NOTE: This draft dated 19 February 2000 prepared by NAVSEA Dahlgren has not been approved and is subject to modification. DO NOT USE PRIOR TO APPROVAL (Project xxxx).

METRIC

MIL-STD-2042-1B(SH)

SUPERSEDING
MIL-STD-2042-1A(SH)
11 September 1996
MIL-STD-2042-1(SH)
7 July 1993

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

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

(PART 1 OF 7 PARTS)

AMSC N/A AREA GDRQ

FOREWORD

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

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 53G, 2531 Jefferson Davis Highway, Arlington, VA 22242-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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

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

Part 1 Cables
Part 2 Equipment
Part 3 Cable Penetrations
Part 4 Cableways
Part 5 Connectors and Interconnections
Part 6 Tests
Part 7 Pierside Connectivity Cable Assemblies and Interconnection Hardware

CONTENTS

CONTENTS

CONTENTS

1. SCOPE

1.1 Purpose. This standard provides detailed methods for fiber optic cable selection, handling, marking, and repair.

1.1.1 Applicability. These criteria apply to installations on specific ships when invoked by the governing ship specification or other contractual document. They are intended primarily for new construction; however, they are also applicable for conversion or alteration of existing ships. The rapidly changing state of the art in fiber optic technology makes it essential that some degree of flexibility be exercised in enforcing this document. Where there is a conflict between this document and the ship specification or contract, the ship specification or contract shall take precedence. Where ship design is such that the methods herein cannot be implemented, users shall submit new methods or modifications of existing methods to NAVSEA 05 for approval prior to implementation.

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-2877	-	Aluminum Alloy Tape.
MIL-I-3064	-	Insulation, Electrical, Plastic-Sealer.
MIL-PRF-24623	-	Splice, Fiber Optic Cable, General Specification for (Metric).
MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for.
MIL-PRF-49291	-	Fiber, Optical, (Metric) General Specification for.
MIL-I-81765/1	-	Insulating Components, Molded, Electrical, Heat Shrinkable, Polyolefin, Crosslinked, Semi-rigid and Flexible.
MIL-C-83522	-	Connectors, Fiber Optic, Fixed Single Terminus, General Specification for.
MIL-PRF-85045	-	Cables, Fiber Optic,(Metric) General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-2042-2	-	Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships (Equipment)(Part 2 of 6 Parts).
MIL-STD-2042-3	-	Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships (Cable Penetrations)(Part 3 of 6 Parts).
MIL-STD-2042-4	-	Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships (Cableways)(Part 4 of 6 Parts).
MIL-STD-2042-5	-	Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships (Connectors and Interconnections)(Part 5 of 6 Parts).
MIL-STD-2042-6	-	Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships (Tests)(Part 6 of 6 Parts).

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

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

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

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

ELECTRONICS INDUSTRY ASSOCIATION/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

EIA/TIA-440 - Fiber Optic Terminology.

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

JAPANESE INDUSTRIAL STANDARD (JIS)

JIS B 8381 - Pneumatic system, Flexible tubes, Tube fittings.

(Application for copies should be addressed to Japanese Standards Association, 1-24, Akasaka 4, Minato-ku, Tokyo 107 Japan.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE AMS-DTL-23053/15 - Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Heavy-Wall, Coated, Flexible, Outer Wall Crosslinked.

(Application for copies should be addressed to Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001)

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

3. DEFINITIONS

3.1 General fiber optics terms. Definitions for general fiber optics terms used in this standard are in accordance with ANSI/EIA-440. Definitions and acronyms for other terms as they are used in this standard are given in the following paragraphs.

3.2 Acronyms. The following acronyms are used in this handbook:

BOF Blown optical fiber
FOCP Fiber optic cable plant
FOCT Fiber optic cable topology
FOICB Fiber optic interconnection box
TRB Tube routing box

3.3 Allocated and not used fiber. A fiber that is designated for use for a particular system, but is not being used to transmit information. Allocated and not used fibers include fibers allocated as system spare fibers, system growth fibers, and system redundant fibers.

3.4 Allocated and used fiber. A fiber that is designated and required for use for a particular system, and is being used to transmit information. Allocated and used fibers include fibers used for normal channels, fibers for alternate channels, and fibers for non-redundant channels.

3.5 Alternate channel. The allocated and used active backup link for a normal channel.

3.6 Authorized approval. Written approval from the cognizant Government activity.

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

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

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

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

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

3.12 Cable repair. Restoration/repair of only the outermost cable jacket.

3.13 Cable splicing.

3.13.1 Conventional cable splicing. Repair of a damaged conventional optical fiber cable by reconnecting severed fibers and providing an environmental enclosure at the spliced region.

3.13.2 BOF cable splicing. The joining of two BOF cable ends by connecting the tube ends together using tube couplers and providing an environmental enclosure at the spliced region.

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

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

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

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

3.18 FOCP Growth fiber. An unallocated fiber intended for later use by fiber optic systems installed after initial ship construction.

3.19 Installing activity. An installing activity is any military or commercial organization involved with the installation of FOCTs aboard Naval ships.

3.20 Local cable.

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

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

3.21 Minimum bend diameter. The diameter at which a conventional optical fiber cable, OFCC (see 3.25), loose tube furcation unit, or BOF bundle (see 3.8) can be bent without degrading optical performance, or the diameter at which a BOF cable or BOF tube (see 3.9) can be bent without kinking a BOF tube. The short-term bend diameter applies during handling and installing; the long-term bend diameter applies to the completed installation.

3.22 Non-redundant channel (NRC). Any allocated and used active link that has no system required backup link.

3.23 Normal channel. An allocated and used active link between system equipment that has a designated active backup link.

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

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

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

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

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

3.27 Spare fiber. A fiber reserved for use as a maintenance spare in the event of damage to an allocated fiber within the FOCT.

3.27.1 FOCP spare fiber. An unallocated spare fiber for use by any system using the FOCP.

3.27.2 System spare fiber. A spare fiber that is allocated and not used and that is reserved for use by a specific system.

3.28 System growth fiber. An allocated and not used fiber identified as a growth requirement for a specific system.

3.29 System redundant fiber. An allocated and not used fiber identified by the user system as a required alternately routed fiber.

3.30 System specific cable. An optical fiber cable that connects end user equipments and does not interface with a FOCP (see 3.15).

3.31 Trunk. A set of trunk cables that run along the same cableways between two FOCP boxes (TRBs, FOICBs).

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

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

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

3.33 Tube furcation assembly. An assembly attached to the end of a BOF tube in a BOF cable used to separate the fibers and provide a cable structure to facilitate the termination of the optical fibers from that BOF tube.

3.34 Unallocated fiber. A fiber that is not designated for use for any system, but is required as part of the FOCT configuration. Unallocated fibers include FOCP spare fibers and FOCP growth fibers.

3.35 Unused fiber. A fiber that is not designated for use for any system and not required as part of the FOCT configuration. Unused fibers occur within the FOCT when the required systems fibers are not an integer multiple of the number of fibers available within standard cable sizes.

4. GENERAL REQUIREMENTS

4.1 Cables. Fiber optic cables for Naval shipboard application shall be in accordance with MIL-PRF-85045.

4.1.1 Cable selection. Cables selected shall be those referenced in ship specifications, ship installation drawings, contract drawings, or other approved drawings as specified in the contract or by the cognizant Government activity. Substitute cables shall not be used without authorized approval (see 3.5). In those instances where the installing activity (see 3.11) is responsible for determining the correct type and size cable for a specific application, the fiber optic cables shall be selected in accordance with MIL-PRF-85045. Fibers shall be in accordance with MIL-PRF-49291, either type SU (single mode) or type MM (multimode) as required by the system.

4.1.2 Spare optical fibers. The number of spare optical fibers shall be in accordance with the ship specification and system drawings. Spare fibers are provided in both trunk cables and local cables that penetrate bulkheads or decks (see 3.20 and 3.32).

4.1.3 Cable storage and handling.

4.1.3.1 Cable storage. Cables shall be stored in a dry place protected from the weather and limited to a temperature range of not less than -40 degrees Celsius (^{o}C) [-40 degrees Fahrenheit (^{o}F)] nor greater than +70^{o}C (+158^{o}F). It is recommended that cables be limited to a maximum temperature +30^{o}C (+86^{o}F). A cable that has been in storage for less than one year may be installed if a visual inspection of the cable shows no mechanical damage that would impair the watertight integrity of the cable's outer sheath or the integrity of the interior components. A conventional optical fiber cable that has been in storage for one year or longer may be installed if it passes the visual inspection (see Method 6A1 in Part 6 of this standard practice), and if the optical attenuation (see Method 6B1 in Part 6 of this standard practice) is less than the value specified. A BOF cable that has been in storage for one year or longer may be installed if it passes the visual inspection (see Method 6A1 in Part 6 of this standard practice), and if a ball bearing with a minimum outer diameter of 4 mm will pass through each BOF tube within the cable. Cables shall be stored on reels with minimum diameters of 24 times the cable outside diameter, or coiled so that the bend diameter shall be not less than 24 times the cable outside diameter. Bare ends of stored cables shall be sealed against moisture using heat shrink end caps as specified herein (see 5.1). Terminated cables shall be sealed against moisture using connector dust covers (for multiple terminus connectors), plastic caps or heat shrink end caps as specified herein (see 5.1).

4.1.3.2 Cable handling. During handling, the conventional optical fiber cable and the BOF cable shall be protected from crushing, kinks, twists, and bends that violate the minimum short term bend diameter of the cable (see 3.21). The minimum short-term bend diameter of conventional optical fiber cable is eight times the cable outside diameter. The minimum short term bend diameter of BOF cable is 0.13 m (5 inches) for single tube BOF cable and 0.45 m (18 inches) for seven tube BOF cable. It is recommended that cables not be handled in ambient temperatures at or below 36^{o}F (2^{o}C) (see Part 4 of this standard practice).

4.1.4 Cables entering interconnection boxes or other equipment. Cables shall enter interconnection boxes or other equipment in accordance with the methods in Part 2 of this standard practice.

4.1.5 Cable penetrations. The passing of cables through decks and bulkheads shall be in accordance with the methods in Part 3 of this standard practice.

4.1.6 Cable installation and protection. Cables shall be installed in the cableways and protected in accordance with Part 4 of this standard practice.

4.1.7 Cable connections. Cable connections to equipment external to the fiber optic cable topology, such as end user equipment (see 3.14), shall be made with multiple terminus heavy duty connectors in accordance with MIL-PRF-28876, single terminus light duty connectors in accordance with MIL-C-83522, or Navy approved commercial light duty connectors as specified in the system drawings. Connectors shall be assembled as specified in Part 5 of this standard practice. Light duty connectors used for external equipment connections shall be housed within that equipment. Light duty connectors used for cable interconnections internal to the fiber optic cable topology shall be housed within interconnection boxes, as specified in Part 2 of this standard practice.

