and termini from the curing oven, and place them on a cure adapter holder block or non-flammable surface. Allow the cure adapters and termini to cool for approximately 4 minutes.

4.3 Polishing the fiber ends.

4.3.1 Domed end polish.

4.3.1.1 Standard procedure. This procedure will produce a terminus with a domed end polish with end face geometry in the range shown in table 5D1-II. This procedure is required for high quality multimode applications and single mode applications with a minimum return loss requirement of 30 decibels (dB).

TABLE 5D1-II. Recommended end face geometry values.

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

Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions shall be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, and 0.1 um diamond mylar backed as used in hand polishing.

NOTE: Alternate polishing materials may be used if approved toMIL-STD-1678-6, Requirement 6403 by NSWCDD (see 6.4) and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.

b. The machine polished connector shall undergo the end face inspection used for the manually polished connector as described herein.

The following steps shall be performed:

NOTE: The procedures contained herein will produce an optical terminus with a PC polish.

WARNING: Wear safety glasses when scoring the fiber to avoid possible eye injury.

Step 1. Clean the glass polishing plate, the resilient pad, the backs of the polishing papers, and the surface of the polishing tool using a wipe dampened with alcohol. Blow all of the surfaces dry with air.

Step 2. Remove the terminus from the cure adapter and score the fiber close to the terminus tip at the epoxy interface using one short light stroke with cleaving tool (see figure 5D1-6). Pull off each fiber with a gentle, straight pull. Deposit the waste fiber in a trash container.

NOTE: Do not break the fibers with the cleaving tool.

NOTE: Termini not being polished should be left in their cure adapters until they are ready for polishing, to protect the fibers from breakage.

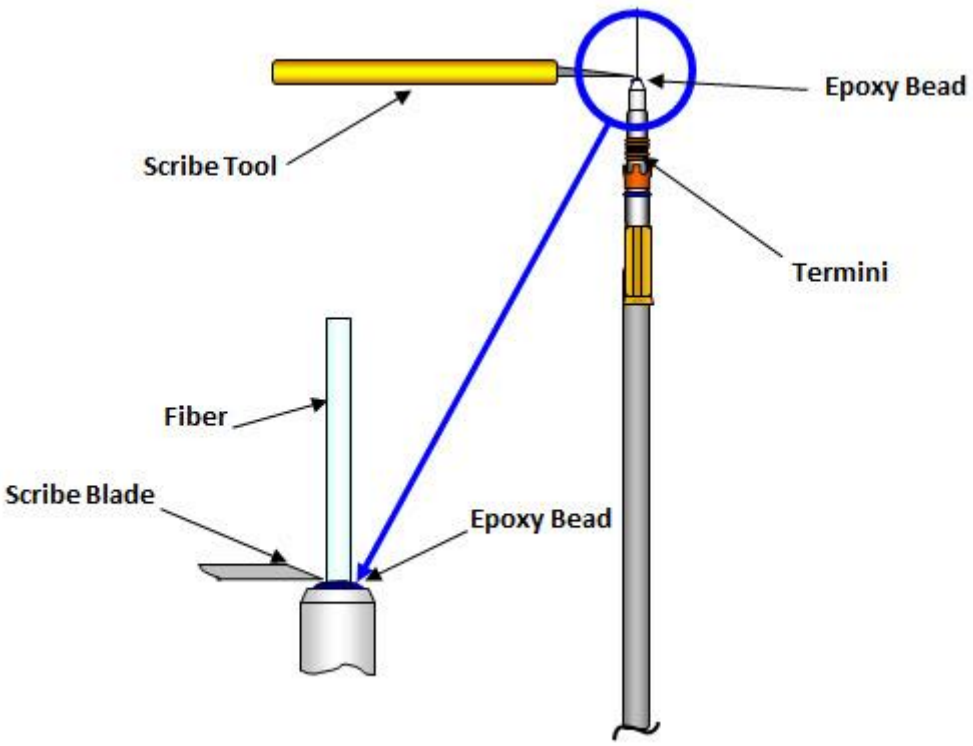

FIGURE 5D1-6. Scoring the fiber.

Step 3. Before inserting the terminus into the polishing tool, hold the terminus vertically and polish the end of the fiber by lightly running the 5 um polishing paper over the top of the terminus tip. (This is referred to as air polishing the terminus.)

Step 4. Rotate the top half of the polishing tool 90 degrees counterclockwise and separate the top from the base.

Step 5. Place the end of the terminus insertion tool at the rear of the crimp sleeve with the OFCC laid in the tool channel (see figure 5D1-7).

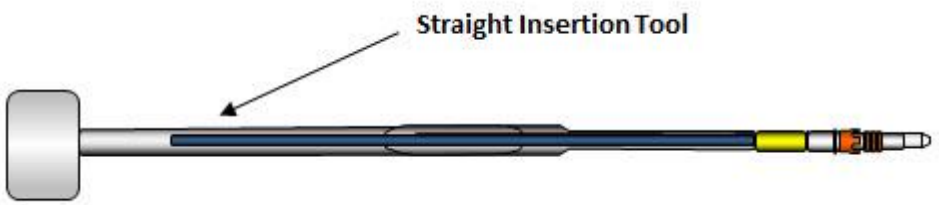

FIGURE 5D1-7. Placing the terminus in the insertion tool.

Step 6.a. For M29504/14 and M29504/15 termini, insert the terminus into the center of the polishing tool top. Apply pressure with the insertion tool until the terminus snaps into place. Remove the tool by pulling straight back (see figure 5D1-8). Proceed to step 7.

NOTE: Difficulty in inserting the terminus into the polishing tool may indicate epoxy on outside of the terminus that must be removed before proceeding.

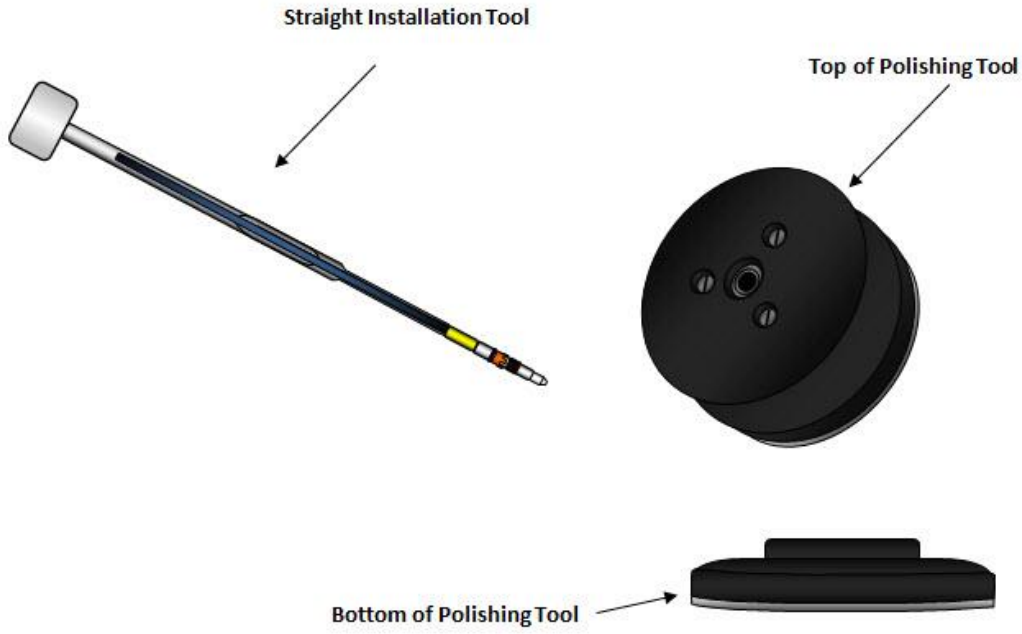

FIGURE 5D1-8. Inserting the terminus into the polishing tool for M29504/14 and M29504/15 termini.

