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DEPARTMENT OF DEFENSE STANDARD PRACTICE

FIBER OPTIC CABLING SYSTEMS REQUIREMENTS AND MEASUREMENTS

(Part 4: TEST SAMPLE CONFIGURATION AND FABRICATION REQUIREMENTS)

(PART 4 OF 6 PARTS)



AMSC N/A

FSC 60GP



FOREWORD

1. This Department of Defense Standard Practice is approved for use by the DLA Land and Maritime Columbus, Defense Logistics Agency, and is available for use by all Departments and Agencies of the Department of Defense.
2. Comments, suggestions or questions on this document should be addressed to DLA Land and Maritime Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to FiberOpticGroup@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at <https://assist.dla.mil>.
3. This standard practice provides detailed information and guidance to personnel concerned with ensuring standardization of fiber optic cable topologies (optical fiber cabling and associated components) on military mobile vehicles used in air, land, and sea applications. In general, the requirements and methods specified herein are not identifiable to any specific mobile vehicle class or type, but are intended to standardize and minimize variations in requirements, test setups, test measurement procedures, test sample fabrication configurations, and other aspects that must be addressed for completeness. Where specified, constraints for usage or platform types will be listed. The term "platform" will be used to refer to the military mobile vehicles in general or, where designated, one particular class (such as "aircraft platform") or one particular type within that class (such as "F-35").
4. In order to provide flexibility in the use and update of the different aspects for requirements and methods, this standard practice is issued in six parts; as follows:
 - Part 1: Design, maintenance and installation requirements. This part addresses design requirements for platforms that use cable harnesses as the means to transport data through optical fiber among communication network and end user equipment. Larger platforms excluding surface ships and submarines that route trunk cables through cableways and drop cables to the end user (application equipment), can cite applicable requirements in Part 1 of the Standard Practice and augment them with use of MIL-HDBK-2051 and MIL-STD-2042 as appropriate. Surface ships and submarines, are to use MIL-HDBK-2051, MIL-STD-2052 and MIL-STD-2042 in lieu of Part 1 of this Standard Practice with the exception of Personnel Proficiency. For Personnel Proficiency, Surface ships and submarines are to use Navy shipboard and application training requirements in requirement 1306 of this Standard Practice.
 - Part 2: Optical measurements. Part 2 of this standard addresses further details to refine or bound (constrain) the performance of each optical test measurement addressed. The test methods, such as those in a TIA455 series standard or military standard/specification, are cited in part 2. This part of the standard practice augments the test method in the standard or specification to ensure consistency with setup and measurement procedure. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor).
 - Part 3: Physical, mechanical environmental, and material measurements. Part 3 of this standard addresses further details to refine or bound (constrain) the performance of each physical, mechanical, environmental and material test measurement or inspection addressed. The test methods, such as those in a TIA455 series standard or military standard/specification, are cited in part 3. This part of the standard practice augments the test method to ensure consistency with setup, measurement procedure, data recording/analysis, and other factors critical to conducting or evaluating test performance. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor).
 - Part 4: Test sample configuration and fabrication requirements. Part 4 of this standard addresses further details to refine or bound (constrain) the configuration and fabrication of test samples for the fiber optic components addressed. Fabrication methods, such as those in the Shipboard installation standard, MIL-STD-2042, or in the general series aircraft maintenance manual, [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#), are cited in part 4. This part of the standard practice augments the fabrication method to ensure consistency with use of the same components (such as cable types) and processes and augments the component specification to ensure consistency of the test sample configuration.

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- Part 5 Design phase, supplemental and legacy measurements. Tests that are more unique to the design phase or tests and inspections that are not just primarily for qualification (supplemental measurements) are addressed in Part 5 of this standard practice. Also, legacy test methods and legacy criteria measurements are provided in this part of the standard practice with the recommended replacement method for the former (legacy) DOD-STD-1678 methods. These former DOD-STD-1678 test methods are listed under the constraint that they be used only with the specific military specifications or commercial standards in which they are cited. The intent is to delete each DOD-STD-1678 test method from that standard practice in Part 5 once its reference from military specification or commercial standard is removed.
- Part 6 Parts and support equipment commonality and standardization requirements. This part of the Standard Practice addresses component part and support equipment standardization requirements for platforms that transport data through optical fiber among communication network and end user equipment. Surface ships and submarines are to use the Navy Shipboard Fiber Optic Recommended Components Parts List, the Navy Shipboard Fiber Optic Recommended Test Equipment List and the Navy Shipboard Fiber Optic Recommended Tools List in addition to part 6 of this Standard Practice. Likewise, larger platforms that route trunk cables through cableways and drop cables to the end user (application equipment), can cite applicable requirements in Part 6 of the Standard Practice, cite the Navy Shipboard Fiber Optic Recommended Components Parts List (with the test equipment list and tool list), or both, as appropriate. The Navy Shipboard Fiber Optic Recommended Components Parts List can be obtained at the Navy Shipboard fiber optic website. Due to the dynamic nature of web addresses, the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address. For surface ships and submarines, where there is conflict between the cited documents on the Web Site and Part 6 of this Standard Practice, the three documents on the Web Site shall take precedence.

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1. SCOPE

1.1 Scope. Part 4 of this standard practice augments the specified fabrication method to ensure consistency with use of the same components (such as cable types) and processes. Mainly, this augmentation provides details to refine or bound (constrict) the requirements for the test sample configuration and fabrication. This part of the standard practice test sample may be referred to as Device Under Test or DUT in this Standard Practice.

1.1.1 Applicability. The test sample configuration and fabrication, such as those in a TIA455 series standard or military standard/specification, are cited elsewhere. This part of the standard practice augments by further refining or bounding the requirements found in the TIA455 series standard or military standard/specification to ensure consistency with test sample configuration and fabrication. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor) and product from different vendors. 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. When there is a conflict between this document and the platform specification or contract, the platform specification or contract should take precedence. Where obsolescence or other issues are such that the configuration or fabrication requirements specified for the refinement or bound (constraint) herein cannot be implemented, users should submit a description of the issue along with a request for clarification or with proposal for redefining the requirement to consider for incorporation into this standard practice to: DLA Land and Maritime Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to FiberOpticGroup@dla.mil.

1.2 Intended uses for Part 4.

1.2.1 Primary use of Part 4. Part 4 of this standard practice was prepared primarily to ensure consistency in the configuration and fabrication of test samples used in qualification testing.

1.2.2 Supplemental use. Part 4 of this standard practice contains information for test sequences that should be used during qualification. These test sequences specify the type and number of test samples that should be used for each inspection (test). The intent is to ensure consistency in test sample configuration and sample size.