4.1.7.1 Termination of fibers. There are four categories of fibers:

a. Allocated and used (see 3.4).

b. Allocated and not used (see 3.3).

c. Unallocated (see 3.34).

d. Unused (see 3.35).

The quantity of the first three categories shall be as specified in the ship specification and on the system drawings.

4.1.7.1.1 Allocated and used fibers. The allocated and used trunk and local cable fibers shall be terminated in accordance with the fiber optic cable plant and system drawings.

4.1.7.1.2 Allocated and not used fibers. The allocated and not used shall be terminated in accordance with the system or fiber optic cable plant drawings.

4.1.7.1.3 Unallocated fibers. Trunk and local cables that penetrate decks and bulkheads shall contain spare (unallocated) fibers. Spare fibers shall be terminated in accordance with the system or fiber optic cable plant drawings. Growth fibers shall not be terminated unless otherwise specified in the fiber optic cable plant or system drawings.

4.1.7.1.4 Unused fibers. The unused fibers shall not be terminated unless otherwise specified in the fiber optic cable plant or system drawings.

4.1.8 Cable testing. Cables shall undergo testing before, during, and after installation in accordance with Part 6 of this standard practice.

4.1.9 Cable and fiber marking. All cables shall be marked in accordance with the ship specification and system drawings and as specified herein. Cable identification tags external to the equipment shall be located as specified in Part 4 of this standard practice. Cable tags shall be of a size suitable to accommodate the required marking but shall have a minimum width of 13 mm (1/2 inch). Tags and strips for marking cables shall be of soft aluminum tape having a natural finish in accordance with MIL-A-2877. Capital letters shall be used on cable tags; height of all letters shall be not less than 5 mm (3/16 inch), and letters and numbers shall be embossed to at least 0.4 mm (1/64 inch) above the surface.

4.1.9.1 Fiber identification markers. Permanent cable markers marked with the fiber identification specified in the ship specification and system drawings shall be used to identify OFCCs or single fiber cables at their termination point within the interconnection box. The identification markers shall always be installed with the left hand marking group next to the termination point. The marker shall be positioned so that it can be easily read without disturbing other components within the equipment. The marker base color shall be white.

4.1.9.2 Heavy-duty connector designation tag. Cables that terminate in a heavy-duty connector shall have a tag placed on the cable next to the connector designating the jack to which the connector is to be attached.

4.1.10 Cable repair (see 3.12). Damage to the outermost jacket of conventional optical fiber cable and BOF cable shall be repaired according to procedures specified herein (see 5.2). Conventional optical fiber cable with damage extending beyond the cable outer jacket to the kevlar strength members or to the OFCC outer jacket shall be replaced. BOF cables with damage extending beyond the cable outer jacket to the kevlar strength members or to the BOF tubes may be cut to remove the damaged section and spliced according to the procedures specified herein (see 5.3).

4.1.11 BOF cable splicing. BOF cables may be installed into the ship in a modular fashion and joined to form single continuous cables. BOF cables to be joined to form a single continuous cable shall be spliced according to the procedures specified herein (see 5.3).

4.1.12 BOF cable furcation. Seven tube BOF cables may be furcated into one, two or three BOF single tube BOF cables. Seven tube BOF cables shall be furcated according to the procedures specified herein (see 5.4).

4.2 Safety precautions. The following safety precautions apply:

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

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 (LED's) and laser diodes may not be visible but may still be hazardous to the unprotected eye. Never stare into the end of an optical fiber connected to an LED or laser diode and do not stare into broken, severed or disconnected optical cables.

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

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

e. Wash your hands after handling bare fibers.

f. Never look into the end of a BOF tube connected to a pressure source.

5. DETAILED REQUIREMENTS

5.1 Cable end sealing. Unterminated cables that are not to be terminated within 14 days (unless otherwise specified by the contract or supervisor of shipbuilding) shall have their ends sealed against moisture in accordance with Method 1A1 of this standard practice. OFCCs broken out within equipment (such as in an interconnection box) that are not to be terminated shall be grouped into bundles, and the bundle ends sealed using Method 1A1 of this standard practice as a guide.

5.2 Cable repair. Damage to outer jackets of conventional optical fiber cable and BOF cable (see 4.1.10) shall be repaired using cable jacket repair sleeves or tape, in accordance with Method 1B1 of this standard practice.

5.3 BOF cable splicing. BOF cables shall be spliced using Method 1C1 of this standard practice.

5.4 BOF cable furcation. Seven tube BOF cables shall be furcated using Method 1D1 of this standard practice.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

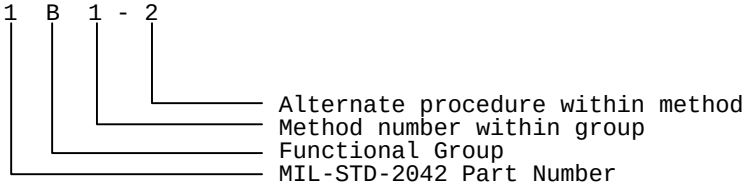
6.1 Intended use. The methods for cable end-sealing, cable repair, BOF cable splicing, and BOF cable furcation depicted in this standard practice are intended primarily for new construction; however, they are applicable for conversion or alteration of existing ships.

6.2 Issue of DODISS. When this standard practice is used in acquisition, the applicable issue of DODISS must be cited in the solicitation (see 2.2.1 and 2.3).

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

Group A: Cable end sealing
Group B: Cable jacket repair
Group C: BOF cable splicing
Group D: Seven tube BOF cable furcation

Then the designation system was completed as follows:



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

6.4 Subject term (key word) listing.

Component
Connections
Marking
Penetrations
Repair
Selection
Storage and handling
Testing

Preparing activity:
NAVY - SH

(Project GDRQ-XXXX)

METHOD 1A1

CABLE END SEALING

1. SCOPE.

1.1 Scope. This method describes a procedure for conventional fiber optic cable and BOF cable end sealing during temporary and long-term storage to prevent water or other liquids from entering into the cable and damaging the fibers.

2. REQUIRED EQUIPMENT AND MATERIALS.

2.1 The equipment and materials in table 1A1-I shall be used to perform this procedure.

TABLE 1A1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Ruler	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
End cap (Raychem SSC series or equal)	1
Wipes	As required
Canned air	As required

3. PROCEDURE.

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

a. Safety glasses shall be worn 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. Observe warnings and cautions on the equipment and materials.

d. Never stare into the end of a fiber connected to a laser source or LED.

e. Never look into the end of a BOF tube connected to a pressure source.

3.2 Procedure.

NOTE: End caps shall meet the requirements of MIL-I-81765/1 and table 1A1-II. The cap interior shall be coated with a heat-activated adhesive.

Step 1 - Clean the end of conventional cable or BOF cable with a wipe dampened with alcohol and blow dry as necessary.

Step 2 - Select an end cap in accordance with table 1A1-II.

TABLE 1A1-II. End cap data and sizes for fiber optic cable.

Cable type	Cable OD mm (inches) nominal	End cap dimensions mm (inches)		
		Length (min)	Expanded I.D.(min)	Recovered I.D.(max)
4-Fiber	8.1 (0.32)	33.5 (1.32)	9.9 (0.39)	4.1 (0.16)
8-Fiber	11.1 (0.44)	55.4 (2.18)	20.1 (0.79)	7.6 (0.30)
36-Fiber	20.8 (0.82)	90 (3.54)	35.1 (1.38)	15 (0.59)
Single-Tube	11.1 (0.44)	55.4 (2.18)	20.1 (0.79)	7.6 (0.30)
7-Tube	29.0 (1.14)	90 (3.54)	35.1 (1.38)	15 (0.59)
7-Tube	31.5 (1.24)	90 (3.54)	35.1 (1.38)	15 (0.59)

Step 3 - Slide the end cap over the end of the cable or BOF cable to be sealed. Position the end cap to ensure a 25 mm (1 inch) minimum overlap (see figure 1A1-1).

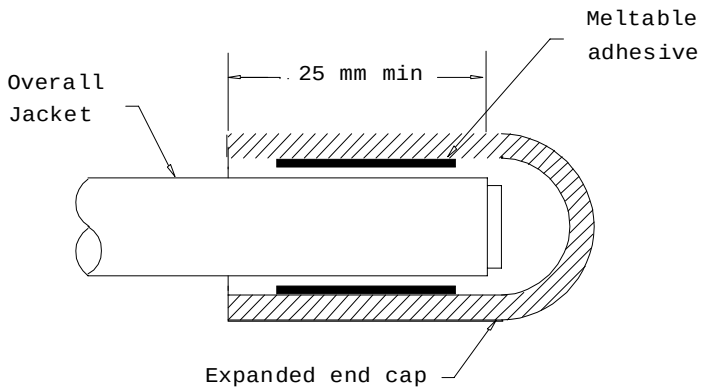


Figure 1A1-1. Installing expanded end cap on cable.

Step 4 - 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 sleeve and allow the cable jacket to cool before reheating, if the cable jacket shows any signs of bubbling.

Hold the heat gun approximately 100 mm (4 inches) from the end cap and as heat is applied, move the heat gun back and forth over the end cap. Shrink the end cap from closed end to open end to avoid trapping air. (NOTE: Minimum recovery temperature is 121°C (250°F).

Step 5 - When the end cap has recovered enough to assume the configuration of the cable and excess adhesive appears at the end of the cap, discontinue heating (see figure 1A1-2). (NOTE: Additional heat will not make end cap shrink more tightly.)

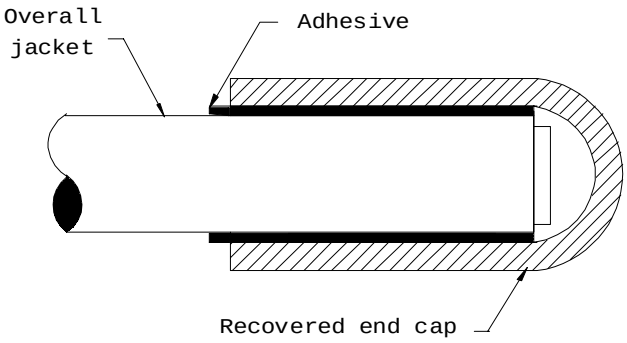


Figure 1A1-2. Completed end seal.

