

**GENERAL SPECIFICATIONS FOR SHIPS
OF THE UNITED STATES NAVY**
DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND
14 January 1998
SECTION 408
FIBER OPTIC CABLE SYSTEMS

408a. General

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A Fiber Optic Cable Plant (FOCP) shall be provided.

Fiber optic cable will be used, in any application, for the transfer of light signals through an optical fiber.

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Fiber optic cable shall meet or exceed, where applicable, the shipboard environmental service life of electric cable.

Fiber optic cable shall be located as shown on the drawings and as specified in these specifications, and in accordance with Sect. 072 and system installation requirements.

Fiber optic cable may be run in cableways with copper conductor signal and power cables unless specifically prohibited.

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Fiber optic cable shall not be run through bilge areas, stowage spaces and tanks (hazardous or non-hazardous areas) unless specifically approved.

Optical fibers may become opaque over time when exposed to radiation bombardment. Therefore, fiber optic cable shall not be run in radioactive areas, unless specifically approved.

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Fiber optic cable shall not be exposed to the weather. Fiber optic cables to mast mounted equipment shall be contained within the mast structure to the maximum extent possible. Fiber optic cable standoffs and fiber optic cable clips exposed to the weather shall be CRES 316.

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Fiber optic safety precautions are mandatory and shall be strictly adhered to in accordance with MIL-STD-2042.

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Light duty (single terminus) connectors and splices used to interconnect fiber optic cable shall be located within interconnection boxes or other equipment. Light duty (single terminus) connectors and splices used for connection between fiber optic cable and other associated fiber optic components shall be located within the end user equipment console or panel.

Requirements in this section do not apply to remote source lighting.

408b. Definitions

Definitions for general fiber optic terms used in this section are in accordance with ANSI/IEEE Std. 100 and EIA Std. 440. Definitions for terms associated with the FOCP are in accordance with MIL-STD-2051.

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

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

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

Basic location number. - See Sect. 507.

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

Fiber optic cable plant (FOCP). - The portion of the fiber optic cable topology made up of the trunk cables and their associated connectors, splices, and interconnection boxes.

Fiber optic cable repair. - Fiber optic cable repair refers to restoration of only the outermost cable jacket.

Fiber optic cable splicing. - The repair of damaged fiber optic cables by reconnecting severed fibers and providing an environmental enclosure at the spliced region.

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

FOCP growth fiber. - An unallocated fiber intended for later use in the installation of fiber optic systems after initial ship construction.

Local cable. - Fiber optic cable that provides a continuous optical path between an interconnection box and end user equipment.

Maintenance spare fiber. - A fiber that is not allocated for use by any system, but is reserved for use in the case of damage to an allocated fiber within a trunk or local cable that penetrates a watertight deck or bulkhead.

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

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

System growth fiber. - An allocated and not used fiber identified as a growth requirement for a particular system.

10 **System spare fiber.** - An allocated and not used fiber identified as a sparing requirement for a particular system.

System redundant fiber. - FOCT fibers identified by the user system as a required alternate path fiber.

15 **System specific cable.** - Fiber optic cable that only connects pieces of end user equipment and does not interface with the FOCP.

Terminated fiber. - A fiber whose endpoints are fitted with a connector or mechanical splice.

Trunk cable. - Fiber optic cable that provides a continuous optical path between FOCP interconnection boxes.

20 **Trunk group.** - The collection of fiber optic cables connected between two FOCP interconnection boxes.

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

25 **Unused fiber.** - A fiber that is not designated for use for any system and not required as part of the FOCP. Unused fibers occur within the FOCP when the sum of allocated and unallocated fibers required in a cable is less than the number of fibers available within a standard cable size.

30 **408c. Selection of fiber optic cables and associated fiber optic components.**

Fiber optic components shall conform to Table I.

35 **Operating wavelength.** - Fiber optic cable systems shall operate at a nominal wavelength of either 850 or 1300 nanometers (nm). The standard Navy transmission wavelength is 1335 ± 45 nm. All tactical data links should operate in this wavelength range. Nontactical links may operate in other wavelength ranges, but general purpose test equipment for fiber optics may not be available shipboard to support other wavelengths. All links with data rates greater than 20 Mbps should
40 use the standard Navy transmission window.

Table I. Fiber Optic Cable and Associated Component Specifications

Fiber Optic Component	Specification or Drawing No.
Cable	MIL-C-85045/13, /14, /15, /16, /17, /18, /20
Fiber	MIL-F-49291/6, /7
Connector (heavy duty)	MIL-C-28876
Backshell	MIL-C-28876/27, /28, /29
Connector (light duty)	MIL-C-83522/16, /17, /18
Splice and splice tray	MIL-S-24623/4
Interconnection box	MIL-I-24728
Switch	MIL-S-24725
Termini	MIL-T-29504/3, /14, /15

5 **Spare fiber requirements for system specific cables.** System specific cables that penetrate a deck or bulkhead shall have a minimum of spare optical fibers provided for maintenance in accordance with Table II. These maintenance spare fibers shall be terminated.