Step 6.b. For M29504/18 and M29504/20 termini, insert the terminus into a standard polishing puck for the 1.25-millimeter (0.0492-inch) ferrule (see figure 5D1-9). Proceed to step 8.

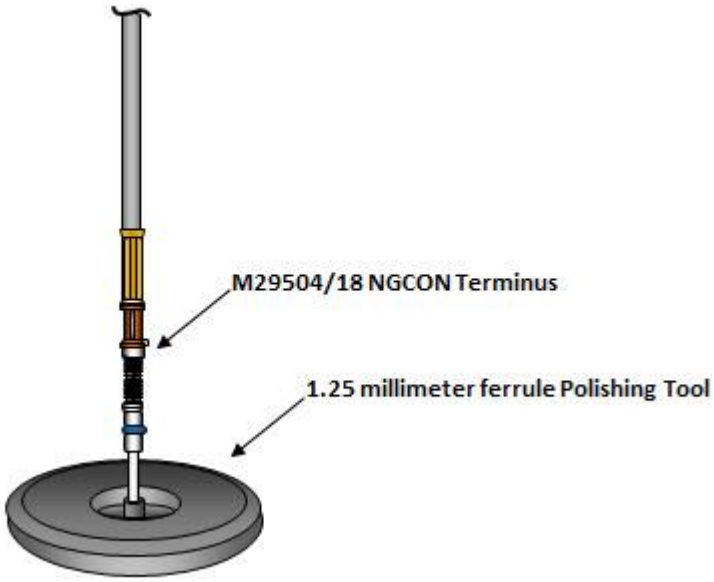

FIGURE 5D1-9. Inserting the terminus into the standard 1.25 millimeter ferrule polishing puck.

Step 7. For M29504/14 and M29504/15 termini, install the top half of the polishing tool on the bottom half and rotate it clockwise (90 degrees) until it locks in place.

Step 8. Place the 5 um polishing paper on the glass plate and begin polishing the terminus with very light pressure (the weight of the tool) using a figure-8 motion. Do not over-polish the terminus.

NOTE: The first polish is complete when all of the epoxy is almost gone from the tip of the terminus.

Since the polishing time varies with the amount of epoxy present on the tip of the terminus, inspect the terminus tip frequently. Whenever the polishing tool is lifted, remove the grit from the tool and the terminus with a wipe dampened with alcohol or with air. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air. Perform a rough inspection of the ferrule end using the eye loupe.

Step 9. Place the resilient pad on top of the glass plate. Place 1 um paper on the resilient pad. Wet the paper and polish the terminus with no pressure using a figure-8 motion for approximately 10 complete motions.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

NOTE: The 1 um polish is complete when all of the epoxy is gone from the tip of the terminus.

NOTE: The 1 um polish may also be performed using dry paper.

Step 10. Replace the 1 um paper with the 0.1 um paper. Wet the paper and polish the terminus with no pressure using a figure-8 motion for approximately 20 to 30 complete motions.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 11.a. For M29504/14 and M29504/15 termini, rotate the top of the polishing tool counterclockwise (90 degrees) and separate the top from the base. Insert the terminus removal tool into the bottom of the terminus cavity of the polishing tool top and press on the hilt of the removal tool until the tool clicks into place (see figure 5D1-10). Depress the plunger and slide the terminus out of the polishing tool. Proceed to step 12.

NOTE: Make sure that the removal tool is clean before inserting the tool into the terminus cavity.

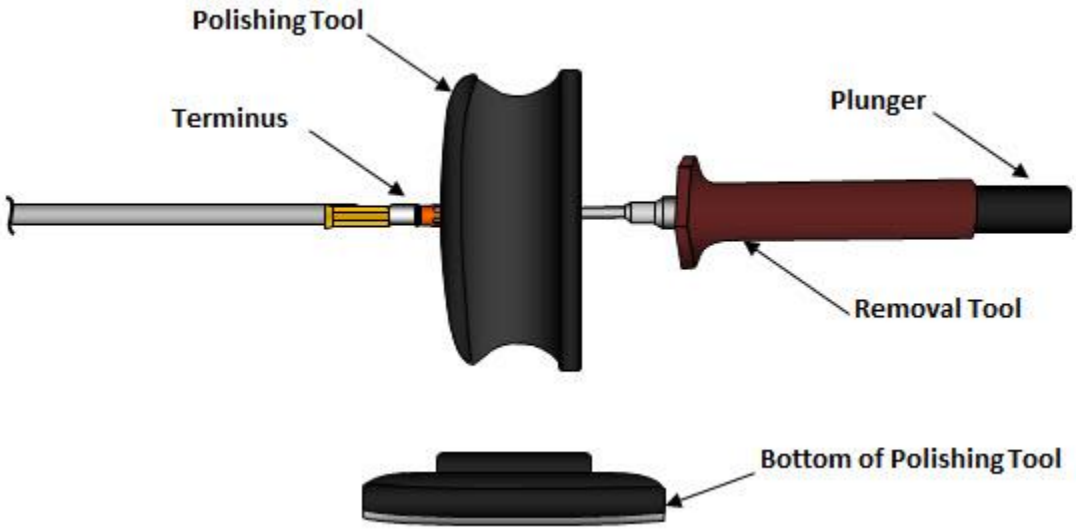

FIGURE 5D1-10. Removing the terminus from the polishing tool.

Step 11.b. For M29504/18 and M29504/20 termini, remove the terminus from the polishing tool.

Step 12. Clean the terminus and the polishing tool with a wipe dampened with alcohol and blow them dry with air.

Step 13. Repeat steps 1 through 12 for all of the termini.

4.3.1.2 Enhanced procedure. This procedure will produce a terminus with a domed end polish. This procedure is required for single mode applications with a minimum return loss requirement of 40 decibels (dB). This procedure is recommended for applications where end face geometry requirements are in the range shown in table 5D1-II. Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions shall be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, 0.1 um diamond mylar backed, and ultrafine mylar backed as used in hand polishing.

NOTE: Alternate polishing materials may be used if approved to MIL-STD-1678-6, Requirement 6403 by NSWCDD (see 6.4) and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.

b. The machine polished terminus shall undergo the same end face inspection used for the manually polished terminus as described herein.

The following steps shall be performed:

NOTE: The procedures contained herein will produce an optical terminus with a (PC) polish.

Step 1. Perform steps 1 through 10 of the standard polish procedure (see 4.3.1.1 of this method).

Step 2. Replace the 0.1 um paper with the ultrafine paper. Wet the paper and polish the terminus with light pressure using a figure-8 motion for 10 to 30 complete motions.

NOTE: The glossy side of the ultrafine paper should be placed facing the resilient pad.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 3. Perform steps 11 and 12 of the standard polish procedure (4.3.1.1 of this method).

Step 4. Repeat steps 1 through 3 for all of the termini.

4.4 End face inspection. The following step shall be performed:

Step 1. Perform end face inspection using either the microscope procedure in 4.4.1 of this method or the fiber optic video inspection system (FOVIS) procedure in 4.4.2 of this method

NOTE: Use of the FOVIS procedure for post termination inspection is only permitted if the FOVIS meets the requirements of MIL-STD-1678-5, Measurement 5203.

4.4.1 End face inspection using 400× microscope. The following steps shall be performed:

Step 1. Examine the terminus with the optical microscope to ensure that the optical surface is smooth and free of scratches, pits, chips, and cracks (see figure 5D1-11). If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish termini) or re-terminate the fiber. A high intensity back light may be used to illuminate the fiber during the end face inspection.

NOTE: Do not polish the terminus more than necessary to pass the end face inspection.