1.2.3 General constraints on use. Part 4 of this standard practice is not intended to be used in lieu of a test laboratory specifying test sample configurations and sample sizes applicable to each specific test procedure.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE STANDARD

[MIL-STD-2042](#) - Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships, Parts 1 to 6.

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-49291](#) - Fiber, Optical, (Metric) General Specification for

[MIL-PRF-24623](#) - Splice, Fiber Optic Cable General Specification for (Metric)

[MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for

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

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE PUBLICATION

[NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4](#) - Aircraft Fiber Optic Cabling, Technical Manual, Installation and Testing Practices.

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

AMERICAN NATIONAL STANDARDS INSTITUTE

[ANSI Z136.2](#) - Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources.

(Copies of these documents are available on-line at www.ansi.org or from the ANSI Customer Service Department, 25 W. 43rd Street, 4th Floor, New York, NY 10036.)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-440](#) - Fiber Optic Terminology.

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

3. DEFINITIONS

3.1 General fiber optics terms. Definitions for general fiber optics terms used in this standard practice are in accordance with TIA-440. Definitions for other terms as they are used in this standard practice are given in the following paragraphs.

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

DUT Device under test
FOCT Fiber optic cable topology
QPL Qualified Products List

3.3 Qualification testing, general. Formal testing designed to demonstrate that the software and hardware of a system meet specified requirements. General qualification testing may be accomplished at any time during the life of a system, such as during prototype development, manufacturing, shipment, storage, installation, and operation. Most often this qualification testing is conducted to determine the extent to which a system passes a specified set of performance criteria.

3.4 Qualification testing, QPL process. For purposes of this standard practice, qualification testing is refined and bounded to the term as used for Government Qualified Products List (QPL) testing or inspection. This testing is performed to determine if the FOCT (fiber optic cable topology) component or DUT (device under test) meets the requirements specified in the fiber optic component applicable military specification. Physical, optical, mechanical, environmental, and material testing is performed in specified test sequences. One parameter is tested at a time. Successful completion places the DUT onto the QPL for that FOCT component military specification. Other terminology is to be used in lieu of qualification for any prototype development, manufacturing, shipment, storage, installation, and operational testing.

4. GENERAL REQUIREMENTS

4.1 Test sample configurations.

4.1.1 Connectors and splices. Cable assembly configuration normally consists of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. For insertion loss tests on multiple termini connectors where a cut-back must be done, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. If a specific mechanical or environmental test requires longer lengths to reach optical measurement instrumentation, added test jumpers may be used after receipt of Government approval. Test sample configurations for multiple termini connectors, termini for multiple termini connectors, and aircraft mechanical splices are further identified in this Standard Practice.

4.1.2 Optical fiber and cable. DUT lengths are generally over 1,000 meters for optical fiber and 500 meters for fiber optic cable. These lengths are required to permit sufficient optical measurement resolution for deviations in optical performance during testing. Some mechanical and environmental tests permit cutting the DUT into multiple sections for testing. Mechanical tests are mostly performed on short lengths (usually less than 10 meters) and environmental tests on longer lengths (150 to 500 meters for fiber optic cable, over 1000 meters for optical fiber). Due to these different lengths, the optical transmittance measurements (for change in optical transmittance) are done in dB for mechanical tests and in dB/km for environmental tests.

4.2 Safety compliance during DUT assembly fabrication.

4.2.1 Fiber optic safety precautions. The fiber optic safety precautions listed in ANSI Z136.2 and subordinate Work Package 004 01 of NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall apply. Verify, at a minimum, that operating/test personnel are aware of 4.2.1a through 4.2.1m.

- a. Keep all food and beverages out of the work area. If fiber particles are ingested they can cause internal injury.
- b. Do not smoke while working with fiber optic systems.
- c. Always wear safety glasses with side shields. Treat fiber optic splinters the same as glass splinters.
- d. Never look directly into the end of fiber cables until you are positive that there is no light source at the other end. Use a fiber optic power meter to make certain the fiber is dark.
- e. Do not touch the ends of the fiber, as they may be razor sharp. Rinse hands thoroughly under running water to rinse away any glass shards.
- f. Contact wearers must not handle their lenses until they have thoroughly rinsed and then washed their hands.
- g. In the event glass shards enter the eye or penetrate the skin seek medical attention immediately.

CAUTION: Do not rub your eye. Only authorized medical personnel should attempt removal of glass shards from the eye. Do not attempt removal of glass from the eye yourself!

- h. Do not touch your eyes while working with fiber optic systems until your hands have been thoroughly cleaned.
- i. Clean hands thoroughly first by rinsing hands under running water to rinse away any glass shards after handling and repairing fiber. Then wash normally. Wear protective gloves if at all possible.
- j. Keep all combustible materials safely away from heat sources.

k. Ultraviolet (UV) safety glasses shall be worn when using the UV curing lamp.

l. Only work in well-ventilated areas.

m. Avoid skin contact with epoxies.

4.3 Consensus for test sample fabrication and sample size. Part 4 of this Standard Practice is a compilation of existing requirements previously released in the form of other documents. Consensus was obtained among various Government activities, responsible for specifying the performance of fiber optic cabling components and systems/networks, on the requirements documented herein. These same Government activities shall be the means to reach consensus on standardization of new/revised requirements, identify new requirements and new technologies that permit its rapid introduction, and provide those requirements to update Part 4 of this Standard Practice.

5. DETAILED REQUIREMENTS

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES

5.1 Connection (connector, termini and mechanical splices) requirements. Requirements for the fiber optic test sample configurations, fabrication and specific methods/practices shall be implemented as specified in 5.1.1 through 5.1.4.

5.1.1 MIL-PRF-29504/4 and MIL-PRF-29504/5 termini. Test sample configurations and fabrication shall be performed to Requirement 4101.

5.1.2 MIL-PRF-29504/14 and MIL-PRF-29504/15 termini. Test sample configurations and fabrication shall be performed to Requirement 4102.

5.1.3 MIL-PRF-29504/18 terminus. Test sample configurations and fabrication shall be performed to Requirement 4103.

5.1.4 MIL-PRF-24623/7 mechanical splice. Test sample configurations and fabrication shall be performed to Requirement 4104.

5.2 Optical Fiber and Cable Requirements. Requirements for the fiber optic test sample configurations, fabrication and specific methods/practices shall be implemented as specified in 5.2.1.

5.2.1 MIL-PRF-49291 optical fiber. Test sample configurations and fabrication shall be performed to Requirement 4201.

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 test sample configurations and fabrication requirements depicted in this standard practice are intended for qualification testing; however, they are applicable for other types of test or evaluation programs that require citing the configuration and fabrication for fiber optic cabling components used on military mobile vehicles also identified as platforms.