10 **Table II - Spare optical fiber requirements.**

Total number of fibers in cable	Maximum number of active fibers	Spare fibers
4	3	1
8	7	1
24	21	3
33	30	3
36	32	4

408d. Installation

15 **Fiber optic cable systems shall be located and installed in accordance with Sect. 304 and as specified herein. The Standard Methods of installation, storage, and handling shown in MIL-STD-2042 shall be used.**

408e. Fiber optic cable systems designating and marking

20 **Fiber optic cables and equipment shall be tagged in accordance with Sect. 305 and as specified herein.**

Fiber optic interconnection and switch boxes. - Fiber optic interconnection and switch boxes shall be marked FO, followed by a dash, and then marked in accordance with Sect. 305.

5 **Fiber optic cable identification. - Fiber optic trunk cables shall be marked with the letters FT, followed by a dash, then FOCP trunk group number, followed by a dash, then fiber optic cable number, followed by a dash, then fiber cable type. The letter M shall be used to designate a multimode fiber cable type. The letter S shall be used to designate a single-mode fiber cable type.**

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Example for FOCP trunk cable:

FT-9-007-M

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FT indicates fiber optic cable plant trunk cable.
9 indicates trunk group number.
007 indicates this is the 7th fiber optic cable in the trunk group.
M indicates this is a multimode 62.5/125 micron fiber cable.

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Fiber optic local and system specific cables shall be marked with the letters FO, followed by a dash, the circuit designation, as listed in Sects. 305 and 400, followed by a dash, the fiber optic cable number, followed by a dash, then fiber cable type.

25 **Example for local and system specific cables:**

FO-14TV-999-M

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FO indicates local or system specific cable.
14TV indicates surveillance, training, and entertainment television system.
999 indicates this is the 999th fiber optic cable in this system.
M indicates this is a multimode 62.5/125 micron fiber cable.

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Optical fiber cable component identification. - Heat shrink tubing shall be used to identify fibers at their termination point within an interconnection box or equipment. The marking on the tubing shall be in accordance with the following: trunk cabling optical fibers shall be marked with the letter F, followed by a dash, the trunk group number, followed by a dash, the fiber optic cable number, followed

by a dash, then fiber cable type, followed by a dash, followed by fiber number within the cable starting with 101.

Example for FOCP trunk cable fiber:

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F-9-007-M-103

F indicates optical fiber.

9 indicates trunk group number.

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007 indicates this is the 7th fiber optic cable in the trunk group.

M indicates multimode fiber.

103 indicates the third fiber in the cable.

Local or system specific cable optical fibers shall be marked with the letter F, followed by a dash, the circuit designation as listed in Sects. 305 and 400, followed by a dash, the fiber optic cable number, followed by a dash, then fiber cable type followed by a dash, followed by the fiber number within the cable, starting with 101.

Example for local or system specific cable fibers:

F-14TV-999-M-101

F indicates optical fiber.

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14TV indicates surveillance, training, and entertainment television system.

999 indicates this is the 999th fiber optic cable in the system.

M indicates multimode fiber optic cable.

101 indicates the first fiber in the cable.

Interconnection box labeling. - The interconnection box shall have a label plate attached to the cover identifying its physical location by a basic location number as specified in Sect. 507. If it is necessary to locate boxes such that the boxes would have the same location, the basic location number shall include a suffix letter, for example, 3-172-1A and 1B. Interconnection box identification and location plates shall be located on the outside of the cover. Drawing, NAVSHIPS No. 804-1640412 may be used as a guide to determine the lettering and dimensional requirements for information labels. Identification labels installed by a manufacturer on his equipment shall be metallic. Each connector or adapter position on the optical patch panels shall be marked. Splice trays shall be marked to identify each splice position, or a chart shall be attached in the box interior detailing the splice position numbers. A configuration chart showing all the connections within the box shall be permanently attached to the inside of the box lid. The input and output cable and

fiber numbers and the connector or splice position number shall be shown for each connection. For those unterminated fibers, the chart shall show the splice tray position or patch panel adapter number reserved for each fiber. In those instances where lasers are used as optical sources, each interconnection box shall be internally
5 marked in accordance with ANSI Z136.1

408f. Fiber optic cable plant

The FOCP shall be designed in accordance with MIL-STD-2051 and the
10 requirements herein. Location of fiber optic cable runs and location of fiber optic interconnection boxes shall comply with MIL-STD-2051 and the drawings.