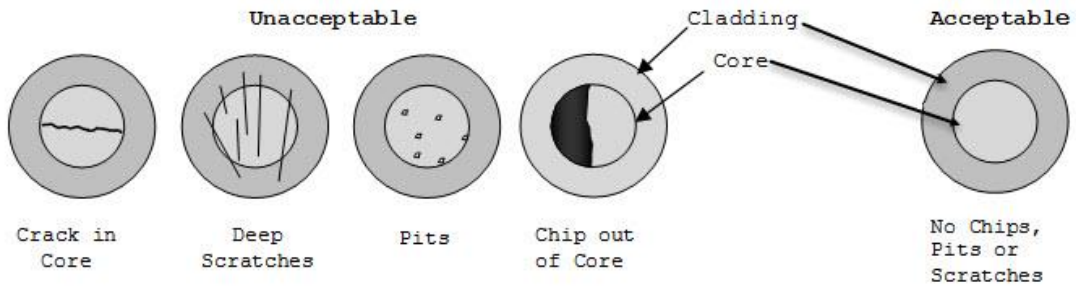

FIGURE 5D1-11. End face inspection criteria.

NOTE: Depending on the optical microscope used, viewing quality may differ.

NOTE: A small number of very light scratches are acceptable in the contact area of the ferrule, outside of the core, and cladding area (see figure 5D1-12).

Step 2. If the terminus is not to be immediately mated into an adapter, install a plastic protective cap over the connector ferrule.

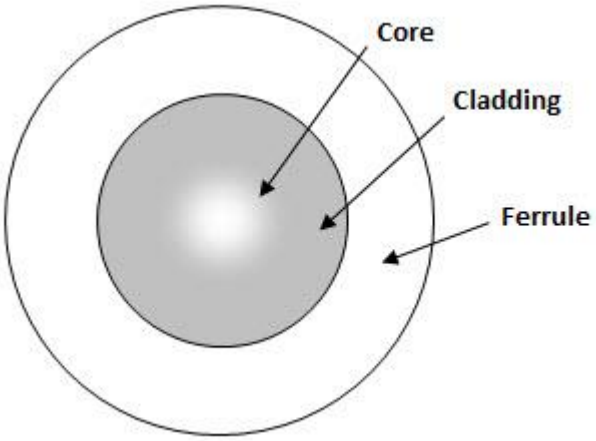

FIGURE 5D1-12. Depiction of ferrule contact area.

4.4.2 End face inspection with approved FOVIS. The following steps shall be performed:

Step 1. Examine the terminus end face with a FOVIS that has been approved for shipboard use by NSWCDD (see 6.4) in accordance with the inspection requirements of MIL-STD-1678-5, Measurement 5203.

Step 2. Apply the inspection criteria located in MIL-STD-1678-5, Measurement 5202 to determine if the connector passes inspection.

Step 3. If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish connectors) or re-terminate the fiber.

Step 4. If the terminus is not to be immediately mated into an adapter, install a plastic protective cap over the terminus ferrule.

METHOD 5D2
TERMINI TERMINATION FOR M29504/20 APC POLISH

1. SCOPE

1.1 Scope. This termination method describes a procedure for placing an M29504/20 terminus onto OFCCs with APC polish.

2. DOCUMENTS APPLICABLE TO METHOD 5D2

2.1 General. The documents listed in this section are specified in Method 5D2 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5D2 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-24792	-	Adhesive, Epoxy, Two Part, Fiber Optics
MIL-PRF-29504	-	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-29504/20	-	Termini, Fiber Optic, Keyed, Connector, Removable, Environment Resisting, Genderless Terminus, Rear Insert/Rear Release, 1.25 mm Ceramic Ferrule, (for MIL-PRF-64266 Connectors)
MIL-DTL-83522	-	Connectors, Fiber Optic, Single Terminus, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1678-6	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 6: Parts and Support Equipment Commonality and Standardization Requirements, Cable Harness Configurations) (Part 6 of 6 Parts)

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

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5D2-I shall be used to perform these procedures. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5D2-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0013	Canned air	As required
TL-0012	Cable jacket stripping tool	1
	Masking tape	As required
TL-0045	Aramid yarn cutting shears	1
TL-0078	Strip tool, OFCC	1
TL-0071	Safety glasses	1
TL-0079	Strip tool, buffer	1
	Cleaning wire	As required
	Epoxy (MIL-PRF-24792)	As required
	3-mm syringe with 20 gauge dispensing needles	As required
TL-0017	Crimp tool	1
	Razor blade	1
TL-0028	Curing oven assembly for MIL-PRF-29504, MIL-DTL-83522. Includes cable stand, cable stand ring, cable clips, and cure adapters.	1
TL-0014	Cleaver	1
TL-0033	7× eye loupe	1
TL-0135	Polishing paper (1 um diamond, Mylar backed)	As required
TL-0062	Glass polishing plate	1
TL-0136	Resilient pad, 90 durometer, 127 x 127 mm (5.5 x 5.5 inches), minimum	1
TL-0061	Polishing paper (ultrafine, Mylar backed)	As required
TL-0060	Polishing paper (0.1 um diamond, Mylar backed)	As required
TL-0058	Polishing paper (5 um aluminum oxide, foam backed)	As required
TL-0131	APC polishing tool	1
TS-0007	Optical microscope, 400×	1
	Optical microscope, 400× 1.25-mm adapter (FMA-LC, or equal [see 4.8])	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2. Installation of the termini onto the fibers. The following steps shall be performed:

NOTE: Do not polish the terminus more than necessary to pass the end face inspection.

Step 1. Turn on the curing oven so that it attains the proper temperature before the termini are placed within it (approximately 30 minutes).

Step 2. Inspect the terminus and verify that the ferrule hole is free and clear of dirt. This can be accomplished by holding the front of the terminus up to a light and verifying that the light is visible from the rear of the terminus. If light cannot be seen through the terminus, push clean cleaning wire through the terminus hole to clear it. Then blow dry air through the hole to remove any debris.

Step 3. Remove the divider from a two-part epoxy package and mix the two parts together until the epoxy is a smooth uniform color. The epoxy can be mixed by either repeatedly rolling or gently sliding the divider over the package (see figure 5D2-1).

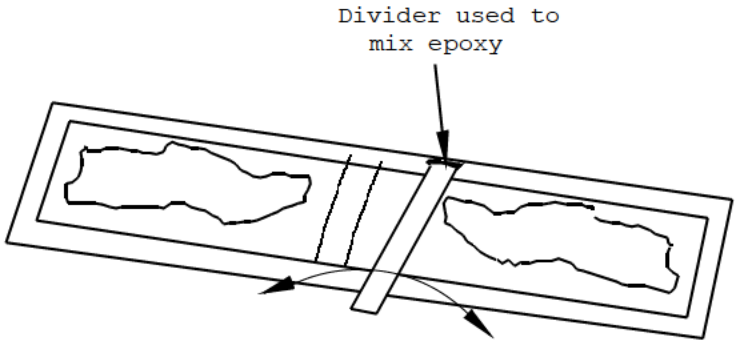

FIGURE 5D2-1. Mixing the epoxy.

CAUTION: Do not introduce large air bubbles into the epoxy during the mixing process. Large air bubbles in the epoxy can lead to connector failure during temperature extremes.

Step 4. Install the syringe tip on the syringe, remove the plunger, and squeeze the epoxy into the syringe. Replace the plunger.

NOTE: Remove air pockets in the syringe by holding the tip of the syringe upward and dispensing epoxy onto a wipe until it runs free and clear.

Step 5. Slide the terminus, rear first, onto the syringe tips (see figure 5D2-2). Keeping the syringe vertical, depress the plunger and slowly inject epoxy into the terminus until it escapes out of the ferrule, forming a very small bead.

NOTE: Do not overfill. Be extremely careful not to get epoxy on the pin spring or other terminus moving parts.