METHOD 1B1

CABLE JACKET REPAIR

1. SCOPE.

1.1 Scope. This method describes procedures for repairing the damaged outer jacket of a conventional cable or a BOF cable, with kevlar strength members intact.

2. REQUIRED EQUIPMENT AND MATERIALS.

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

3. PROCEDURES.

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

a. Safety glasses shall be worn when handling bare fibers.

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

c. Observe warnings and cautions on equipment and materials.

d. Never stare into the end of a fiber connected to a laser source or LED.

e. Never look into the end of a BOF tube connected to a pressure source.

3.2 Procedure I. Method 1B1-1. Wraparound sleeve with rail closure.

3.2.1 The equipment and materials in table 1B1-I shall be used to perform this procedure.

TABLE 1B1-I. Equipment and materials.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Repair sleeve (Raychem CRSM-x-1200 or equal)	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

NOTE: The cable jacket repair sleeve material shall meet the requirements of SAE AMS-DTL-23053/15 and table 1B1-II. The material shall be coated with a heat-activated adhesive and fabricated into a wrap around sleeve with a rail closure system as shown on the figures below.

Step 1 - Select a repair sleeve in accordance with table 1B1-II.

TABLE 1B1-II. Repair sleeve dimensions (wraparound).

Cable type	Cable OD nominal mm (inches)	B dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Rail to rail		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
4-fiber	8.1 (.32)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
8-fiber	11.1 (.44)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
36-fiber	20.8 (.82)	76 (3.0)	A + 2B	79.8 (3.14)	48.5 (1.91)	2.0 (0.08)
Single-tube	11.1 (.44)	76 (3.0)	A + 2B	45.7 (1.8)	23.9 (.94)	2.0 (0.08)
7-tube	29.0 (1.14)	76 (3.0)	A + 2B	215.5 (8.48)	75.8 (2.98)	2.0 (0.08)
7-tube	31.5 (1.24)	76 (3.0)	A + 2B	215.5 (8.48)	75.8 (2.98)	2.0 (0.08)

Step 2 - Trim off the frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or OFCC jacket (see figure 1B1-1). Square up the jacketing where required.

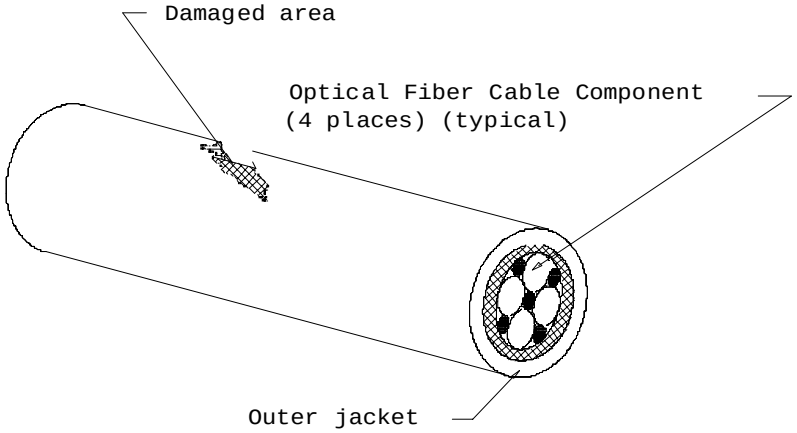


Figure 1B1-1. Damaged cable.

NOTE: Refer to figure 1B1-2 for a definition of A and B dimensions.

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see table 1B1-II and figure 1B1-2).

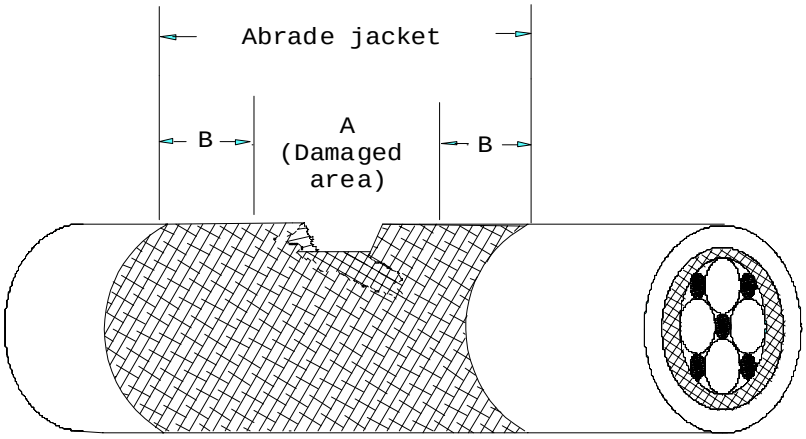


Figure 1B1-2. Cable preparation.

Step 4 - Clean the abraded area with a wipe dampened with alcohol, and blow dry with air.

Step 5 - Fill any large depressions or voids with tape, as required, to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of the adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press it into the damaged area. Repeat the process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour the tape to the cable (see figure 1B1-3).

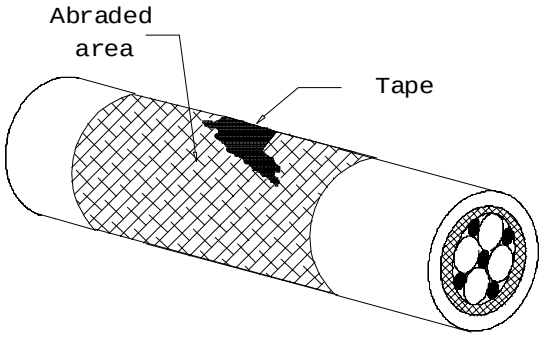


Figure 1B1-3. Tape contoured to cable.

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 1B1-II).

Step 7 - CAUTION: Do not overheat the cable. The jacket should be just warm to the touch. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket.

Hold the heat gun approximately 100 mm (4 inches) away from the cable and apply heat to all parts of the cable jacket to which the repair sleeve is to be applied.

Step 8 - Assemble the repair sleeve as shown (see figure 1B1-4). Leave approximately 13 mm (0.5 inch) overhang of channel on both sides of sleeve (see figure 1B1-5).

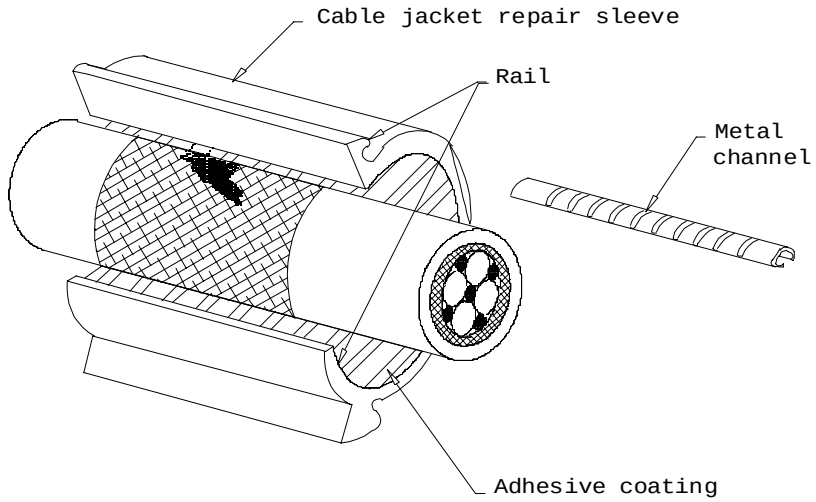


Figure 1B1-4. Installing sleeve.

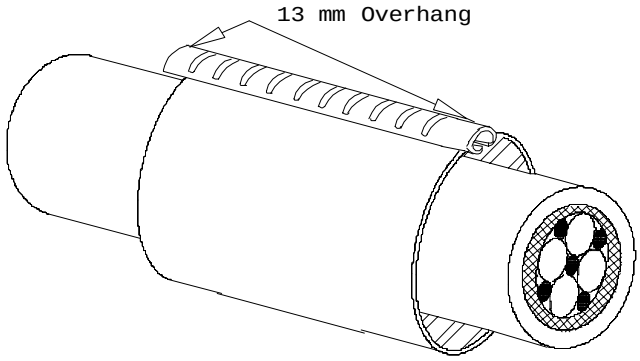


Figure 1B1-5. Assembled sleeve.

Step 9 - 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 sleeve and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the sleeve over the damaged area and, holding the heat gun approximately 100 mm (4 inches) away, heat evenly from the center to the ends around the entire sleeve until the sleeve changes color indicating a full recovery (see figure 1B1-6). Melted sealant should be visible at the end of sleeve.

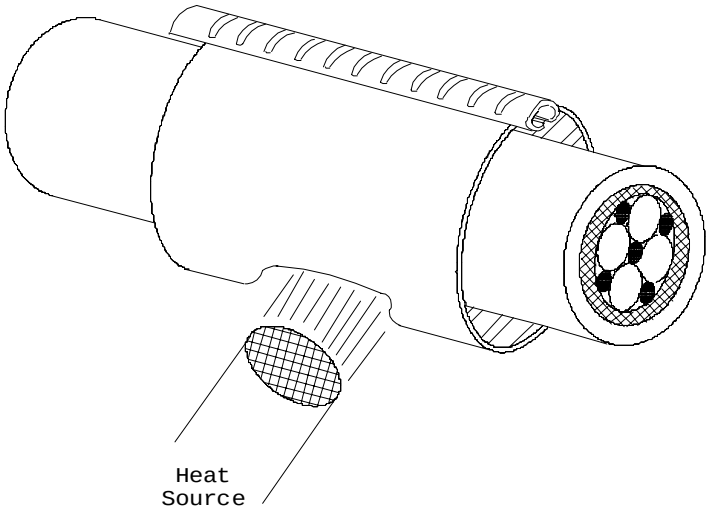


Figure 1B1-6. Shrinking sleeve.

Step 10 - When the sleeve has cooled, the rail and metal channel may be trimmed from the sleeve to provide greater flexibility to the cable (see figure 1B1-7).