Number of optical fibers. - The FOCT shall provide additional fibers for growth and for increased reliability and survivability through sparing and
15 redundancy as specified herein.

Fiber classifications. - The FOCP fiber classifications shall be as listed in Table III. Figure 1 shows a typical example of fiber classifications for local and
20 trunk cables.

User systems requirements. - The number and types of fibers for user systems shall be in accordance with the system drawings.

Termination of fibers. - Fibers shall be terminated as shown in Table III.
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FOCP requirements. - Redundant trunk fibers shall be provided for user system NRC fibers on a one for one basis. Redundant fiber optic trunk cables shall be separated for survivability. Each trunk group within the FOCP shall contain a minimum of 5 percent of the initial allocated and used FOCP fibers, rounded up to
30 the next whole number, as maintenance spares. Each fiber optic local cable that penetrates a deck or bulkhead shall contain a minimum of 5 percent of the initial allocated and used fibers, rounded up to the next whole number, as maintenance spares. All maintenance spare fibers shall be terminated. In instances where more than one cable connects the same two pieces of equipment, such as a typical trunk
35 group connecting two interconnection boxes, the spare fibers shall be evenly distributed among the cables.

**Fiber optic trunk groups shall have fibers provided for future growth, equal to at least 20 percent of the number of allocated (and used) and spare fibers in the
40 trunk, rounded up to the nearest even number. The growth fibers shall be evenly**

distributed among the fiber optic cables in the trunk group and between redundant paths. Growth fibers within trunk cables shall not be terminated.

Table III. FOCP Fiber Classifications and Termination Requirements

Classification	Trunk fibers	Local fibers	Terminated at Construction
Allocated and used	Normal channels Alternate channels NRC	Normal channels Alternate channels NRC	X X X
Allocated and not used	System spares System redundant FOCP redundant for NRC	System spares System redundant System growth	X X X
Unallocated	FOCP Maintenance spares FOCP growth	Maintenance spares	X
Unused	Fibers in standard cable size in excess of the sum of the allocated and unallocated fibers required in that cable.		

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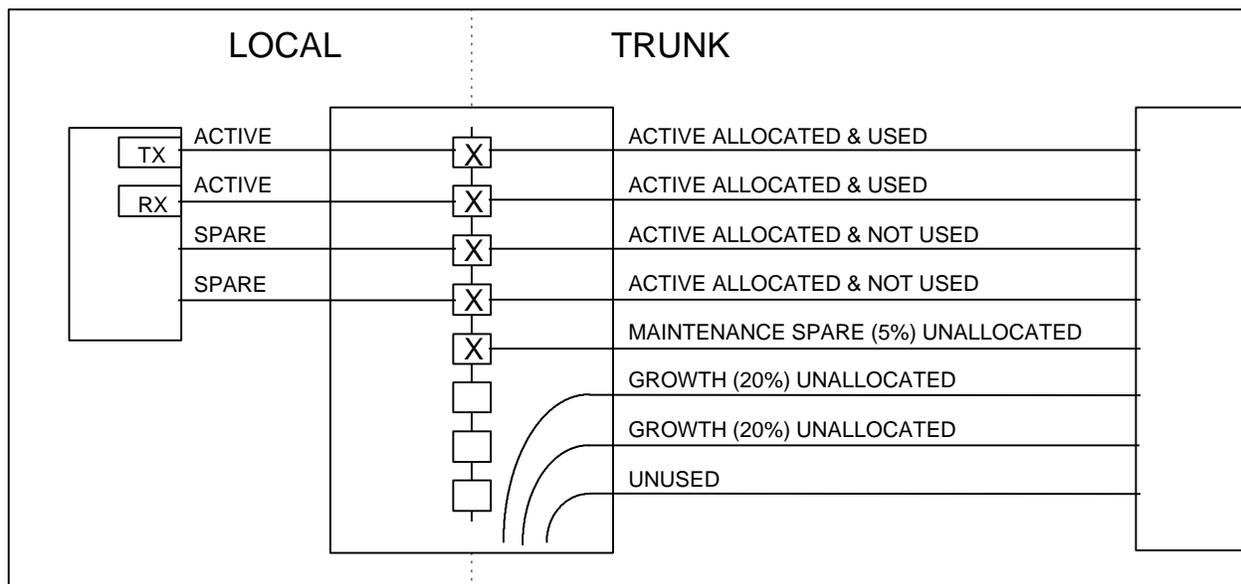


Figure 1: Fiber Classifications

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Fiber optic interconnection boxes. - The interconnection boxes shall have capacity for fiber optic connectors or splices for all allocated fibers in the box and as specified herein. All active and spare fibers shall have a splice or connector position assigned. In addition, termination space shall be allocated within the interconnection box to accommodate the greater of either the number of local growth

fibers or the number of trunk growth fibers contained within the interconnection box. Terminated growth fibers in local cables shall be stowed in the termination spaces allocated for growth within the interconnection box. Unterminated fibers shall be stowed within the interconnection box in accordance with MIL-STD-2042.