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

6.3 Subject term (key word) listing.

Test sample fabrication requirements

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6.4 Changes from previous issue. The margins of the specification are marked with vertical lines to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

6.5 Supersession data.

The six parts of MIL-STD-1678 replace superseded DOD-STD-1678 with completely new fiber optic requirements and measurements. With the exception of some legacy material in Part 5 of MIL-STD-1678, none of the fiber optic test and measurement material comprising superseded DOD-STD-1678 has been included. With the exceptions noted in Part 5 of this standard practice, this standard practice should be applied in lieu of the legacy methods in superseded DOD-STD-1678.

REQUIREMENTS

FIBER OPTIC TEST SAMPLE CONFIGURATIONS,
FABRICATIONS, AND SPECIFIC METHOD/PRACTICES

CONNECTION (CONNECTOR, TERMINI, AND MECHANICAL SPLICES) REQUIREMENTS

(Requirements 4101 – 4106)

REQUIREMENT 4101

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS / PRACTICES FOR
MIL-PRF-29504/4 & /5 TERMINI

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (i.e., fabrication) of the fiber optic test sample (DUT assembly) for MIL-PRF-29504/04 & /05 termini and, by extension for fiber optic applications, MIL-DTL-38999 connectors. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.

[MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

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

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE PUBLICATION

[NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4](#) - Aircraft Fiber Optic Cabling, Technical Manual, Installation and Testing Practices.

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

REQUIREMENT 4101

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

3. Definitions.

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable bundle, fiber optic. Single fiber cables grouped together and usually secured by lacing tape. The cable bundle can be placed in convoluted tubing, used in various protected harness configurations or used as is in an open cable harness configuration.

3.3 Cable, loose tube. A fiber optic cable design is one configured with one or more optical fibers are fitted loosely within a tube, giving the optical fibers freedom to move. This mobility and isolation from the tube minimizes the effects of external forces on the performance of the link. The isolation allows cable expansion and contraction with temperature independent of the optical fibers.

3.4 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coating (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, and allows for more roughed handling (such as better crush and impact resistance).

3.5 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.6 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

3.7 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.8 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.9 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.10 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

REQUIREMENT 4101

4. Configurations. In the context of Requirement 4101, the component being tested (device under test or DUT) is the MIL-PRF-29504/4 & MIL-PRF-29504 /5 termini. The test sample or DUT assembly is the DUT with the other fiber optic components that comprise these assembled components. Configurations for DUT assemblies that shall be used for qualification conform to specific type, size and other fiber optic component parameters that serve to constrain and standardize on the DUT assembly make-up. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also. Configurations used and fabrications performed shall be those as specified in 4.1 through 4.4.

4.1 Termination. The terminus termination process of the test sample fabrication shall be in accordance with Work Packages WP 010 05, 010 06, 010 07, and 010 08 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 for style 1 termini, style 2 termini with ceramic ferrules, style 2 termini with metal ferrules (and jeweled inserts), and style 3 termini, respectively.

4.2 Connector accessories configuration. The backshell configurations to use as part of the test sample have not been standardized to date. Refer to the Qualifying Activity for backshell configurations to be used.

4.3 Connector accessories assembly. The connector accessories assembly process shall be in accordance with Work Package WP 011 03 or WP 011 05, as applicable, of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4.

4.4 Test sample configurations.

4.4.1 Qualification inspections, except interoperability. Dependent upon the inspection/test performed (see [table 4101-I](#)), the termini test samples shall be in one of three configurations:

- a. Un-terminated,
- b. As part of a single fiber cable (i.e., a cable assembly),
- c. As an integral part of a multiple termini connector (i.e., within a multiple termini connector that is part of a cable assembly).

The construction details for each of the three test sample configurations for "Qualification" shall be performed as listed in section 5 herein.

4.4.2 Interoperability. Policy to perform testing, submission to test laboratory, test sample submission, test sample configuration and other fabrication requirements for "Interoperability" shall be performed as listed in section 5 herein.

REQUIREMENT 4101

TABLE 4101-I. Qualification inspections (except interoperability).

Terminus ferrule material and fiber size	Ceramic ferrule			Metal ferrule	
Test performed <u>12/</u>	SM fiber <u>5/</u>	MM fiber <u>5/</u>	MM 100/140 after MM <u>6/</u>	MM 100/140	MM Fiber
Tests for unterminated termini					
Group 1 <u>3/</u>					
Size <u>1/</u>	X	X	X	X	X
Weight <u>1/</u>	X	X		X	
Identification markings <u>1/</u>	X	X		X	
Workmanship <u>1/</u>	X	X		X	
Circular runout <u>1/</u>	X	X		X	
Group 2 <u>2/</u>					
Terminus retention <u>1/</u>	X	X		X	
Terminus engagement & separation forces <u>1/</u> , <u>13/</u>	X	X		X	
Terminus cleaning	X	X		X	
Group 3					
None					
Tests for termini as part of a single fiber cable					
Group 1					
None					
Group 2					
Cable pull out force <u>4/</u>	X	X		X	
Group 3					
Salt spray	X	X		X	
Tests for termini as an integral part of a multiple termini connector					
Interoperability <u>7/</u>					
Group 1					
Optical tests					
Insertion loss (initial)	X	X	X	X	X
Return loss (single mode only)	X				
Group 2					
Mating durability	X	X		X	
Terminus cleaning	X	X		X	
Return loss <u>10/</u>	X				
Group 3 Environmental/Mechanical					
Mechanical tests <u>8/</u>					
Shock, MIL-DTL-901 <u>9/</u>	X	X		X	
Shock, half-sine pulse <u>9/</u>	X	X		X	
Vibration, swept sine <u>9/</u>	X	X		X	
Vibration, random at temperature <u>9/</u>	X	X		X	
Vibration, random at ambient <u>9/</u>	X	X		X	
Insertion loss (verification) <u>11/</u>	X	X		X	
Return loss (single mode only) <u>11/</u>	X				
Environmental tests <u>8/</u>					
Thermal shock	X	X		X	
Temperature life	X	X		X	
Insertion loss (verification) <u>11/</u>	X	X		X	
Return loss (single mode only) <u>11/</u>	X				

- 1/ These inspections are to be performed by the manufacturer at the production facility. Exception may be taken for weight, circular run out, terminus retention, and terminus engagement and separation forces when approved by the qualifying activity.
- 2/ Test fixture for this test is to include fiber optic; MIL-DTL-38999 series III shell size 17 connectors with 8 cavity inserts; both plug and receptacle for retaining the termini during testing.
- 3/ Sample size. One pair = one pin terminus and one socket terminus. A minimum sample size shall be used to ensure sufficient quantity for termini inspections as part of a single fiber cable and for termini inspections as an integral part of a multiple fiber connector.