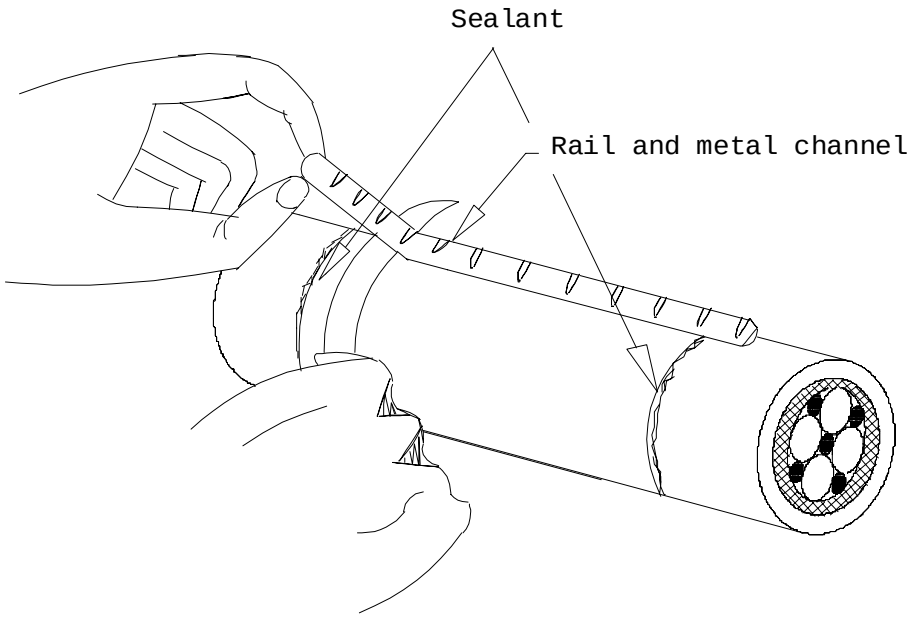


Figure 1B1-7. Trimming rails and metal channel.

3.3 Procedure II. Method 1B1-2 tube sleeve.

3.3.1 The equipment and materials in table 1B1-III shall be used to perform this procedure.

TABLE 1B1-III. Equipment and materials.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Repair sleeve (Raychem SST-FR series or equal)	1
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

NOTE: The cable repair sleeve material shall meet the requirements of SAE AMS-DTL-23053/15 and table 1B1-IV. The material shall be coated with a heat-activated adhesive and fabricated into a tube shape as shown on the figures below.

Step 1 - Select a repair sleeve in accordance with table 1B1-IV.

Step 2 - Trim off the frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or OFCC jacket (see figure 1B1-8). Square up the jacketing where required.

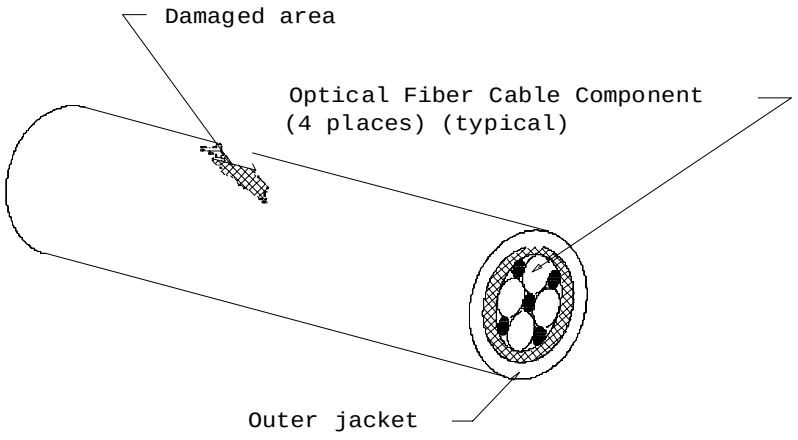


Figure 1B1-8. Damaged cable.

TABLE 1B1-IV. Repair sleeve dimensions (tube).

Cable type	Cable OD mm (inches) nominal	B Dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Inside diameter		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
4-Fiber	8.1 (.32)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
8-Fiber	11.1 (.44)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
36-Fiber	20.8 (.82)	101 (4.0)	A + 2B	27.9 (1.10)	9.5 (0.38)	3.0 (0.12)
Single-Tube	11.1 (.44)	101 (4.0)	A + 2B	19.1 (0.75)	5.6 (0.22)	3.0 (0.11)
7-Tube	29.0 (1.14)	101 (4.0)	A + 2B	38.1 (1.50)	12.7 (0.50)	3.6 (0.14)
7-Tube	31.5 (1.24)	101 (4.0)	A + 2B	38.1 (1.50)	12.7 (0.50)	3.6 (0.14)

NOTE: Refer to figure 1B1-9 for a definition of A and B dimensions.

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see table 1B1-IV and figure 1B1-9).

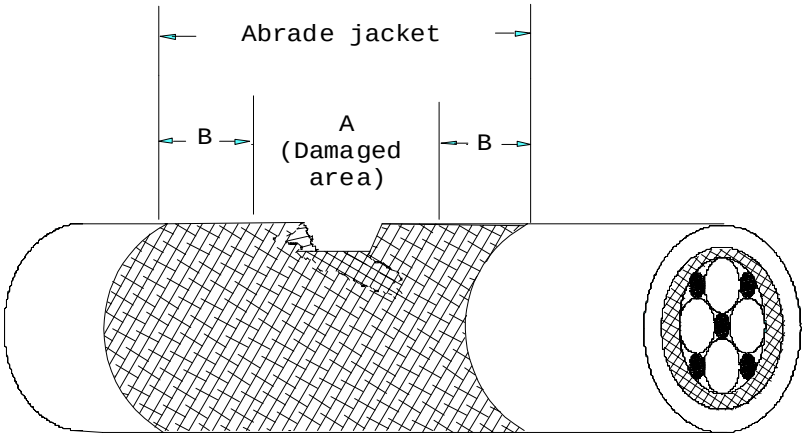


Figure 1B1-9. Cable preparation.

Step 4 - Clean the abraded area with alcohol and blow dry with air.

Step 5 - Fill any large depressions or voids with tape, as required, to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of the adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press it into the damaged area. Repeat the process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 1B1-10).

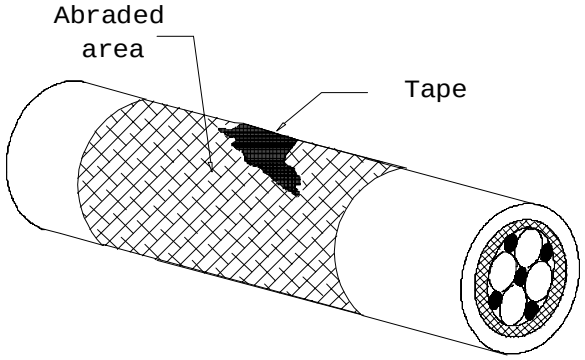


Figure 1B1-10. Tape contoured to cable.

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 1B1-IV.)

Step 7 - 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 sleeve and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the repair sleeve over the damaged area. Hold the heat gun approximately 100 mm (4 inches) away and heat the center by applying heat evenly around the sleeve until it shrinks over cable (see figure 1B1-11). Working towards one end, shrink the sleeve to the cable until sealant is flowing at end of the sleeve. Repeat the procedure on the other half of the sleeve (see figure 1B1-12).

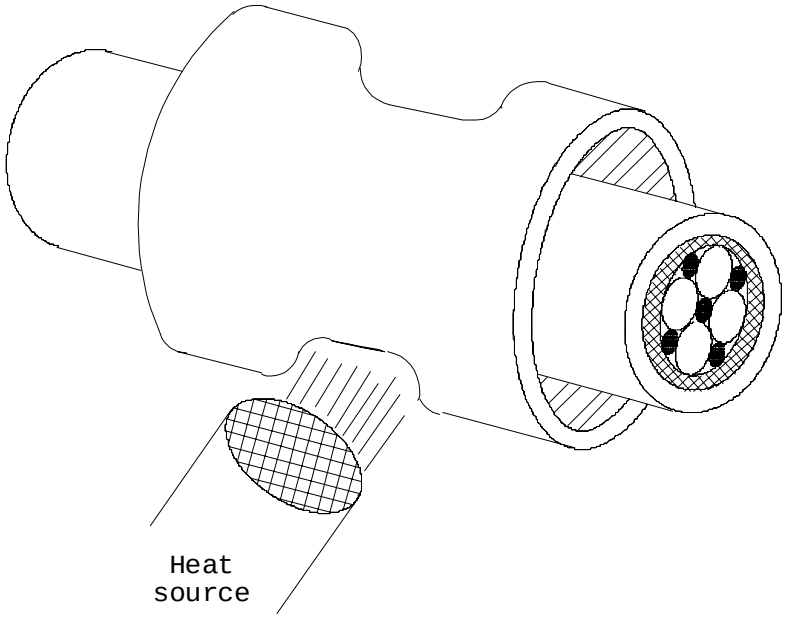


Figure 1B1-11. Shrinking the sleeve.

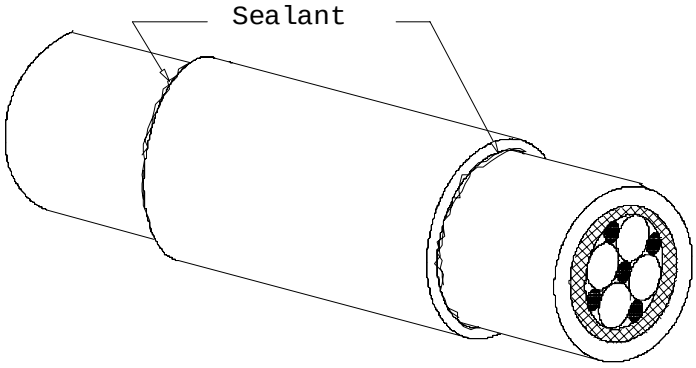


Figure 1B1-12. Completed repair.

Step 8 - Remove heat and allow the sleeve to cool.

3.4 Procedure III. Method 1B1-3 rubber tape.

3.4.1 The equipment and materials in table 1B1-V shall be used to perform this procedure.

TABLE 1B1-V. Equipment and materials.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Heat gun (Raychem 500B or equal)	1
Fiberglass tape (1 in.)	As required
Electrical coating (3M Scotch Kote or equal)	As required
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

Step 1 - Trim off any frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or the OFCC jacket (see figure 1B1-13). Square up the jacketing where required.

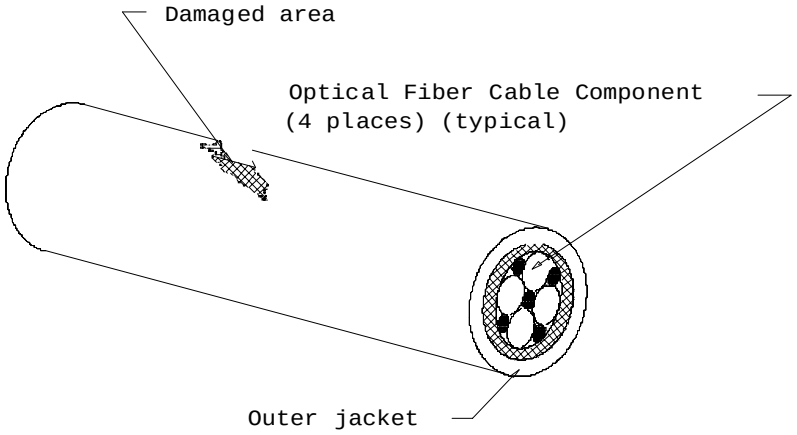


Figure 1B1-13. Damaged cable.