5 Fiber optic interconnection boxes shall be locked to prevent unauthorized access.

Bonding, grounding, and shielding. - Bonding, grounding, and shielding for boxes that contain active fiber optic components shall be in accordance with Sect. 407.

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Fiber optic cable repair. - Fiber optic cable repair shall be in accordance with MIL-STD-2042. Fiber optic cable shall not be spliced unless shown on the drawings.

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FOCP management. - The contractor shall provide a fiber optic topology management system for configuration management of the fiber optic topology. The fiber optic cable plant management system is intended to provide an automated configuration management capability for use by ship personnel. This software application shall be a stand-alone passive system. The human-machine interface shall be a Graphical User Interface (GUI). The fiber optic topology management system shall be capable of providing end-to-end graphical representation of optical fiber paths within the fiber optic topology. Textual information associated and displayed for each end-to-end path shall include as a minimum: individual fiber, cable, interconnection box, and connector identification, circuit identification, installed optical loss data, and end user equipment identification. The fiber optic topology management system shall provide schematic representation of each interconnection box and patch panel associated with the fiber optic topology. This schematic representation shall contain the same information as the as-built drawings. Information in the fiber optic topology management system shall be capable of being updated as the configuration of the fiber optic topology is changed.

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The fiber optic topology management system shall be capable of identification and reporting of reconfiguration options and available spare and growth resources. The information contained within the fiber optic topology management system shall use the same database structure and format as the network manager (if required) in order to establish a comprehensive network management and damage control situational awareness.

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408g. Handling and storage.

Handling and storage of fiber optic components shall be in accordance with MIL-STD-2042.

5 **408h. Shock and vibration.**

Fiber optic components shall meet grade A shock requirements in accordance with Sect. 072. Fiber optic components shall meet the vibration requirements in accordance with Section 073.

10 **408i. Technical documentation.**

Data shall be prepared to demonstrate compliance with the requirements herein covering cabling and cableways. As a minimum, the data shall include the following:

15 **Cableway locations.**

Cable identification at deck and bulkhead penetrations, and at those hangers where cables enter or leave the cableway.

Bulkhead and deck penetrations, including location and size of each hole.

Cable hanger design for each cable group.

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The drawings shall contain sufficient information so that a cable can be easily traced. Where practical, fiber optic cable documentation may be combined with electrical cable documentation.

25 **Isometric fiber optic cabling diagrams.** - Isometric fiber optic cabling diagrams shall indicate the relative location of inter compartment fiber optic cable runs between FOCP system components. For simplicity, decks on which no system equipment is installed may be represented by a ship's frame centerline. Long fiber optic cable runs along a deck may be simplified by eliminating deck areas where no
30 equipment is installed and by representing eliminated frame spaces with a broken line. The centerline frame space scale for the diagrams shall not be less than 1/16 inch to the foot or less than 1:200. Compartment outlines for spaces containing FOCP system equipment shall approximate the actual contours and shall be shown to indicate relative location within the ship. For clarity, compartments containing
35 multiple items of equipment or in which a number of fiber optic cables are installed may be depicted as separate enlarged views. A material list shall be provided. Applicable cableway installation drawings shall be included in the list of references.

40 **Cable running sheets.** - Cable running sheets may be provided in lieu of elementary or isometric cabling diagrams, subject to the following conditions. The cableway key plan may be provided as a series of two-dimensional deck plans;

however, a comma-delimited ASCII file giving the three dimensional coordinates of each cableway checkpoint and penetration shall be developed and provided. The coordinate reference for these dimensions shall be consistent with all other ship's drawings. Cable running sheets shall be provided in both hard copy and comma-delimited ASCII file formats, with each cable identified on a unique line in the file, followed by the starting point, the checkpoints associated with that cable, and the ending point.

Fiber optic cabling block diagrams. - Fiber optic cabling block diagrams shall be prepared and shall identify equipment and compartments. The diagrams shall be arranged to indicate relative compartment locations; for example: compartments located on the forward part of the ship shall be shown on the right half of the diagram.

Fiber optic interconnection box layout/fiber connection list. - A fiber optic interconnection box layout/fiber connection list shall be prepared that provides a detailed description of all fiber connections within each fiber optic interconnection box. This list shall detail connector identification, connector type, fiber identification, fiber type, and connection location within the interconnection box.

Fiber optic cable topology optical power budget analysis report. - A fiber optic cable topology optical power budget analysis report shall be prepared to document the optical power budgets for each system that uses the fiber optic cable topology. The fiber optic cable topology optical power budget analysis report shall be developed in accordance with MIL-STD-2052.