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TABLE 4101-I. Qualification inspections (except interoperability) - Continued.

- 4/ Each terminus is to be terminated on one end of a single fiber cable. Cable used is to have provisions compatible with termini strain relief, as applicable. Termini, selected from the group that underwent inspections for un-terminated termini, shall be used. A minimum sample size of 16 pin termini and 16 of the applicable counterpart socket termini, selected from the group that underwent inspections for un-terminated termini, shall be used for each of these tests. Pin terminus. Separate test samples for the pin terminus must be prepared on single fiber cable with strain relief. The change in optical transmittance shall be met both during and after the test. Socket terminus. Separate test samples for the socket terminus must be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus). The change in optical transmittance shall be met after the test.
- 5/ Complete test sequence shall be done for test samples with single mode fiber and with multimode fiber.
- 6/ Limited test sequence shall be done for test samples with multimode 100 fiber if complete test sequence performed with test samples with multimode fiber either before or concurrently.
- 7/ Interoperability. This testing is done by DLA Land and Marine-VTP which maintains/retains the interoperability standards. Please note that separate test samples are required for interoperability testing. These test samples will then be retained by DLA Land and Marine as interoperability standards.
- 8/ Mechanical tests. See [appendix A, table 4101 A-I, note 4/](#).
- 9/ Shock and vibration. Two connector mated pair must be tested. At least four termini pair in connector mated pair are to be monitored for optical signal discontinuity (and for change in optical transmittance). Any other mated pair not monitored for optical signal discontinuity is to be monitored for change in optical transmittance.
- 10/ Return loss after mating durability. If failure occurs, ferrule end faces may be repolished and test redone.
- 11/ An insertion loss verification and a return loss test is required near or after the conclusion of the mechanical tests and after the environmental tests.
- 12/ Test sequence listed is performed for each different cable strain relief (Styles 1 and 2) and ferrule material (ceramic, metal) allowed under the specification sheet.
- 13/ Perform on socket terminus only.

5. Implementation. Test samples (DUT assemblies) shall be prepared for both "Qualification, except interoperability" and for "Interoperability" as specified in [5.1](#) and [5.2](#).

5.1 Qualification, except interoperability. DUT assemblies for termini qualification shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for qualification test samples (DUT assemblies), except interoperability, shall be implemented as specified in [appendix A](#).

5.2 Interoperability. DUT assemblies for termini interoperability shall consist of the tests specified in 4.10 of MIL-PRF-29504 except that terminus insertion and removal forces shall not be performed. Configuration and fabrication requirements for interoperability test samples (DUT assemblies), shall be implemented as specified in [appendix B](#).

6. NOTES

6.1 Intents behind standardization efforts.

6.1.1 Decrease matrix of test samples to be tested. Parties involved wanted to see termini tested with various ferrule hole diameters, ferrule material, strain relief capture mechanisms, epoxy types, cable types (tight buffer, loose tube, polyimide coated fiber, etc.), fiber types, etc. The number of test samples required became impracticably large. Government determined the test sample configurations that would be considered minimum, but acceptable. These test sample configurations are described in Requirement 4101.

6.1.2 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.1.3 Test data consistency. Testing to be performed needs to standardize on test sample configurations, test sample fabrication (including the fiber optic components/materials used), method to achieve launch condition, specific test practices, etc. in order to reduce test variables (achieve better test consistency).

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6.2 Interoperability. Separate test sample configurations are required for interoperability testing. These test sample configurations are in addition to the ones to be used for the other qualification tests.

6.3 Supplemental information. This information was included in NAVSEA Drawing 8283255, in addition to the information on test sample fabrication. NAVSEA Drawing 8283255 is superseded by Requirement 4101. This supplemental information formerly in a NAVSEA Drawing is provided in 6.3.1 through 6.3.2.

6.3.1 Optical source wavelength summary.

- a. Test samples with single mode fiber.
 - (1) Optical tests except return loss: 1310 nm (connection loss more dominant for this component).
 - (2) Return loss: 1310 nm.
- b. Test samples with multimode fiber.
 - (1) Optical tests except return loss: 850 nm or 1300 nm (850 nm preferred)
 - (2) Return loss: 1310 nm.

6.3.2 Polishing puck specifications.

- a. Interoperability. Polishing pucks (pin or socket) must be standardized to the extent that interoperability with any termini (pin or socket) is achieved by the polishing puck accommodating the minimum length for ferrule protrusion.
- b. Dimensional specifications.
 - (1) The standardized polishing puck must accommodate a terminus with the maximum envelope dimensions, as defined in [MIL-PRF-29504/4](#) or [MIL-PRF-29504/5](#) whichever is applicable.
 - (2) Length of ferrule protrusion from the terminus barrel (body). Polishing puck must be designed to accommodate a minimum exposed ferrule length or minimum ferrule protrusion from the terminus barrel (body) of 0.158 inches.
 - (3) Terminus perpendicularity. The terminus must be oriented in the standardized polishing puck so that it remains perpendicular, along its axial (versus radial) direction, to the polishing surface of the polishing puck.
- c. Mechanical specifications.
 - (1) Stability of polishing surface area. Standardized polishing puck must include an adequate polishing surface area to prevent tilting so that the terminus (along the axial direction) remains perpendicular to the polishing film and plate during the polishing process.
 - (2) Grooved polishing surface. Standardized polishing pucks must be grooved to the extent sufficient for preventing polishing puck binding to the polishing film during a wet polish, but still obtain a sufficient polish (either wet or dry).
 - (3) Sufficiently large exiting diameter for cable assembly (applicable if specific polishing puck design includes a collar or other restriction). Standardized polishing puck must have a sufficiently large diameter opening to allow rear of terminus barrel (body) fit into the puck when shrink sleeve/tubing, aramid yarn (such as Kevlar) bunches up or other fabrication anomalies require the opening to be increased.

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APPENDIX A

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES
(EXCEPT INTEROPERABILITY)

A.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of MIL-PRF-29504/4 and MIL-PRF-29504/5 termini. Fabrication criteria are addressed in [appendix B](#) for test samples to be used for interoperability.

A.2 Applicable documents.

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

A.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase and Legacy Measurements)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

GENERAL SERIES TECHNICAL MANUAL

[NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455](#) - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

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A.3 Test samples, unterminated termini. Minimum number of termini required for one fiber size to perform a full termini only qualification is provided in table 4101 A-I.