Step 2 - Abrade the jacket circumferentially approximately 80 mm (3 inches) on either side of the damaged area using emery cloth or a fine file (see figure 1B1-14).

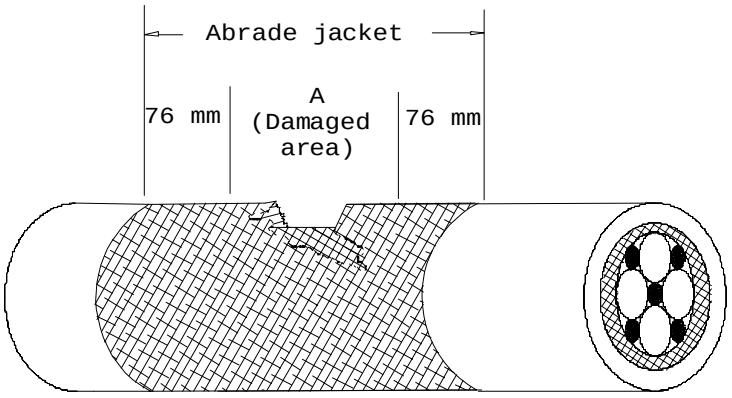


Figure 1B1-14. Cable preparation.

Step 3 - Clean the abraded area with alcohol and blow dry with air.

Step 4 - Fill any large depressions or voids with adhesive tape as required to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press them into the damaged area. Repeat process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 1B1-15).

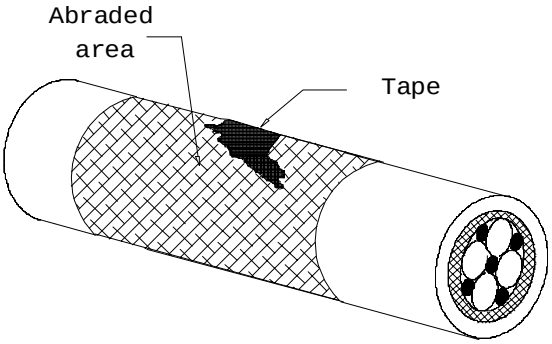


Figure 1B1-15. Tape contoured to the cable.

Step 5 - Cover the entire abraded area with one layer of half lapped adhesive and sealant tape, pulling the tape to approximately one-half its original thickness.

Step 6 - Cover the adhesive and sealant tape with one layer of half lapped fiberglass tape.

Step 7 - CAUTION: Do not over heat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the tape and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Holding the heat gun approximately 100 mm (4 inches) away from the cable, heat the entire area covered by the tape for approximately 3.5 minutes

with the heat gun to blend the adhesive and sealant into the fiberglass tape.

Step 8 - Apply a coat of electrical coating to the entire area and let it set a minimum of 10 minutes.

3.5 Procedure IV. Method 1B1-4. Wraparound sleeve with adhesive closure.

3.5.1 The equipment and materials in table 1B1-VI shall be used to perform this procedure.

TABLE 1B1-VI. Equipment and materials.

Description	Quantity
Safety glasses	1
Ruler	1
Electricians knife	1
Emery cloth (or fine file)	As required
Adhesive and sealant tape (Raychem Thermofit S1030 or equal)	As required
Repair sleeve (Raychem SFR series or equal)	1
Heat gun (Raychem 500B or equal)	1
Alcohol bottle with alcohol/2-propanol	1
Wipes	As required
Canned air (or compressed air)	As required

NOTE: The cable repair sleeve material shall meet the requirements of SAE AMS-DTL-23053/15 and table 1B1-VII. The material shall be coated with a heat-activated adhesive and fabricated into a wrap with a self adhesive closure system as described below.

Step 1 - Select a repair sleeve in accordance with table 1B1-VII.

TABLE 1B1-VII. Repair sleeve dimensions (wraparound).

Cable type	Cable OD mm (inches) nominal	B Dimension mm (inches)	Repair sleeve dimensions mm (inches)			
			Length (minimum)	Inside diameter		Wall thickness after shrinking (+/- 10%)
				Expanded (minimum)	Recovered (maximum)	
36-Fiber	20.8 (.82)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)
7-tube	29.0 (1.14)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)
7-tube	31.5 (1.24)	76 (3.0)	A + 2B	31.8 (1.25)	12.7 (.50)	2.0 (0.08)

NOTE 1: Refer to figure 1B1-17 for a definition of A and B dimensions.
NOTE 2: Repair sleeves are not currently available for the conventional 4-fiber, 8-fiber cable and single-tube BOF cable sizes.

Step 2 - Trim off any frayed, burned, or protruding jacket material with a knife using care not to damage the kevlar or the OFCC jacket (see figure 1B1-16). Square up the jacketing where required.

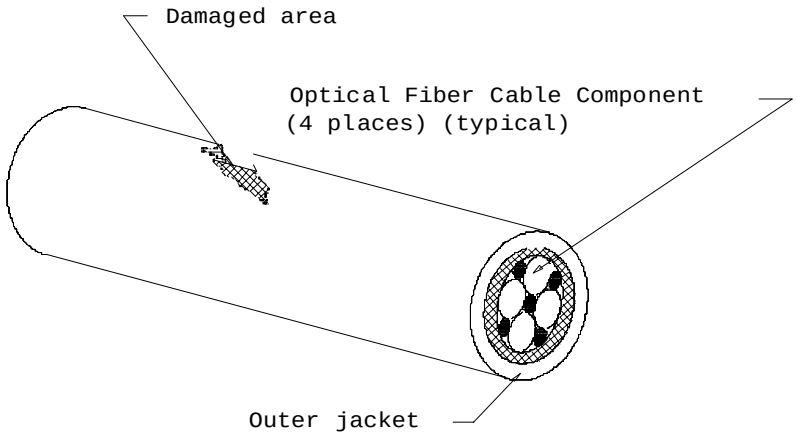


Figure 1B1-16. Damaged cable.

Step 3 - Abrade the jacket circumferentially to the dimension shown using emery cloth or a fine file (see figure 1B1-17).

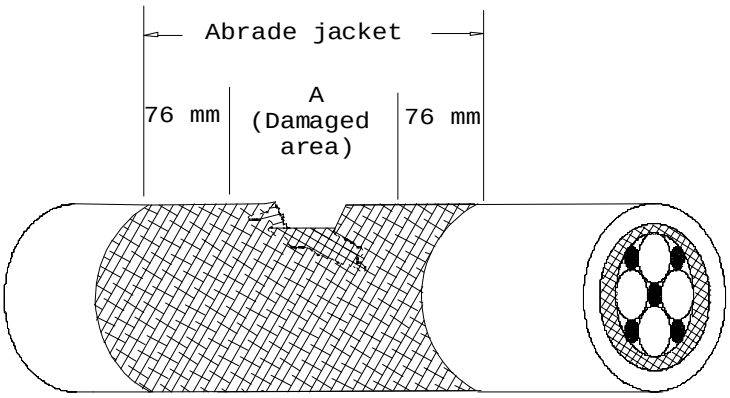


Figure 1B1-17. Cable preparation.

Step 4 - Clean the abraded area with alcohol and blow dry with air.

Step 5 - Fill any large depressions or voids with adhesive tape as required to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press them into the damaged area. Repeat process until the damaged area is filled, then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour to the cable (see figure 1B1-18).

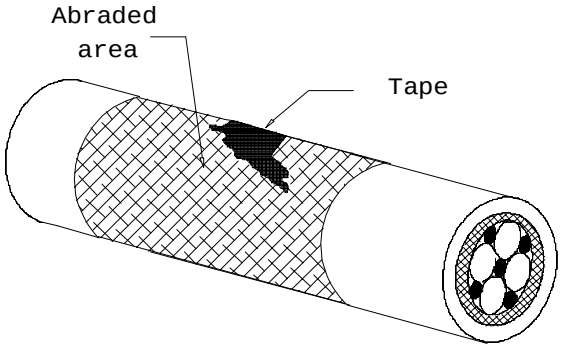


Figure 1B1-18. Tape contoured to cable.

Step 6 - Cut the cable jacket repair sleeve to the proper length (see table 1B1-VII.)

Step 7 - CAUTION: Do not overheat the cable. The jacket should be just warm to the touch. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket.

Hold the heat gun approximately 100 mm (4 inches) away from the cable and apply heat to all parts of the cable jacket to which the repair sleeve is to be applied.

Step 8 - Remove the protective release tape from both flaps of the sleeve to expose the surfaces of the contact adhesive.

Step 9 - Place the sleeve around the cable so that the sealant side of the sleeve is next to the cable, align the sleeve side edges, and press the contact surfaces together along the full length of the sleeve (see figure 1B1-19).

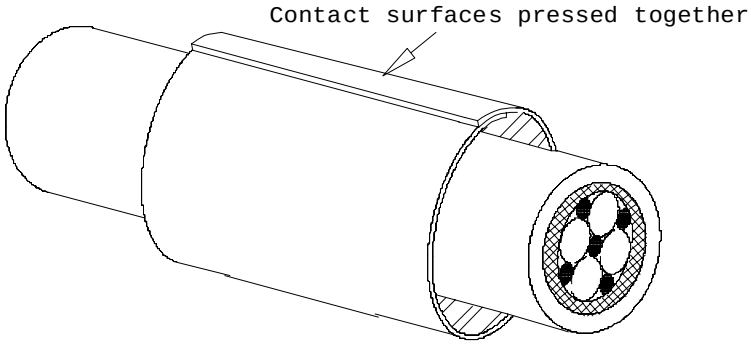


Figure 1B1-19. Assembled sleeve.

Step 10 - CAUTION: Do not over heat the cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the cable jacket. Discontinue heating of the tape and allow the cable jacket to cool before reheating if the cable jacket shows any signs of bubbling.

Center the repair sleeve over the damaged area. Hold the heat gun approximately 100 mm (4 inches) away and heat the center by applying heat evenly around the sleeve until it shrinks over cable (see figure 1B1-20). Working towards one end, shrink the sleeve to the cable until sealant is

flowing at end of the sleeve. Repeat the procedure on the other half of the sleeve (see figure 1B1-21).