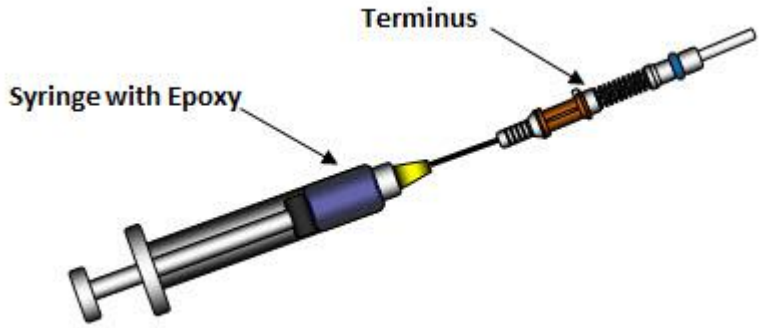

FIGURE 5D2-2. Injecting epoxy into the terminus.

Step 6. Withdraw the syringe from the terminus. Maintain some pressure on the plunger as the syringe is withdrawn so that the terminus is completely filled with epoxy. Using a wipe dampened with alcohol, wipe away any epoxy on the outer diameter of ferrule without disturbing the epoxy bead.

NOTE: Alternatively, the terminus may be completely filled by maintaining a light pressure on the syringe plunger and allowing the epoxy to push the terminus off of the syringe tip.

Step 7. Feather the aramid yarn evenly around the fiber and insert the fiber into the rear of the terminus (see figure 5D2-3). Gently work the fiber through the terminus until the buffer seats against the rear of the ferrule. (The terminus should be rotated around the fiber as the fiber is inserted.) The OFCC jacket should come up to the rear of the terminus and the aramid yarn should surround the rear of the terminus. Do not allow aramid yarn to enter the rear of the terminus. Once inserted, do not allow the fiber to slip back.

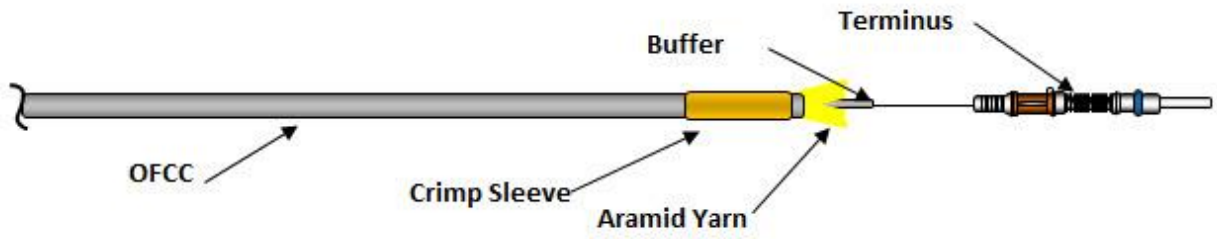

FIGURE 5D2-3. Inserting the fiber into the terminus.

Step 8. Slide the crimp sleeve over the aramid yarn and crimp it to the rear of the terminus using the crimp tool.

NOTE: If small wings are visible on the sides of the crimp sleeve after crimping, rotate the terminus 60 degrees in the crimp tool and crimp the terminus a second time.

Step 9. Verify that the aramid yarn does not protrude excessively from under the crimp sleeve. Excessive aramid yarn protrusion will cause the terminus to not seat properly in the finished connector. If excessive aramid yarn protrudes from under the crimp sleeve, trim it back using a razor blade.

Step 10. Verify that there is a small amount of epoxy around the fiber where it protrudes from the ferrule (for best results). If it is found that there is no small bead of epoxy on the terminus tip, carefully add a small amount of epoxy around the fiber.

NOTE: There should only be a small amount of epoxy around the fiber to support it later during the polishing process. If too much epoxy is around the fiber during the curing process, it may cause the fiber to crack.

Step 11. Using a wipe dampened with alcohol, carefully wipe away any excess epoxy on the fiber that is more than 2 millimeters (0.1 inch) from the ferrule tip surface.

Step 12. Insert the terminus into the cure adapter until it snaps into place (see figure 5D2-4).

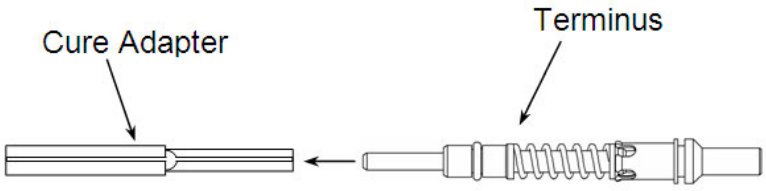

FIGURE 5D2-4. Inserting the terminus into the cure adapter.

Step 13. Repeat steps 2 through 12 for each fiber to be terminated.

Step 14. Place the cure adapters in the curing oven, and position the cable vertically over the oven using the cable stand, cable stand ring, and cable clip (see figure 5D2-5). Cure the epoxy for a minimum of 15 minutes (maximum of 30 minutes) at 120 °C (248 °F). Ensure that the cure adapter and heater block configuration in use allows the termini to be within the heater block with little or no portion of the crimp sleeve exposed above the top surface of the block.

NOTE: Alternate cure schedules may be used with approval of NSWCDD (see 6.4).

NOTE: When the cable is positioned above the terminus, make sure that no bends are placed in the OFCCs. Each OFCC should enter the terminus parallel to the terminus.

NOTE: Curing time begins when the last cure adapter has been placed in the curing oven.

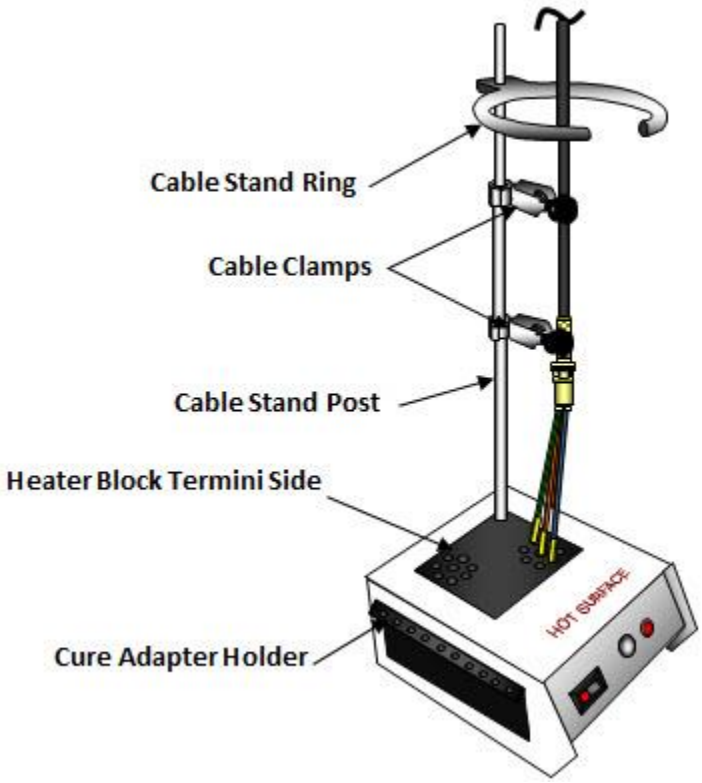

FIGURE 5D2-5. Termini in the curing oven.

Step 15. Turn the curing oven off and remove the cure adapters and termini from the curing oven. Allow the cure adapters and termini to cool for approximately 4 minutes.

4.3 Polishing the fiber ends.

4.3.1 APC polish. This procedure will produce a terminus with an 8-degree angled end polish (see figure 5D2-6). This procedure is applicable for single mode applications with a minimum return loss requirement of 60 decibels (dB). Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions shall be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um diamond mylar backed, and 0.1 um diamond mylar backed, as used in hand polishing.