TABLE 4101 A-I. Termini allocation table for each fiber size. 1/

Test performed	Number of pin termini	Number of socket termini
Qualification, except interoperability		
Untermated termini tests		
	64	64
Group 1	64 of 64	64 of 64
Group 2 (16 pair minimum)	16 of 64	16 of 64
Group 3 (polymeric materials only)	None	None
Termini as part of a single fiber cable tests 2/		
	16 of 64	16 of 64
Group 1	None	None
Group 2 (16 pair – minimum each test)	16 of 16	16 of 16
Cable pull out force	16	16
Group 3	16 of 16	16 of 16
Salt spray 3/	16	16
Termini as an integral part of a multiple termini connector		
	32 of 64	32 of 64
Group 1 (6 connector mated pair)	32 of 64	32 of 64
Group 2 Mating durability (2 connector mated pair)	16 of 32	16 of 32
Group 3 Mechanical (2 connector mated pair)	4/	4/
Group 3 Environmental (2 connector mated pair)	16 of 32	16 of 32
Interoperability 5/		
	53	53

1/ See A.3.1 and A.3.2 and notes with table 4101-I for further detail. See MIL-PRF-29504/4 and /5 for listing of tests to be performed. See table 4101-I for breakdown by fiber size.

2/ Termini-to-ST jumpers.

3/ 16 termini from the termini designated for Group 2 (cable pullout force).

4/ No additional termini required. Same 2 connector mated pair from Group 2 are used.

5/ Configuration and fabrication requirements for interoperability samples are found in appendix B

A.3.1 Quantity. Minimum of 64 pin termini and 64 socket termini for each fiber type (single mode, multimode, multimode 100). Note: This minimum number does not include the number of termini required for interoperability (53 pin termini and 53 socket termini, see appendix B for further details on interoperability).

A.3.2 Allocation of these 64 pin termini and 64 socket termini for remaining testing is as follows:

A.3.2.1 Untermated termini.

- Group 1: 64 pin termini and 64 socket termini.
- Group 2: 16 pin termini and 16 socket termini (from the group 1 termini).

A.3.2.2 Termini as part of a single fiber cable.

- Group 2 cable pullout: 16 pin termini and 16 socket termini.
- Group 3 salt spray: use test samples from Group 2 cable pullout.

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A.3.2.3 Termini as an integral part of a multiple termini connector.

- a. Interoperability: See [appendix B](#).
- b. Group 1 Optical (insertion loss & return loss) then Group 2 mating durability followed by Group 3 mechanical tests: 2 mated pair (16 pin termini and 16 socket termini).
- c. Group 1 Optical (insertion loss & return loss) then Group 3 environmental tests: 2 mated pair (16 pin termini and 16 socket termini).

A.4 Test samples. Termini as part of a single fiber cable.

A.4.1 Quantity. 16 pin termini and 16 socket termini selected from the lot of un-terminated termini.

A.4.2 Configurations and fabrication.

A.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable for termini with ceramic ferrules, multimode 100 on loose tube cable for termini with metal ferrules) and fabrication of termini-to-ST connector jumpers shall conform as specified in [A.5.1](#), [A.5.3](#), and [A.5.7](#) below. For cable pullout, test samples for the pin and the socket termini shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the heat shrink sleeve for Style 1 termini and epoxy inside the terminus barrel (body) for Style 2 termini).

A.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#). Post polish shall result in a domed ferrule end face with a PC polish for termini and for instrument end connectors.

A.4.3 Cable type. Cable used must be of same configuration specified in [A.5.2](#) below; however, this cable does not need to meet environmental specifications in MIL-PRF-29504/4 and MIL-PRF-29504/5. The optical fiber in the cable used must be the same or equivalent to the approved cabling as stated in [A.5.2](#) below. Submit request for alternate cable to DLA Land and Maritime – VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table.

A.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

A.5 Test samples. Termini as an integral part of a multiple termini connector.

A.5.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for termini with ceramic ferrules and for ST connectors (or other instrumentation-end connectors). End face geometry requirement shall be a flat ferrule with a NC polish for termini with metal ferrules. End face geometry shall be as specified in MIL-STD-1678-1.

A.5.2 Cable type. The Government must approve cable brand and part number prior to test sample termination. Cables approved to date are those listed in tables 4101 A-II and 4101 A-III.

A.5.2.1 Test samples used for insertion loss only. Cable used must be of same configuration specified; however, this cable does not need to meet environmental specifications in MIL-PRF-29504/4 and MIL-PRF-29504/5. The fiber in the cable used must be the same or equivalent to the approved cabling as listed in [A.5.2](#). NAVAIR 4.5 will determine if the fiber is equivalent. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table.

TABLE 4101 A-II. Loose tube cable.

Fiber size (microns)	Cable vendor	CAGE code	Part number	Alternate part number
62.5/125/155	General Cable	4AJA4	OC-1660	None
100/140/172	General Cable	4AJA4	OC-1260	None

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TABLE 4101 A-III. Tight buffer cable.

Fiber size (microns)	Cable vendor	CAGE code	Part number	Alternate part number
9/125	OFS Fitel	0MZN3	C14447	None
50/125 <u>1/</u>	OFS Fitel	0MZN3	C10027	BC06815
100/140/172 <u>1/</u>	OFS Fitel	0MZN3	BC05082	None

1/ Cable must be preconditioned prior to terminus termination and connector assembly as specified in [MIL-STD-1678-5](#) Measurement 5301.

A.5.3 Epoxy type. Approved epoxy shall be used for test sample termination. Epoxies approved to date are those in table 4101 A-IV.

TABLE 4101 A-IV. Epoxy types.

Epoxy type	Vendor/CAGE code	Part number	Cure schedule
Two-part liquid, Epo-tek 353ND <u>1/</u>	64201	353ND-2g	<u>2/</u>
	08RC6	3700-5520	<u>2/</u>
Solid	06324	<u>3/</u>	<u>4/</u>
	71468		<u>4/</u>

1/ Two part, heat cured epoxy provided in 2 gram A-PAKS. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ See table I, WP 010 02 in NAVAIR 01-1A-505-4, T.O. 1-1A-14-4/TM 1-1500-323-24-4.

3/ No part number specified. Solid epoxy "beads or pre-forms" provided with terminus. This epoxy is only for use with MIL-PRF-29504/4 & /5 style 2 terminus with a metal ferrule (and je weled insert).

4/ Preheat oven at $225 \pm 5^{\circ}\text{C}$ for 20 minutes then cure at $225 \pm 5^{\circ}\text{C}$ for 10 minutes.

A.5.4 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see [A.5.1](#)).

A.5.4.1 Polish type. The standard polish specified in NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

A.5.4.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in the Work package for the applicable terminus type in NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall be used.

A.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced only if other steps and processes adhere to and resultant termination meets specified optical performance.

A.5.5 Connectors.

A.5.5.1 Configuration. A MIL-DTL-38999, series III, shell size 17 qualified flanged connector receptacle with an 8 channel (cavity) insert and a MIL-DTL-38999, series III, shell size 17 qualified connector plug, with an 8 channel (cavity) insert shall be used.