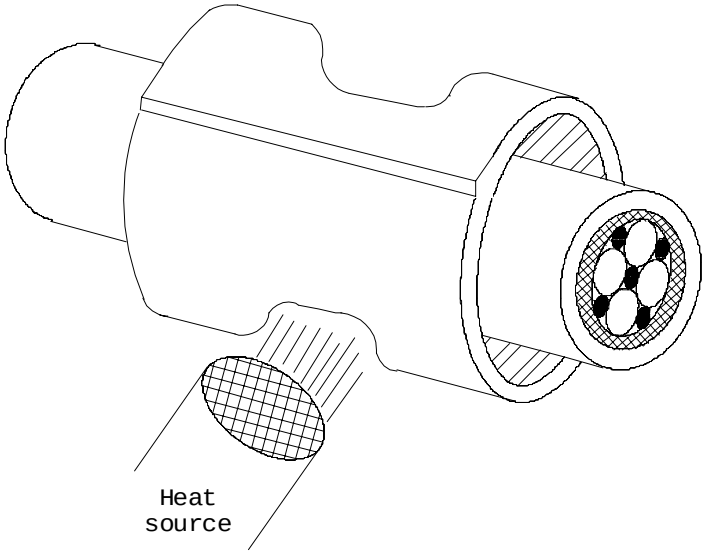


Figure 1B1-20. Shrinking the sleeve.

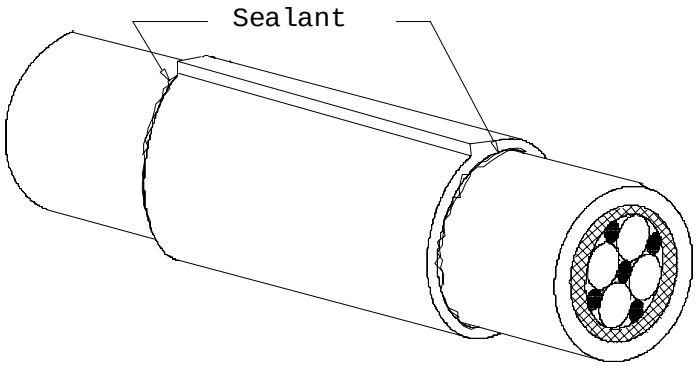


Figure 1B1-21. Completed repair.

Step 11 - Remove heat and allow the sleeve to cool.

METHOD 1C1

BOF CABLE SPLICING

1. SCOPE

1.1 Scope. This method describes procedures for splicing together two multi-tube BOF cable ends. This method is only applicable for the splicing of multi-tube BOF cables.

2. REQUIRED EQUIPMENT AND MATERIALS.

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

3. PROCEDURE

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

a. Observe warnings and cautions on equipment and materials.

b. Never look into the end of a BOF tube connected to a pressure source.

3.2 Procedure.

3.2.1 The equipment and materials in Table 1C1-I shall be used to perform this procedure.

Table 1C1-I. Equipment and materials.

Description	Quantity
Cable jacket stripping tool (NAVSEA DWG 6872811-08 or equal)	1
BOF cable cutter	1
Tube cutter	1
Kevlar shears (NAVSEA DWG 6872811-16 or equal)	1
Pipe (approved for shipboard use)	As required
Male threaded pipe adapter (compatible with pipe)	2
Female threaded pipe adapter (compatible with pipe)	2
Pipe cutter	1
Heat gun (Raychem 5008 or equal)	1
Tape sealant (Raychem Thermofit S1030 or equal)	As required
Heat shrink sleeve (Raychem SST-FR series or equal)	As required
Tape	As required
Tube coupler (JIS B 8381 I-U-8-00 or equal)	As required
Wipes	As required
Alcohol bottle with alcohol/2-propanol	1
Canned air	As required
Ruler	1

NOTE: The heat shrink sleeve material shall meet the requirements of SAE AMS-DTL-23053/15. The material shall be coated with a heat-activated adhesive and fabricated into a tube shape as shown on the figures below.

3.2.2 Coupling the BOF cable tubes.

Step 1 - Determine the desired length of the splice section and the tube coupler stagger scheme (see figure 1C1-1).

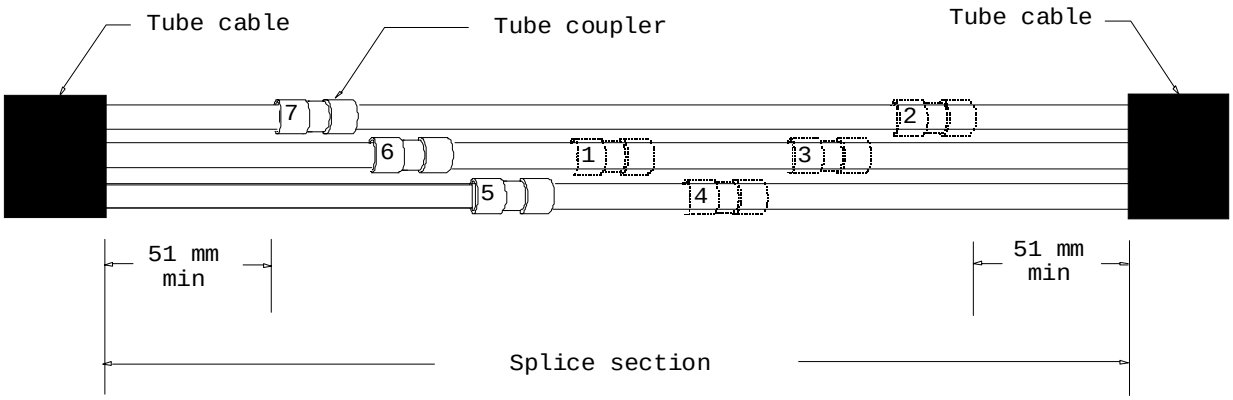


Figure 1C1-1. Example tube coupler stagger scheme.

NOTE: The length of the splice section depends on the diameter of pipe used for the splice center section and the number of tubes in the BOF cable. Center section pipes with inner diameters slightly larger than the BOF cable outer diameter will require long splice section lengths to allow for tube coupler staggering within the splice. Larger center section pipe diameters allow for shorter tube coupler stagger distances and a shorter overall splice section length.

NOTE: Tubes shall not have tube couplers installed closer than 50 mm (2 inches) to the ends of the splice section.

Step 2 - Place the two BOF cables approximately in their final installed configuration. With the BOF cable cutter, trim the two BOF cables to the desired length.

NOTE: The two BOF cables should be cut so that they have an overlap equal to the splice section length.

Step 3 - Select pipe for the splice ends with an inner diameter slightly larger than the BOF cable outer diameter. With the pipe cutter, cut two lengths of the pipe 150 mm (6 inches) in length.

NOTE: The inner diameter of the pipe should be no greater than 8 mm (0.3 inches) larger than the outer diameter of the BOF cable.

Step 4 - Assemble a female threaded pipe adapter to each 150 mm (6 inch) section of pipe using approved procedures.

Step 5 - Select pipe for the splice center section. With the pipe cutter, cut the pipe to length (see Figure 1C1-2).

NOTE: The splice center section pipe diameter may be larger than the splice end pipe diameter, but the male threaded pipe adapters used on the center section pipe must be compatible with the female threaded pipe adapters assembled to the splice end pipes.

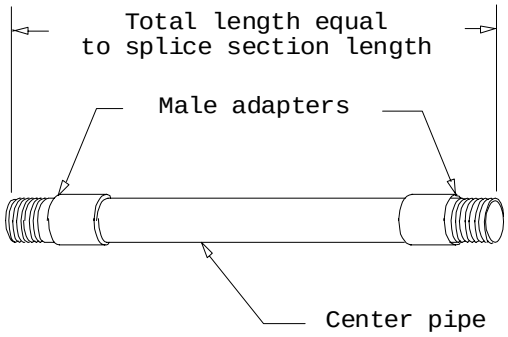


Figure 1C1-2. Splice center section length.

Step 6 - Assemble the male threaded pipe adapters to each end of the center section pipe using approved procedures.

NOTE: The total length of the assembled male threaded adapters and center section pipe shall be equal to the splice section length.

Step 7 - Determine the total splice length. The total splice length can be obtained by mating the two splice ends to the splice center section and measuring the length of the assembly.

Step 8 - Cut a length of heat shrink sleeve (with an inner diameter greater than the outer diameter of the splice center section and splice ends) equal to the total splice length minus 30 mm (1 inch).

Step 9 - Cut two lengths of heat shrink sleeve (with an inner diameter greater than the outer diameter of pipe on the splice end) approximately 200 mm (8 inches) in length.

Step 10 - Slide the heat shrink sleeves, the splice ends, and the splice center section onto the two BOF cables as shown in figure 1C1-3.

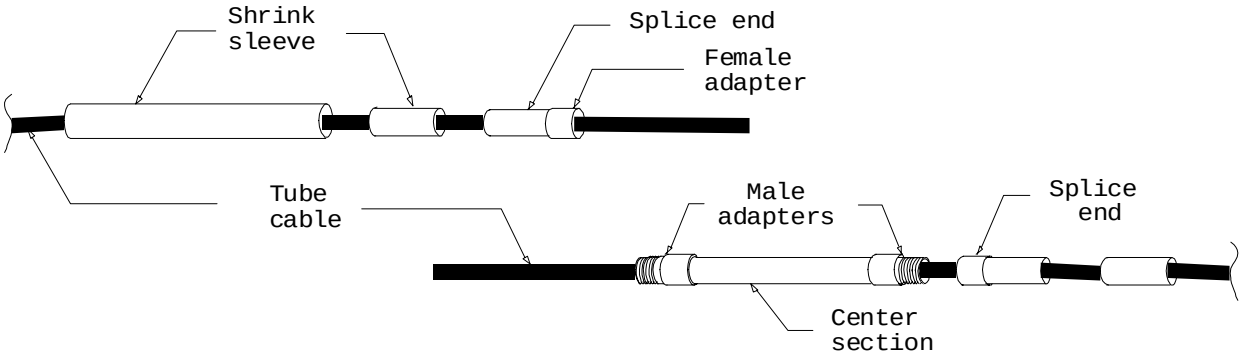


Figure 1C1-3. Splice parts on the BOF cables.

Step 11 - Measure each BOF cable from the cable end a distance equal to the splice section length, and mark the cable outer jacket.

Step 12 - With the cable jacket-stripping tool, ring cut each BOF cable jacket at the mark and strip the jacket from the each BOF cable end.

NOTE: Make sure that the individual BOF tubes are not punctured, crushed, or kinked while removing the BOF cable jacket.

Step 13 - Trim the strength members so that they extend one half of the splice section length from the BOF cable outer jacket. Fold them back along the BOF cable outer jacket and tape them to the jacket (the tape will be removed later).

Step 14 - Trim back the cable fillers and waterblocking tape around the BOF tubes to the BOF cable jacket edge.