NOTE: Alternate polishing materials may be used if approved to MIL-STD-1678-6, Requirement 6403, by NSWCDD (see 6.4) and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.

b. The machine polished connector shall undergo the same end face inspection used for the manually polished connector as described herein.

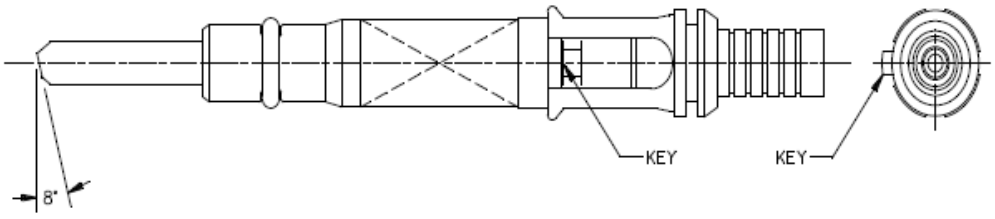

FIGURE 5D2-6. M29504/20 keyed terminus with APC polish.

The following steps shall be performed:

Step 1. Remove the terminus from the cure adapter and score (cleave) the fiber close to the terminus tip at the epoxy interface using one short, light strike with a cleaving tool (see figure 5D2-7). Pull off each fiber with a gentle, straight pull. Deposit the waste fiber in a fiber scrap container or on a piece of electrical tape.

NOTE: Do not break the fibers with the cleaving tool.

NOTE: Inspect the spring on the terminus after scoring and prior to polishing to ensure spring movement. If full spring movement is not evident, the terminus must be removed and replaced.

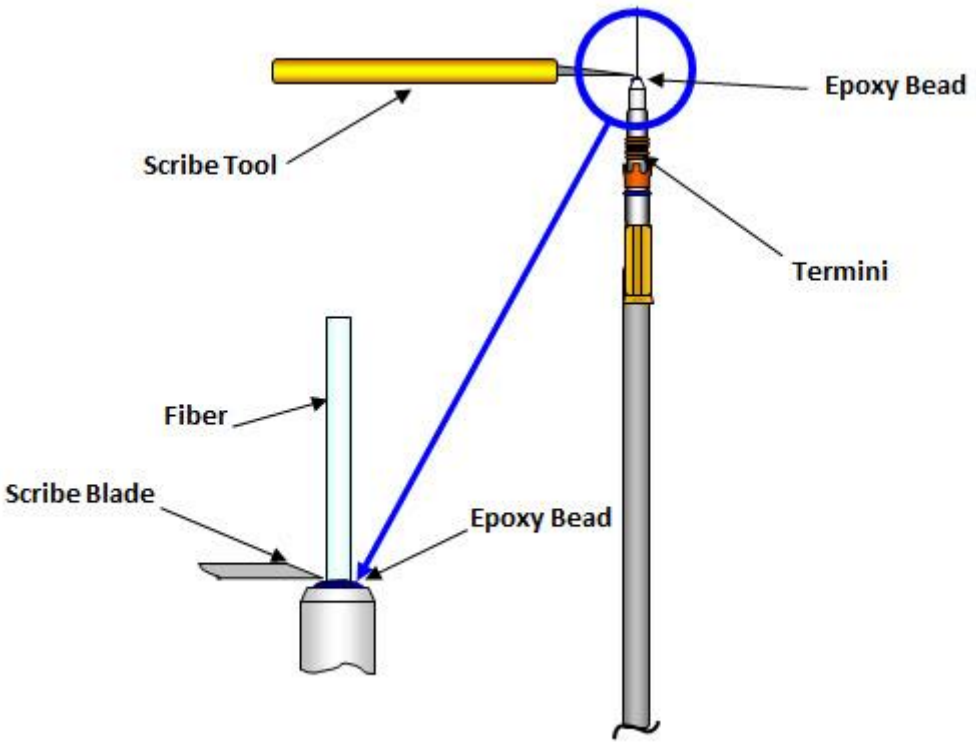

FIGURE 5D2-7. Scoring the fiber.

Step 2. Hold the terminus vertically and polish off the end of the fiber by lightly running the 5 um alumina polishing paper over the top of the terminus tip (this is referred to as air polishing the connector). Use only the weight of the polishing paper over the top of the terminus. Polish the terminus tip using a circular motion until there is little to no epoxy left on the tip of the ferrule.

Step 3. Clean the glass polishing plate, resilient pad, the backs of polishing papers, and the surface of the polishing tool using a wipe dampened with alcohol. Blow all of the surfaces dry with air.

NOTE: Difficulty with inserting the connector ferrule into the polishing tool may indicate epoxy on the outside of the ferrule that must be removed before proceeding.

NOTE: Clean the terminus and polishing tool before proceeding to step 4.

Step 4. Insert the terminus into an APC polishing tool (see figures 5D2-8).

NOTE: Ensure that the keyed part of the terminus is aligned with the key insert of the polishing tool.

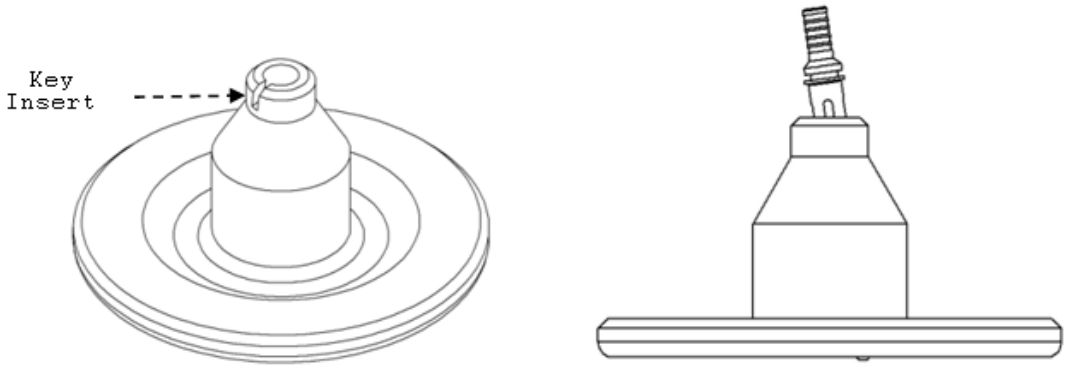

FIGURE 5D2-8. Insertion of terminus into the polishing tool.

Step 5. Place an unused 5 um alumina polishing paper on the glass plate and begin polishing the terminus with medium pressure for a total of 25 wide figure-8 motions. Do not over-polish the terminus. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air.

NOTE: The figure-8s should be approximately 100 millimeters (4 inches) in height. Each half of the figure-8 should appear more circular than elliptical (the figure-8 should be about 50 millimeters [2 inches] wide).

NOTE: Inspect the terminus end face with the 400× inspection scope using the 1.25-millimeter adapter to verify that there is no damage present before proceeding to step 6.

Step 6. Place the resilient pad on top of the glass plate. Place the 1 um diamond polishing paper on top of the resilient pad and polish the terminus with heavy pressure for a total of 50 figure-8 motions. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow them dry with air.

NOTE: Inspect the terminus end face with the 400× inspection scope using the 1.25-millimeter adapter to verify that there is no dirt or residue present before proceeding to step 7.

Step 7. Replace polishing paper with 0.1 um diamond polishing paper. Place the 0.1 um diamond polishing paper on top of the resilient pad and polish the terminus with heavy pressure for a total of 50 figure-8 motions. When polishing is complete, clean the terminus and the polishing tool using a wipe dampened with alcohol and blow then dry with air.

Step 8. Repeat steps 1 through 7 for all termini.

NOTE: Replace the first polishing paper after each use. Replace the second and third polishing papers after every third terminus has been completely polished.

4.4 End face inspection. The following steps shall be performed:

Step 1. Perform end face inspection using either the microscope procedure in 4.4.1 of this method or the FOVIS procedure in 4.4.2 of this method.