A.5.5.2 Variation. There are two variants that may be used for this connector. One variant is the MIL-DTL-38999 Series III electrical connector while the other is a MIL-DTL-38999 tight tolerance series III connector (the latter being specification sheets MIL-DTL-38999/60 & /61 specific to fiber optic applications). These two variants have different optical performance requirements that shall be used in verifying compliance.

A.5.5.3 Backshell (connector accessory). A MIL-PRF-64266/13 or equivalent is preferred. A MIL-PRF-64266/12, MIL-PRF-64266/14, MIL-PRF-64266/19, MIL-PRF-64266/20 or MIL-PRF-64266/21 backshell or equivalent is acceptable.

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A.5.5.4 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert. All 8 channels are to be active optically for termini qualification testing.

A.5.5.5 Fiber type. Each mated pair shall contain only one fiber type.

A.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of [MIL-STD-1678-2](#).

A.5.7 Fabrication. Termini type with ceramic ferrules. At a minimum, separate sets of test samples shall be tested on cable assemblies fabricated with single mode fiber, with multimode fiber and with multimode 100/140 fiber. Test sample configurations shall consist of termini-to-ST connector jumpers. Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

A.5.7.1 Single mode 9. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4101 A-V.

TABLE 4101 A-V. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	125.5 +1/-0 μ m
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4101 A-III .
Epoxy type	Two part, heat cured, liquid type per table 4101 A-IV .
Test sample quantity	4 mated pair per A.5.1 through A.5.6 .
Tests performed	Full test sequence (see table 4101 A-I).

1/ 9.3/125 micron at 1310 nm.

A.5.7.2 Multimode. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 50/125 micron fiber shall conform to table 4101 A-VI.

TABLE 4101 A-VI. Fabrication for multimode fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 μ m with 1 micron maximum circular run out <u>1/</u>
Fiber size	50/ 125 micron
Cable type	Tight buffer per table 4101 A-III . <u>2/</u>
Epoxy type	Two part, heat cured, liquid type per table 4101 A-IV .
Test sample quantity	4 mated pair per A.5.1 through A.5.6 .
Tests performed	Full test sequence (see table 4101 A-I).

1/ For test samples with polyimide coated fiber, the requirement shall be 156 +3/-0 μ m with 3 micron maximum circular run out

2/ For test samples with polyimide coated fiber, the requirement shall be for loose tube cable per [table 4101 A-II](#).

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A.5.7.3 Multimode 100. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 100/140/172 micron fiber shall conform to table 4101 A-VII.

TABLE 4101 A-VII. Fabrication for multimode 100 fiber size.

Parameter	Requirement
Ferrule hole diameter	173 +3/-0µm
Fiber size	100/140/172 micron
Cable type	Tight buffer per table 4101 A-III .
Epoxy type	Two part, heat cured, liquid type per table 4101 A-IV .
Test sample quantity	2 mated pair per A.5.1 through A.5.6 .
Tests performed	Limited test sequence (see table 4101 A-I). <u>1/</u>

1/ Size and insertion loss only if met requirements for multimode.

2/ Qualification by similarity. This quantity (i.e., test sample size of 2 mated pair) and limited testing is applicable only if qualification requirements are met for the cable assembly configuration with multimode 50/125 fiber (see b (2) under qualification by similarity in MIL-PRF-29504/4 & MIL-PRF-29504/5).

A.5.8 Fabrication. Termini type with metal ferrules. At a minimum, separate sets of test samples shall be tested on cable assemblies fabricated with multimode fiber and with the multimode 100/140 fiber. Test sample configurations shall consist of termini-to-ST connector jumpers. Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

A.5.8.1 Multimode 100. Candidate terminus-to-ST connector jumpers with multimode cable containing 100/140/172 micron fiber shall conform to table 4101 A-VIII.

TABLE 4101 A-VIII. Fabrication for multimode 100 fiber size with metal ferrule termini.

Parameter	Requirement
Ferrule hole diameter	175 +3/-0 µm
Fiber size	100/140/172 micron
Cable type	Loose tube per table 4101 A-II .
Epoxy type	Solid type per table 4101 A-IV .
Test sample quantity	4 mated pair per A.5.1 through A.5.6 .
Tests performed	Full test sequence (see table 4101 A-I).

A.5.8.2 Multimode. Candidate terminus-to-ST connector jumpers with multimode cable containing 62.5/125 micron fiber shall conform to table 4101 A-IX.

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TABLE 4101 A-IX. Fabrication for multimode fiber size with metal ferrule.

Parameter	Requirement
Ferrule hole diameter	157 +3/-0 μ m
Fiber size	62.5/ 125/155 micron
Cable type	Loose tube per table 4101 A-II.
Epoxy type	Solid type per table 4101 A-IV.
Test sample quantity	2 mated pair per A.5.1 through A.5.6.
Tests performed	Limited test sequence (see 2/ for constraints) 1/

[1/](#) Size and insertion loss only if meet qualification by similarity constraints listed in [2/](#).

[2/](#) Qualification by similarity. This quantity (i.e., test sample size of 2 mated pair) and limited testing is applicable only if qualification requirements are met for the cable assembly configuration with multimode 62.5/125/155 fiber (see b (5) under qualification by similarity in MIL-PRF-29504/4 and MIL-PRF-29504/5).

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APPENDIX B

CONFIGURATION AND FABRICATION REQUIREMENTS FOR INTEROPERABILITY TEST SAMPLES

B.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the interoperability testing of MIL-PRF-29504/04 and /05 termini. In the past, the Government has partnered with termini/connector companies that were undergoing Qualified Products List testing in an effort to verify interoperability of fiber optic, multiple termini connectors that conform to MIL-PRF-28876. This partnership allows the Government to verify the interoperability of connectors with that of participating companies. DLA Land and Maritime - VTP is now the Government entity that performs the testing for interoperability. This partnership for interoperability testing is now extended to other termini/connectors including the MIL-PRF-29504/4 & MIL-PRF-29504/5 termini.

B.2 Applicable documents.

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

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-24792](#) - Adhesive, Epoxy, Two Part, Fiber Optics
- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
- [MIL-PRF-85045](#) - Cables, Fiber Optics, (Metric), General Specification For

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase and Legacy Measurements)

(Copies of these documents are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

GENERAL SERIES TECHNICAL MANUAL

[NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWC DD Web Site in the Fiber Optics Recommended List section. This NSWC Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified tool. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

B.3 Policy pertaining to test sample submission. Vendors shall be responsible for the fabrication, submittal and replacement/refurbishment of cable assemblies (test samples) in the configurations specified below to the Government for Interoperability testing.