NOTE: Make sure that the individual BOF tubes are not punctured, crushed, or kinked while trimming back the cable elements.

Step 15 - Use the tube cutter to cut tube number one of both BOF cables at approximately the center of the splice section. Visually verify that the ends of both tubes are cut perpendicular to the tube length.

Step 16 - Apply a thin layer of caulking compound around the last 6 mm (0.25 in) of the prepared end of tube number one of both of the BOF cables. Slide a tube coupler onto one of the BOF tubes and firmly seat the tube within the tube coupler. Slide the second BOF tube into the other end of the tube coupler and firmly seat the tube within the tube coupler.

NOTE: The distance between the two BOF cable jackets should now be equal to the splice section length.

Step 17 - Apply an axial load of approximately 22 N (5 lbs) between the two tubes to verify that both BOF tubes are properly engaged into the tube coupler.

Step 18 - Referring to the stagger scheme determined in Step 1, use the tube cutter to cut tube two of each of the two BOF cables to the appropriate length. Visually verify that the end of each tube is cut perpendicular to the tube length.

Step 19 - Repeat steps 16 and 17 for tube number two of each of the BOF cables.

Step 20 - Repeat steps 18 and 19 for each of the other tubes in the BOF cables.

NOTE: BOF cables shall always be spliced with matching tube numbers coupled together.

3.2.3 Assembling the splice body.

Step 1 - Clean the end of each of the BOF cable jackets with a wipe dampened with alcohol and blow dry as necessary.

Step 2 - Apply one wrap of sealant tape around the entire exposed section of BOF tubes (See figure 1C1-4). Then, holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour the tape to the tubes.

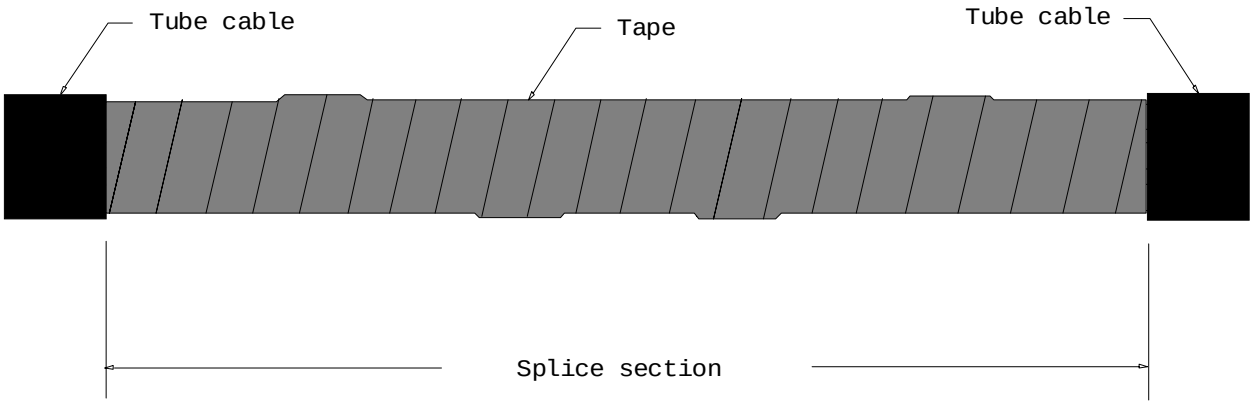


Figure 1C1-4. Taped splice section.

NOTE: Do not apply too much sealant tape to the tubes or the center splice section will not slide over the taped tubes.

Step 3 - Slide the splice center section over the taped tubes so that the ends of the male pipe adapters are lined up with the ends of the BOF cable jackets (see figure 1C1-5).

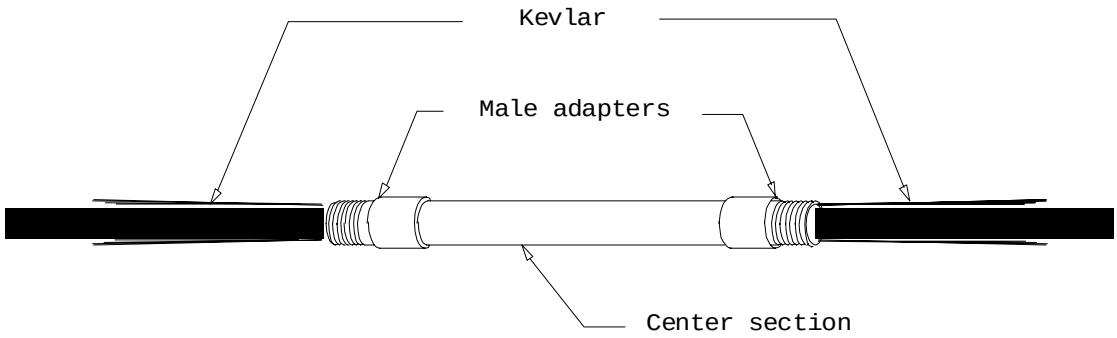


Figure 1C1-5. Positioning the splice center section.

Step 4 - Remove the tape from the kevlar and fold the kevlar over the splice center section.

Step 5 - Holding the kevlar taught and the center section against the end of the BOF cable jacket, slide the first splice end up to the splice center section and engage the adapter threads for a minimum of 3 complete revolutions.

NOTE: Make sure that the BOF cable does not rotate as the splice end is tightened onto the splice center section.

NOTE: Once the splice end is engaged, movement of the BOF cable into or out of the splice should not occur.

Step 6 - Repeat step 5 for the second splice end.

Step 7 - Form the kevlar up over the center section and tape the kevlar ends to the splice near the center of the splice.

Step 8 - Slide the short heat shrink sleeve up over one end of the splice. The sleeve should be placed so that it covers the pipe on the splice end and extends beyond the splice end a minimum of 80 mm (3 inches).

Step 9 - CAUTION: Do not overheat the BOF cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the BOF cable jacket. Discontinue heating of the sleeve and allow the BOF cable jacket to cool before reheating if the BOF cable jacket shows any signs of bubbling.

Holding the heat gun approximately 100 mm (4 inches) away from the heat shrink sleeve, shrink the sleeve from the middle to both ends around the entire sleeve. Heat until the sleeve has shrunk to a snug fit around the splice end pipe and the BOF cable, and the sealant is flowing at the ends.

Step 10 - Repeat steps 8 and 9 for the other end of the splice.

Step 11 - Slide the long heat shrink sleeve up the BOF cable. The sleeve should be placed so that it is approximately centered over the splice.

Step 9 - Holding the heat gun approximately 100 mm (4 inches) away from the heat shrink sleeve, shrink the sleeve from the middle to both ends around the entire sleeve. Heat until the sleeve has shrunk to a snug fit around the BOF cable splice, and the sealant is flowing at the ends (see figure 1C1-6).

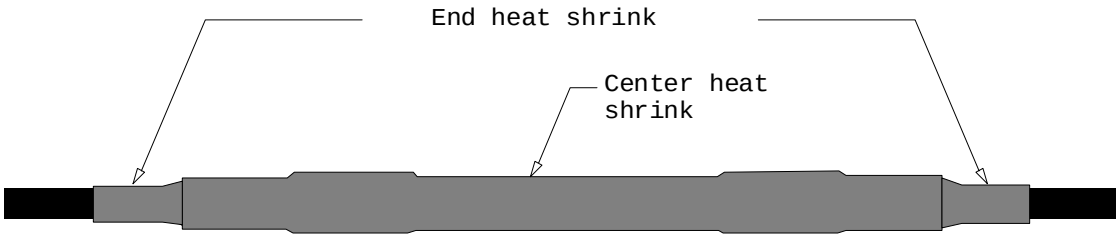


FIGURE 1C1-6. Completed splice.

Step 10 - Verify the continuity of each spliced tube with a ball bearing using method 6H1 of this standard.

NOTE: Alternatively, the continuity of each spliced tube may be verified prior to assembling the splice body.

METHOD 1D1

BOF CABLE FURCATION

1. SCOPE

1.1 Scope. This method describes procedures for furcating a seven tube BOF cable into one or more single tube BOF cables for distribution within a compartment. This method is only applicable for furcation of a seven-tube BOF cable into three or fewer single tube BOF cables.

2. REQUIRED EQUIPMENT AND MATERIALS.

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

3. PROCEDURES

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

a. Observe warnings and cautions on equipment and materials.

b. Never look into the end of a BOF tube connected to a pressure source.

3.2 Procedure.

3.2.1 The equipment and materials in Table 1D1-I shall be used to perform this procedure.

Table 1D1-I. Equipment and materials.

Description	Quantity
Cable jacket stripping tool (NAVSEA DWG 6872811-08 or equal)	1
BOF cable cutter	1
Tube cutter	1
Kevlar shears (NAVSEA DWG 6872811-16 or equal)	1
Heat gun (Raychem 5008 or equal)	1
Tape sealant (Raychem Thermofit S1030 or equal)	As required
Heat shrink sleeves (Raychem SST-FR series or equal)	As required
Caulking compound in standard caulking tube (CID A-A-00272 or equal)	As required
Caulking gun	1
Tube coupler (JIS B 8381 I-U-8-00 or equal)	As required
Wipes	As required
Alcohol bottle with alcohol/2-propanol	1
Canned air	As required

Step 1 - With the BOF cable cutter, trim the cable to the desired length within the space.

Step 2 - Measure a length of the seven-tube BOF cable approximately 44 mm (1.7 inches) from the cable end, and mark the cable outer jacket.

Step 3 - With the cable jacket-stripping tool, ring cut the jacket at the mark and strip the BOF cable outer jacket from the BOF cable end.

NOTE: Make sure that the individual BOF tubes are not punctured, crushed, or kinked while removing the BOF cable jacket.

Step 4 - Trim back the strength members, cable fillers and waterblocking tape around the BOF tubes to the BOF cable jacket edge. Also, trim back the BOF tubes that will not be connected to single tube BOF cables to the BOF cable jacket edge.

NOTE: Make sure that the individual BOF tubes are not punctured, crushed, or kinked while trimming back the cable elements and BOF tubes that will not be connected.

Step 5 - Place the caulking compound tube nozzle into the end of one of the BOF tubes that will not be connected. Inject the caulking compound such that it completely fills an approximately 12.7 mm (0.5 inch) length of the tube. Clean any excess caulking compound from the tube with a wipe. Repeat for all of the other tubes in the cable that will not be connected.

Step 6 - For each BOF tube that will be connected to a single tube BOF cable, use the tube cutter to trim approximately 6 mm (0.25 in) off the end of the tube. Visually verify that the end of each tube is cut perpendicular to the tube length.