NOTE: Use of the FOVIS procedure for post termination inspection is only permitted if the FOVIS meets the requirements of MIL-STD-1678-5, Measurement 5203.

4.4.1 End face inspection with 400× microscope. The following steps shall be performed:

Step 1. Examine the terminus with a 400× inspection scope using the 1.25 millimeter adapter to ensure that the optical surface is smooth and free of scratches, pits, chips, and fractures (see figure 5D2-9). If any defects are present, repeat the polish with the 0.1 um diamond paper by polishing for 10 (±1) figure-8s. Re-terminate the fiber if necessary.

NOTE: Do not polish the terminus more than necessary to pass the end face inspection. Alternatively, a high intensity back light may be used to illuminate the fiber during the end face inspection.

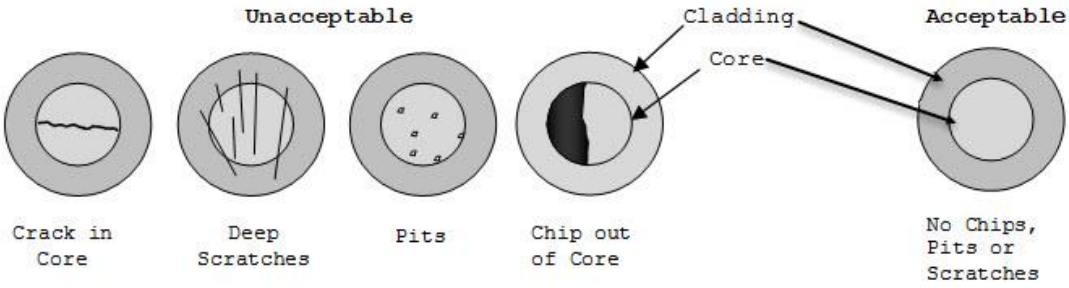

FIGURE 5D2-9. End face inspection criteria.

NOTE: Depending on the optical microscope used, viewing quality may differ.

NOTE: A small number of very light scratches are acceptable in the contact area of the ferrule, outside of the core and cladding area (see figure 5D2-10).

Step 2. If the terminus is not to be immediately mated into an adapter, install a plastic protective cap over the terminus ferrule.

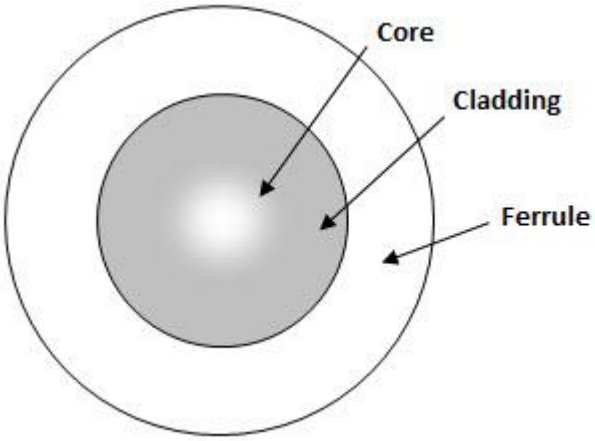

FIGURE 5D2-10. Depiction of ferrule contact area.

4.4.2 End face inspection with approved FOVIS.

Step 1. Examine the terminus end face with a FOVIS that has been approved for shipboard use by the NSWCDD (see 6.4) in accordance with the inspection requirements of MIL-STD-1678-5, Measurement 5203.

Step 2. Apply the inspection criteria located in MIL-STD-1678-5, Measurement 5202 to determine if the connector passes inspection.

Step 3. If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish connectors) or re-terminate the fiber.

Step 4. If the terminus is not to be immediately mated into an adapter, install a plastic protective cap over the terminus ferrule.

METHOD 5D3
SINGLE FERRULE TERMINATION FOR ST, LC, and SC TYPE CONNECTORS

1. SCOPE

1.1 Scope. This method describes a procedure for polishing ST, LC, and SC single terminus (light duty) connectors onto OFCCs.

2. DOCUMENTS APPLICABLE TO METHOD 5D3

2.1 General. The documents listed in this section are specified in Method 5D3 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Method 5D3 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-STD-1678-6	-	Fiber Optic Cabling Systems Requirements and Measurements (Part 6: Parts and Support Equipment Commonality and Standardization Requirements, Cable Harness Configurations) (Part 6 of 6 Parts)

(Copies of this document are available online at http://quicksearch.dla.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIRED EQUIPMENT AND MATERIALS

3.1 Equipment and materials. The equipment and materials in table 5D3-I shall be used to perform this procedure. More detail on approved sources for items with reference numbers can be found on the Dahlgren shipboard fiber optics website (see 6.5). The list on which items appear is indicated by the two-letter prefix as follows:

a. TL = Recommended Tool List

b. TS = Recommended Test Equipment List

TABLE 5D3-I. Equipment and materials.

Reference #	Description	Quantity
TL-0016	Wipes (if not using pre-wetted alcohol pads)	As required
TL-0002 or TL-0044	Isopropyl alcohol, 99% pure anhydrous or alcohol pad, sealed	1
TL-0013	Canned air	As required
TL-0071	Safety glasses	1
TL-0062	Glass polishing plate	1
TL-0058	Polishing paper (5 um aluminum oxide, foam backed)	As required
TL-0063	Polishing tool ST/SC connector	1
TL-0057	Polishing paper (1 um aluminum oxide, Mylar backed)	As required
TL-0060	Polishing paper (0.1 um diamond, Mylar backed)	As required
TL-0067	Resilient Pad, 70 to 90 durometer, 127 × 127 mm (5.5 × 5.5 inches), minimum	1
TL-0061	Polishing paper (ultrafine, Mylar backed)	As required
TL-0121	Polishing tool (puck), LC connector	1
TL-0097	Water bottle, 4 oz squeeze with cap	1
TL-0033	Eye loupe, 7×	1
	Razor blades	As required
TS-0007	Optical microscope, 400×	1
	Dust covers	As required
TL-0014	Cleaver	1
NOTE: Products to be considered for addition to the recommended tool or test equipment lists shall obtain approval as specified (see 6.4).		

4. PROCEDURES

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

a. Wear safety glasses at all times when handling bare fibers or dispensing epoxy.

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

c. Avoid skin contact with epoxies.

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

4.2 Procedure.

4.2.1 Polishing the fiber ends.

4.2.1.1 Domed end polish.

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

NOTE: For ST connectors, this procedure only works for connector ferrules that have been pre-radiused by the connector manufacturer. Some multimode optical fiber connectors may not have pre-radiused ferrules. When implementing this procedure on multimode optical fiber connectors, verify with the connector manufacturer that the connectors have pre-radiused ferrules.

4.2.1.1.1 Standard procedure. This procedure will produce a terminus with a domed end polish with end face geometry in the range shown in table 5D3-II. This procedure is required for high quality multimode applications and single mode applications with a minimum return loss requirement of 30 decibels (dB).

TABLE 5D3-II. Recommended end face geometry values.

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

Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions shall be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, and 0.1 um diamond mylar backed, as used in hand polishing.

NOTE: Alternate polishing materials may be used if approved to MIL-STD-1678-6, Requirement 6403, by the NSWCDD (see 6.4) and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.

b. The machine polished connector shall undergo the same end face inspection used for the manually polished connector as described herein.

NOTE: The procedures contained herein should produce an optical terminus with a PC polish.

The following steps shall be performed:

WARNING: Wear safety glasses when scoring the fiber to avoid possible eye injury.

Step 1. Remove the connector from the cure adapter and score the fiber close to the ferrule tip at the epoxy interface using one short light stroke with cleaving tool (see figure 5D3-1). Pull off the fiber with a gentle, straight pull. Deposit the waste fiber in a fiber scrap container or on a piece of electrical tape.

NOTE: Do not break the fiber with the cleaving tool.