B.3.1 Test sample retention. One stipulation is that the test samples are to be retained by the Government for use as standards in future interoperability testing to be performed by the Government in-house personnel. Only personnel to be present during interoperability testing are Government, in-house personnel. At no time shall other parties have access to or examination of the interoperability standards.

B.3.2 Replacement/refurbishment. Another stipulation is that the vendor shall agree to replace or refurbish these interoperability standards as the need arises. Any items requiring replacement/refurbishment in this agreement shall be performed by the vendor at no cost to the Government.

B.3.3 Notification for submission. Initial notification to submit test samples for interoperability shall be made to DLA Land and Maritime-VQP Qualifications Group.

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B.3.4 Arrangements to perform interoperability testing. Once approved by DLA Land and Maritime-VQP, the vendor shall make financial, test and shipping arrangements with the DLA Land and Maritime-VTP Passive Test Section. Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime-VTP point of contact.

Shipping address:
DLA Land and Maritime
3990 East Broad St.
Bldg 11, Section 7, VTP
Columbus OH 43213-1199

TABLE 4101 B-I. Termini interoperability test variations. 1/

Test variation	Connector receptacle	Termini socket	Connector plug	Termini pin
1	X	A	X	B
2	X	B	X	A
3	X	B	X	B

X = Previously certified connector , B = Candidate termini

A = Previously certified termini

1/ Socket termini placed in connector receptacle, pin termini in connector plug.

TABLE 4101 B-II. Termini allocation table for each fiber size. 1/

Test performed	Number of pin termini	Number of socket termini
	53	53
Interoperability of counterpart terminus 2/,3/	37 of 53	37 of 53
Insertion loss (test variations per table 4101 B-I)	8 of 31	8 of 31
Insertion loss, additional (for larger shell sizes) 4/	29 of 53	29 of 53
Insert-to-termini compatibility 5/	16 of 53	16 of 53
Terminus retention force	16 of 16	16 of 16

1/ See B.4, B.5 and notes with table 4101-I for further details.

2/ Termini-to-ST jumpers.

3/ Candidate pin terminus-to-ST connector jumper (minimum quantity: 16 of each fiber size) and candidate socket terminus-to-ST connector jumper (minimum quantity: 8 of each fiber size) shall be tested in a connector per B.4.6.

4/ When testing for candidate connector interoperability and to allow for the interoperability of counterpart termini to enable connector interoperability for up to shell size 25, an additional, terminated 29 pin termini and an additional, terminated 29 socket termini shall be submitted.

5/ Un-terminated termini.

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B.4 Interoperability of counterpart terminus. Test sample and qualified termini shall be inserted into and fully populate qualified connectors for test variations performed in [table 4101 B-I](#). Cable assemblies for connector receptacles and plugs shall be configured with single fiber cable and no backshells. Minimum number of termini required for one fiber size to perform this interoperability test shall be as specified in [table 4101 B-II](#). Insertion loss shall be measured in accordance with MIL-STD-1678-2, Measurement 2101 using the simulated cut-back method. Tools, specified for insertion and removal of MIL-PRF-29504/4 and MIL-PRF-29504/5 termini from the connector insert cavities, shall be used successfully for terminus insertion and removal of the terminus-to-ST connector jumpers for this interoperability test.

B.4.1 Allocation of the 53 pin termini and 53 sockets. Allocation of the 53 pin termini and 53 socket termini (pertains to both single mode and multimode).

B.4.1.1 Interoperability of counterpart terminus.

- i. Insertion loss. 8 pin termini and 8 socket termini (for each fiber size, see [table 4101 B-II](#)).
- ii. Insertion loss, additional. 29 pin termini and 29 socket termini.

B.4.1.2 Insert-to-termini compatibility.

- i. Terminus retention force. 16 pin termini and 16 socket termini.

B.4.1.3 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for termini with ceramic ferrules and for ST connectors. End face geometry requirement shall be a flat ferrule with a NC polish for termini with metal ferrules. End face geometry shall be as specified in MIL-STD-1678-1.

B.4.2 Cable type. Interoperability test samples shall be constructed using MIL-PRF-85045/16 single fiber cable. For the 9/125 micron fiber size, M85045/16-02 shall be used. For the 62.5/125 micron fiber size, M85045/16-01 shall be used. For the 100/140/172 fiber size, the cable specified in [table 4101 A-II](#) shall be used.

B.4.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

B.4.3.1 Multimode. No launch condition jumpers are required for the multimode fiber sizes. Overfilled launch conditions are used for interoperability testing.

B.4.3.2 Single mode. A mandrel diameter shall be used as the means of mode conditioning to filter out higher order modes. The technique of wrapping the fiber around a mandrel shall be performed as specified see 3.5 of [TIA-455.34](#). A diameter of 30 mm shall be used with 3 complete turns of the fiber wrapped around the mandrel.

B.4.4 Epoxy type and cure schedule.

B.4.4.1 Type of two part epoxy. Approved sources of supply for MIL-PRF-24792, PIN M24729-A, as listed in the Navy Recommended Fiber Optic Components Parts List (see [B.2.2.2](#)).

B.4.4.2 Cure schedule. Turn on the curing oven and set for a temperature of 120°C (248°F). Verify that the curing oven has stabilized at the curing temperature prior to curing. Cure the epoxy for a minimum of 10 minutes (maximum of 30 minutes) at 120°C (248°F). Remove from the curing oven.

B.4.5 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see [B.4.1.3](#)).

B.4.5.1 Polish type. The standard polish specified in [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

B.4.5.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in the Work package for the applicable terminus type in NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall be used.

B.4.5.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced only if other steps and processes adhere to and resultant termination meets specified optical performance.

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B.4.6 Connectors.

B.4.6.1 Configuration. For interoperability, a MIL-DTL-38999, series III, shell size 17 qualified flanged connector receptacle, 8 channel (cavity) insert, with no backshell and a MIL-DTL-38999, series III, shell size 17 qualified connector plug, 8 channel (cavity) insert, with no backshell will be used. ST connectors must be provided as the instrument end connectors for interoperability samples.

- a. Variation. Termini shall be tested in a MIL-DTL-38999 series III connector (shell size 17 with an 8 cavity insert). There are two variants that may be used for this connector. One variant is the MIL-DTL-38999 series III electrical connector while the other is a MIL-DTL-38999 tight tolerance series III connector (the latter being specification sheets MIL-DTL-38999/60 & MIL-DTL-38999/61 specific to fiber optic applications). These two variants have different optical performance requirements that shall be used in verifying compliance.