Step 7 - Cut a 230 mm (9 inch) length of heat shrink sleeve (in accordance with the diameter in Table 1D1-II). Slide the heat shrink sleeve over the end of the 7-tube BOF cable so that it is approximately 50 cm (2 ft) from the end of the cable.

NOTE: The heat shrink sleeve material shall meet the requirements of SAE AMS-DTL-23053/15 and table 1D1-II.

Table 1D1-II. Heat shrink sleeve dimensions (7-tube BOF cable).

Part Number	Expanded	Fully Recovered	
	I.D. (min)	I.D. (max)	Wall Thickness
23053/15-112-0	50.8 mm (2.0 in.)	14.0 mm (0.550 in.)	1.14 mm (0.045 in.)

Step 8 - Access the single tube BOF cables that are to be connected to the seven-BOF cable within the compartment. Measure approximately 3.8 cm (1.5 inches) from the end of each single tube BOF cable and mark the outer jacket. With the cable jacket-stripping tool, ring cut and remove each single tube BOF cable outer jacket up to the mark.

NOTE: Make sure that the individual tube is not punctured, crushed, or kinked while removing the single tube BOF cable jacket.

Step 9 - For each single tube BOF cable, trim back any strength members or waterblocking tape around the BOF tube to the BOF cable jacket edge.

Step 10 - For each single tube BOF cable, use the tube cutter to trim approximately 16 mm (0.6 in) off the end of the tube. Visually verify that the end of each tube is cut perpendicular to the tube length.

Step 11 - Clean the ends of the single tube BOF cable jackets with a wipe dampened with alcohol and blow dry as necessary.

Step 12 - For each single tube BOF cable, cut a 150 mm (6.0 inch) length of heat shrink sleeve (in accordance with the diameter in Table 1D1-III). Slide the heat shrink sleeve over each single tube BOF cable.

NOTE: The heat shrink sleeve material shall meet the requirements SAE AMS-DTL-23053/15 and table 1D1-III.

Table 1D1-III. Heat shrink sleeve dimensions (single tube BOF cable).

Part Number	Expanded	Fully Recovered	
	I.D. (min)	I.D. (max)	Wall Thickness
23053/15-110-0	25.4 mm (1.0 in.)	7.0 mm (0.275 in.)	1.14 mm (0.045 in.)

Step 13 - Apply a thin layer of caulking compound around the last 6 mm (0.25 in) of the prepared end of the BOF tube of the first single tube BOF cable. Slide a tube coupler onto the BOF tube and firmly seat the tube within the tube coupler.

NOTE: There should be a gap between the tube coupler and the single tube BOF cable jacket. If there is not a gap, remove the tube from the tube coupler, strip off 2 to 3 mm (0.1 inch) of the single tube BOF cable jacket, and reinstall the tube within the tube coupler.

Step 14 - Apply an axial load of approximately 22 N (5 lbs) between the single tube BOF cable and the tube coupler to verify that the BOF tube is properly engaged into the tube coupler. Move the heat shrink sleeve up the single tube BOF cable over one-half of the tube coupler.

Step 15 - CAUTION: Do not overheat the BOF cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the BOF cable jacket. Discontinue heating of the sleeve and allow the BOF cable jacket to cool before reheating if the BOF cable jacket shows any signs of bubbling.

Holding the heat gun approximately 100 mm (4 inches) away, heat evenly from the center to the ends around the entire sleeve. Heat until the sleeve has shrunk to a snug fit around the tube coupler and the single tube BOF cable and the sealant is flowing at the ends (see figure 1D1-1).

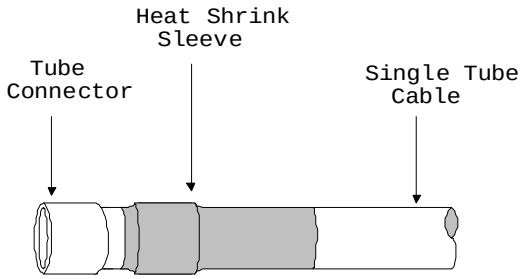


FIGURE 1D1-1. Installed single tube BOF cable sleeve.

Step 16 - Apply a thin layer of caulking compound around the last 6 mm (0.25 in) of the appropriate BOF tube in the seven-tube BOF cable. Slide the tube coupler of the single tube BOF cable onto the BOF tube of the 7-tube BOF cable and firmly seat the tube within the tube coupler.

Step 17 - Apply an axial load of approximately 22 N (5 lbs) between the single tube BOF cable and the 7-tube BOF cable to verify that the BOF tubes are

properly engaged into the tube coupler.

Step 18 - Repeat steps 13 through 17 for each single tube BOF cable to be connected.

Step 19 - Clean the end of the 7 tube BOF cable jacket with a wipe dampened with alcohol and blow dry as necessary.

Step 20 - Fill in any depressions or voids within the exposed BOF cable end with tape, to restore the cable contour as follows:

WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Cut off short strips of the adhesive tape and heat them slightly with the heat gun to soften them. Roll the tape with your fingers and press it into the cable void. Repeat the process until all of the BOF cable voids are filled (see figure 1D1-2).

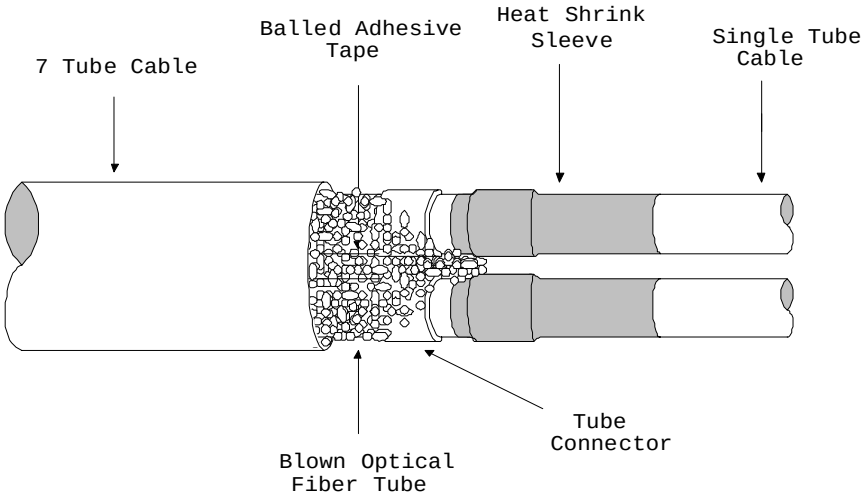


FIGURE 1D1-2. Tape contoured to the cable.

NOTE: Alternatively, MIL-I-3064 type HF plastic sealer may be used to fill/build up around the BOF tubes.

Step 21 - Apply one wrap of tape around the entire area, starting 80 mm (3 inches) from one side of the 7-tube BOF cable end and ending 80 mm (3 inches) on the other side of the 7-tube BOF cable end (See figure 1D1-3).

Step 22 - WARNING: Application of too much heat will cause the adhesive to flow and may cause burns if it comes in contact with the skin.

Holding the heat gun approximately 100 mm (4 inches) away, apply just enough heat to the tape to form and contour the tape to the cable ends.

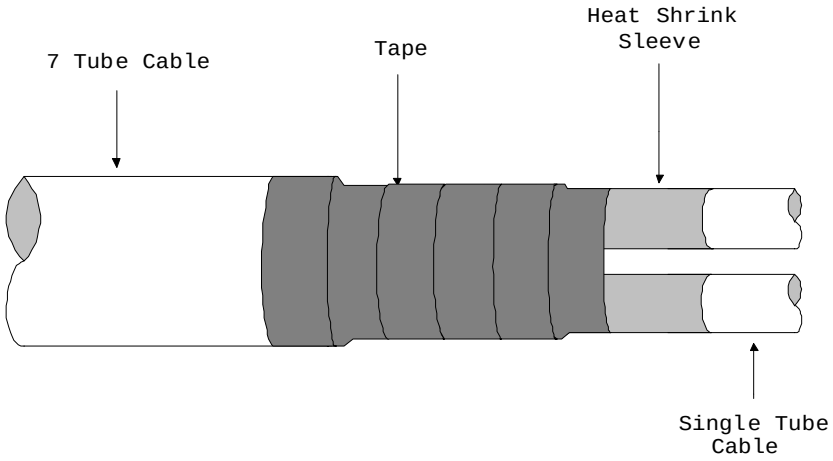


FIGURE 1D1-3. Completely taped cable end.

Step 23 - CAUTION: Do not overheat the BOF cable. Prolonged exposure of the jacket to temperatures above 160°C (320°F) may damage the BOF cable jacket. Discontinue heating of the sleeve and allow the BOF cable jacket to cool before reheating if the BOF cable jacket shows any signs of bubbling.

Slide the heat shrink sleeve up the seven-tube BOF cable and position over the taped section so that the sleeve extends past the tape approximately 40 mm (1.5 inch) on each side. Holding the heat gun approximately 100 mm (4 inches) away, heat evenly from the center to the ends around the entire sleeve. Heat until the sleeve has shrunk to a snug fit around the complete assembly and melted sealant is visible at the ends of the sleeve (see figure 1D1-4).

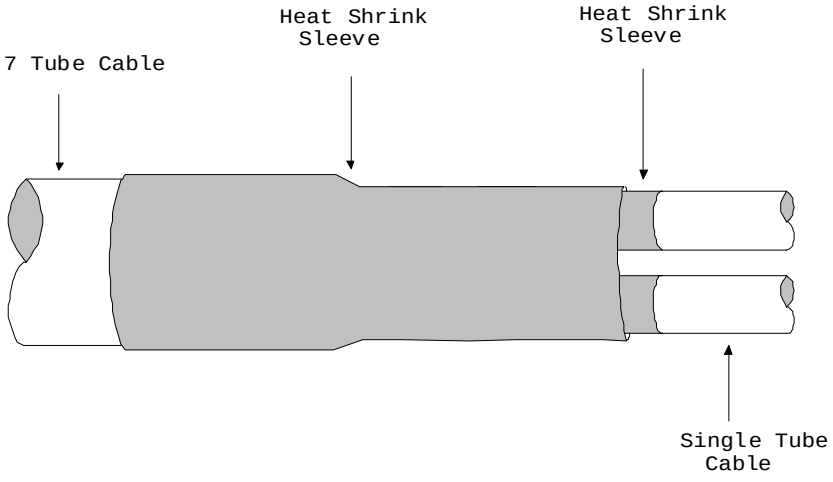


FIGURE 1D1-4. Completed furcation.

Step 24 - Verify the continuity of each connected tube with a ball bearing using method 6H1 of this standard.