NOTE: Holding the cleaving tool perpendicular to the fiber assures that the fiber will be cleaved above the ferrule end face.

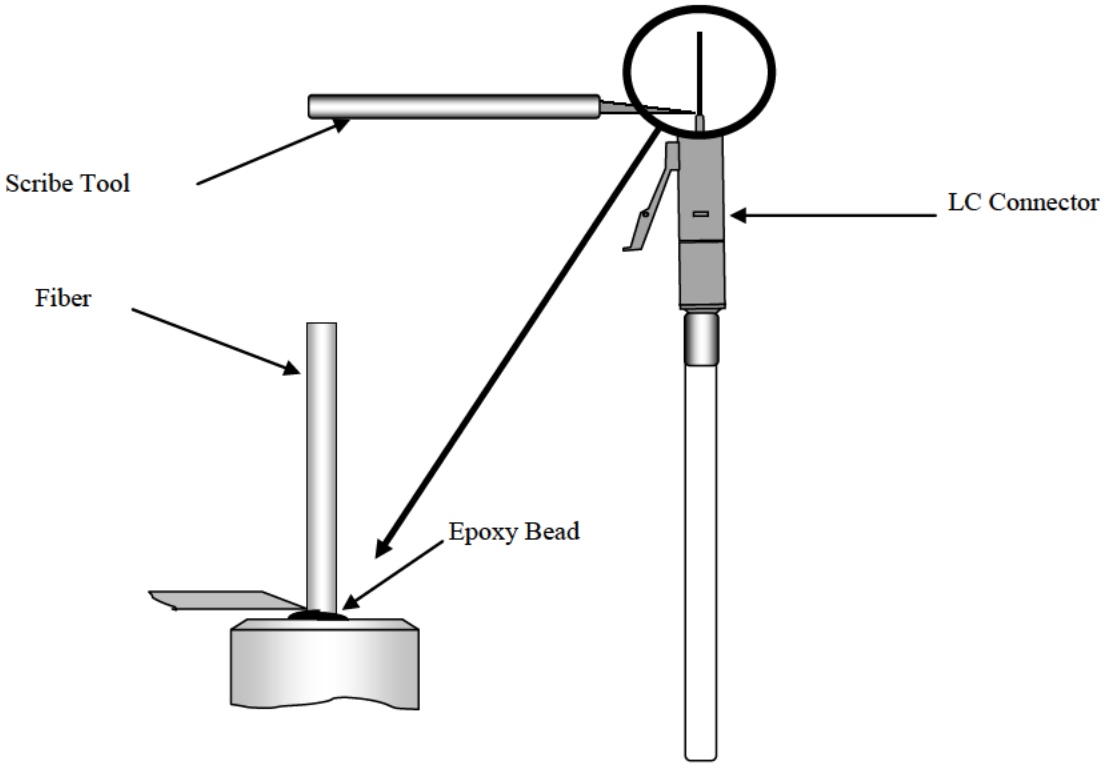

FIGURE 5D3-1. Scoring the fiber (LC connector shown as example).

NOTE: The LC connector may bond to the cure adapter. Use a pair of needle nose pliers to hold behind the housing shoulder of the LC connector and then slowly rotate the cure adapter to break the LC connector free of the cure adapter. Be careful not to break the fiber during this process. Use a razor blade to clean excess epoxy from the side of the ferrule. Afterwards, verify that the LC connector has not been damaged.

Step 2. Before inserting the connector into the polishing tool, hold the connector vertically and lightly run the 5 um polishing paper over the top of the connector tip (this is referred to as air polishing the connector). Use only the weight of the polishing paper on top of the connector. Polish the connector tip using a circular motion. The epoxy bead may be polished until there remains only a small layer on the connector tip (ferrule end face).

Step 3. Clean the glass polishing plate, the resilient pad, the backs of the polishing papers, and the surface of the polishing tool using a wipe dampened with alcohol. Blow all of the surfaces dry with air.

Step 4. Insert the connector into the polishing tool (see figure 5D3-2).

NOTE: Difficulty in inserting the connector ferrule into the polishing tool may indicate epoxy on outside of the ferrule, which must be removed before proceeding.

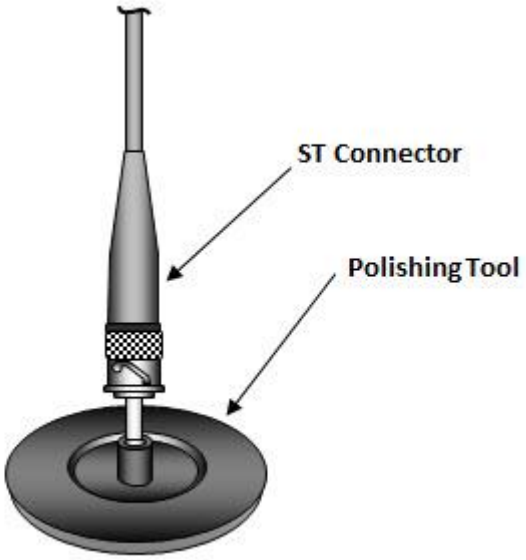

FIGURE 5D3-2. Inserting the connector into the polishing tool (ST shown as example).

Step 5. Place the 5 um polishing paper on the glass plate and begin polishing the connector with very light pressure (the weight of the tool) using a figure-8 motion (see figure 5D3-3). Do not over-polish the connector.

NOTE: The first polish is complete when all of the epoxy is almost gone from the tip of the ferrule.

NOTE: Since the polishing time varies with the amount of epoxy present on the tip of the ferrule, inspect the ferrule tip frequently. Whenever the polishing tool is lifted, remove the grit from the tool and the ferrule using a wipe dampened with alcohol or with air. When polishing is complete, clean the ferrule and the polishing tool using a wipe dampened with alcohol and blow them dry with air. Perform a rough inspection of the ferrule end using the eye loupe.

NOTE: Inspect the spring on a LC connector to ensure spring movement. If full spring movement is not evident, then the LC connector must be removed and replaced. Test after first polish on plate so as not to break the fiber. Place resilient pad on glass plate. Then place ferrule end face on the resilient pad and apply pressure to deflect the spring.

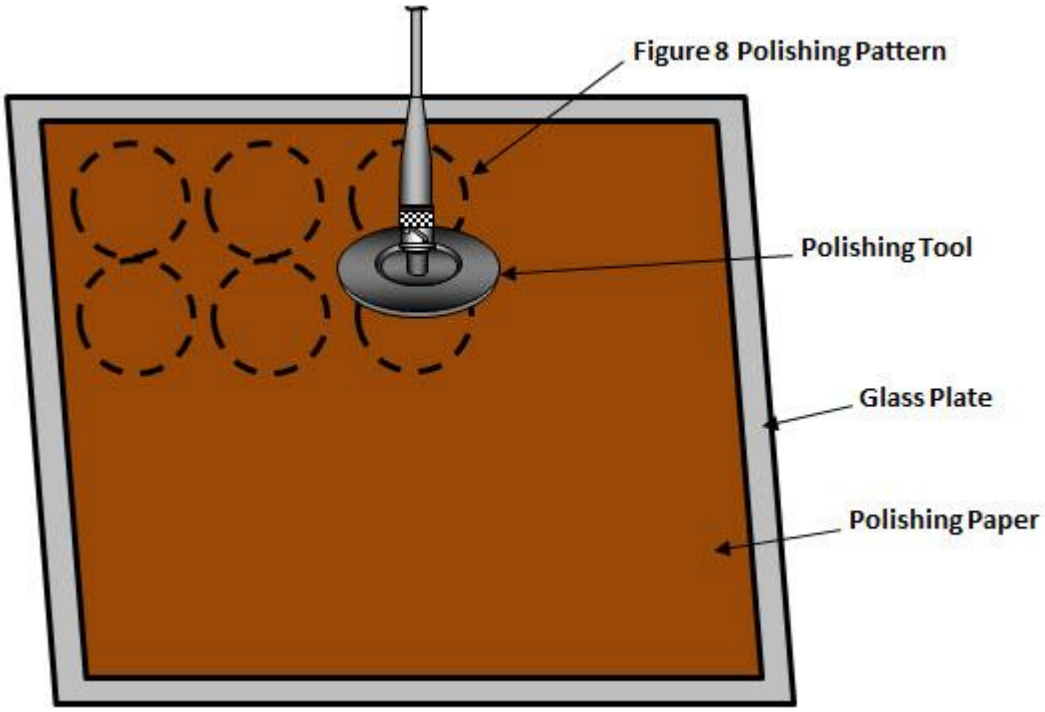

FIGURE 5D3-3. Polishing the connector.

Step 6. Place the resilient pad on the glass plate. Place the 1 um paper on the resilient pad. Wet the paper and polish the connector with no pressure using a figure-8 motion for approximately 10 complete motions for ST and LC type connectors. For SC type connectors, complete approximately 25 figure-8 motions. Do not over-polish.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

NOTE: The 1 um polish is complete when all of the epoxy is gone from the tip of the terminus.

NOTE: The 1 um polish may also be performed using dry paper.

Step 7. Clean the connector and the polishing tool with alcohol and blow them dry with air. Inspect the connector end face with the 400× inspection scope to verify that all of the epoxy has been removed. If additional polishing is necessary, wipe the polishing paper clean and wet the paper again before proceeding with additional polishing. Conduct another 2 to 3 figure-8 motions. Repeat this step until all of the epoxy is gone from the tip of the terminus.

Step 8. Replace the 1 um paper with the 0.1 um paper. Wet the paper and polish the connector with no pressure using a figure-8 motion for approximately 20 to 30 complete motions for ST and LC type connectors. For SC type connectors, complete approximately 45 figure-8 motions.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 9. Remove the connector from the polishing tool, and clean it using a wipe dampened with alcohol and blow it dry with air.

Step 10. Repeat steps 1 through 9 for all remaining connectors.

Step 11. Proceed to 4.2.2 of this method to inspect the end face of the polished connector.

4.2.1.1.2 Enhanced procedure. This procedure will produce a connector with a domed end polish. This procedure is typically used for single-mode applications with a minimum return loss requirement of 40 decibels (dB), or when specified in the contract. This procedure is recommended for applications where end face geometry requirements are in the range shown in table 5D3-II. Procedures for hand polishing are contained herein. Machine polishing may be used as an alternate method, provided the following requirements are satisfied:

a. The manufacturer's instructions will be rigidly adhered to, except that the polishing papers or disks shall be 5 um aluminum oxide foam backed, 1 um aluminum oxide mylar backed, 0.1 um diamond mylar backed, and ultrafine mylar backed as used in hand polishing.

NOTE: Alternate polishing materials may be used if approved to MIL-STD-1678-6, Requirement 6403, by the NSWCDD (see 6.4) and the polishing machine includes the appropriate stops to prevent changes to the ferrule length.

b. The machine polished connector shall undergo the same end face inspection used for the manually polished connector as described herein.

The following steps shall be performed:

NOTE: The procedures contained herein should produce an optical terminus with a PC polish.

Step 1. Perform steps 1 through 8 of the standard polish procedure.

Step 2. Replace the 0.1 um paper with the ultrafine paper. Wet the paper and polish the terminus with light pressure using a figure-8 motion for 10 to 30 complete motions.

NOTE: The glossy side of the ultrafine paper should be placed facing the resilient pad.

NOTE: The polish tool should hydroplane above the paper surface during this polish.

Step 3. Remove the connector from the polishing tool, clean it using a wipe dampened with alcohol and blow it dry with air.

Step 4. Repeat steps 1 through 3 for all remaining connectors.

Step 5. Proceed to 4.2.2 of this method to inspect the end face of the polished connector.

4.2.2 End face inspection. The following steps shall be performed:

Step 1. Perform end face inspection using either the microscope procedure in 4.2.2.1 of this method or the FOVIS procedure in 4.2.2.2 of this method.

NOTE: Use of the FOVIS procedure for post termination inspection is only permitted if the FOVIS meets the requirements of MIL-STD-1678-5, Measurement 5203.

4.2.2.1 End face inspection with 400× microscope. The following steps shall be performed:

Step 1. Examine the connector with the optical microscope to ensure that the optical surface is smooth and free of scratches, pits, chips, and cracks (see figure 5D3-4). If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish connectors) or re-terminate the fiber. A high intensity back light may be used to illuminate the fiber during the end face inspection.

NOTE: Do not polish the connector more than necessary to pass the end face inspection.

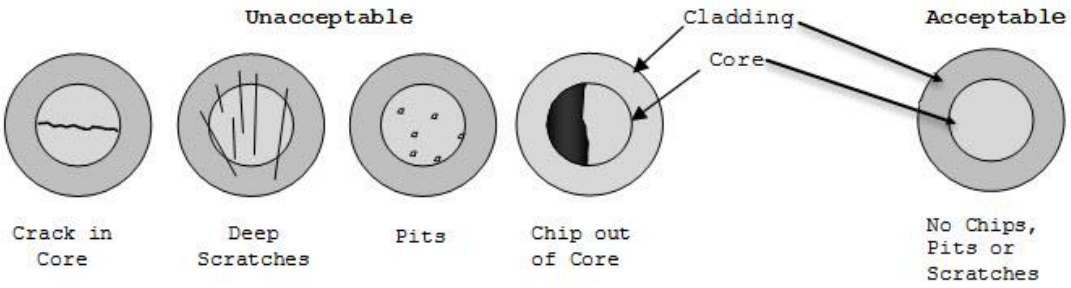

FIGURE 5D3-4. End face inspection criteria.

NOTE: Depending on the optical microscope used, viewing quality may differ.

NOTE: A small number of very light scratches are acceptable in the contact area of the ferrule, outside of the core and cladding area (see figure 5D3-5).

Step 2. If the connector is not to be immediately mated into an adapter, install a plastic protective cap over the connector ferrule.

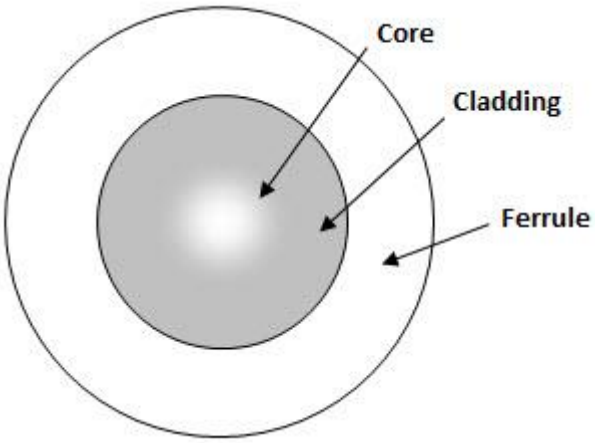

FIGURE 5D3-5. Depiction of ferrule contact area.

4.2.2.2 End face inspection with approved FOVIS.

Step 1. Examine the connector end face with a FOVIS that has been approved for shipboard use by NSWCDD (see 6.4) in accordance with the inspection requirements of MIL-STD-1678-5, Measurement 5203.

Step 2. Apply the inspection criteria located in MIL-STD-1678-5, Measurement 5202 to determine if the connector passes inspection.

Step 3. If any defects are present, repeat the polish with the 0.1 um paper (and the ultrafine paper for enhanced polish connectors) or re-terminate the fiber.

Step 4. If the connector is not to be immediately mated into an adapter, install a plastic protective cap over the connector ferrule.

Preparing activity:
Navy – SH
(Project SESS-2014-009)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.