B.4.6.2 Candidate termini future use. Once qualified, these interoperability "standards" shall be used to determine interoperability of both other MIL-PRF-29504/4 and MIL-PRF-29504 /5 termini. At the discretion of DLA Land and Maritime-VTP, these interoperability standards can be used to determine interoperability of MIL-DTL-38999/60 & MIL-DTL-38999/61 connectors.

B.4.6.3 Submission. Connector submission is optional, but any submission must be a qualified connector.

B.4.6.4 Insert cavity population. All eight (8) channels are to be active optically for termini interoperability testing. Interoperability testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

B.4.6.5 Fiber type. Each mated pair shall contain only one fiber type.

B.4.7 Fabrication of termini with ceramic ferrules.

B.4.7.1 Single mode 9. Termini on cable assemblies (terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4101 B-III. One mated pair (1 fully populated, MIL-DTL-38999, Series III, shell size 17, qualified connectors without backshells, connector receptacles is with a flange mounting) shall contain a total of 8 pin termini-to-ST connector jumpers and 8 socket termini-to-ST connector jumpers.

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TABLE 4101 B-III. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	125.5 +1/-0 μ m
Ferrule material	Ceramic
Fiber size	9/ 125 micron ^{1/}
Cable type	Tight buffer per B.4.2 ^{2/}
Cable length	2 meters ^{3/}
Epoxy type	Two part, heat cured, liquid type per B.4.4.1 .
Test sample quantity	8 pin termini and 8 socket termini cable assemblies per table 4101 B-II .
Submission quantity	37 pin termini and 37 socket termini cable assemblies per note 4/ in table 4101 B-II .
Tests performed	Interoperability of counterpart termini ^{2/}

^{1/} 9.3/125 micron at 1310 nm.

^{2/} Interoperability test sample s shall be as fabricated with 9/125 micron fiber.

^{3/} Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

B.4.7.2 Multimode. Termini with ceramic ferrules on cable assemblies (terminus-to-ST connector jumpers) with multimode 62.5/125 micron cable shall conform to [table 4101 B-IV](#). One mated pair (1 fully populated, MIL-DTL-38999, series III, shell size 17, qualified connectors without backshells, connector receptacles is with a flange mounting) shall contain a total of 8 pin termini-to-ST connector jumpers and 8 socket termini-to-ST connector jumpers.

TABLE 4101 B-IV. Fabrication for 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 μ m
Fiber size	62.5/125 micron
Ferrule material	Ceramic
Cable type	Tight buffer per B.4.2 .
Cable length	2 meters ^{1/}
Epoxy type	Two part, heat cured, liquid type per B.4.4.1 .
Test sample quantity	8 pin termini and 8 socket termini cable assemblies per table 4101 B-II .
Submission quantity	37 pin termini and 37 socket termini cable assemblies per note 4/ in table 4101 B-II .
Tests performed	Interoperability of counterpart termini

^{1/} Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

B.4.7.3 Multimode 100. Termini with metal ferrules (and jeweled insert) on cable assemblies (terminus-to-ST connector jumpers) with multimode 100/140 micron cable shall conform to [table 4101 B-V](#). One mated pair (1 fully populated, MIL-DTL-38999, series III, shell size 17, qualified connectors without backshells, connector receptacle is with a flange mounting) shall contain a total of 8 pin termini-to-ST connector jumpers and 8 socket termini-to-ST connector jumpers.

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TABLE 4101 B-V. Fabrication for 100/140/172 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	175 +3/-0 μ m
Ferrule material	Metal (with jeweled insert)
Fiber size	100/140/172 micron
Cable type	Loose tube per B.4.2.
Cable length	2 meters ^{1/}
Epoxy type	Two part, heat cured, liquid type per B.4.4.1.
Test sample quantity	16 pin termini and 16 socket termini cable assemblies per table 4101 B-II.
Submission quantity	37 pin termini and 37 socket termini cable assemblies per note 4/ in table 4101 B-II.
Tests performed	Interoperability of counterpart termini

^{1/} Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

B.5 Insert-to-termini compatibility.

B.5.1 Terminus retention force. Non-terminated pin and socket termini shall be inserted into a previously qualified connector(s) using a terminus insertion tool. An axial compressive load shall be applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. A pre-load not greater than 13.3 N (3 lbs.) may be used to seat the terminus for the initial measurement. Axial loads shall be applied at a rate of 4.4 N/s (1.0 lb/s) up to a maximum load 98 N (22.0 lbs.). The maximum load shall be maintained for at least 5 seconds. Minimum number of termini tested shall be the quantity listed for insert-to-terminus compatibility in [table 4101 B-II.](#)

REQUIREMENT 4102

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES FOR
MIL-PRF-29504/14 & /15 TERMINI

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (i.e., fabrication) of the fiber optic test sample (DUT assembly) for MIL-PRF-29504/14 & /15 termini and, by extension for fiber optic applications, MIL-PRF-28876 connectors. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.

[MIL-PRF-28876](#) - Connectors, Fiber Optic, Circular, Plug and receptacle Style, Multiple Removable Termini, General Specification for.

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

3. Definitions.

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coating (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, and allows for more roughed handling (such as better crush and impact resistance).

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3.3 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.4 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

3.5 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.6 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.7 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.8 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

4. Configurations. In the context of Requirement 4102, the component being tested (device under test or DUT) is the MIL-PRF-29504/14 & MIL-PRF-29504/15 termini. The test sample or DUT assembly is the DUT with the other fiber optic components that comprise these assembled components. Configurations for DUT assemblies that shall be used for qualification conform to specific type, size and other fiber optic component parameters that serve to constrain and standardize on the DUT assembly make-up. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also. Configurations used and fabrications performed shall be those as specified in 4.1 through 4.3.

4.1 Termination. The terminus termination process of the test sample fabrication shall be in accordance with Part 5 of MIL-STD-2042.

4.2 Connector accessories assembly. The connector accessories assembly process shall be in accordance with Part 5 of MIL-STD-2042.

4.3 Test sample configurations.

4.3.1 Qualification inspections, except interoperability. Dependent upon the inspection/test performed (see [table 4102-1](#)), the termini test samples shall be in one of three configurations:

- a. Un-terminated,
- b. As part of a single fiber cable (i.e., a cable assembly),
- c. As an integral part of a multiple termini connector (i.e., within a multiple termini connector that is part of a cable assembly).

The construction details for each of the three test sample configurations for "Qualification" shall be performed as listed in section 5 herein.

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4.3.2 Interoperability. Policy to perform testing, submission to test laboratory, test sample submission, test sample configuration and other fabrication requirements for "Interoperability" shall be performed as listed in section 5 herein.

TABLE 4102-I. Qualification inspections (except interoperability).

Test performed	Full qualification	Reduced qualification allowance <u>10/</u>		
	M29504 /14, /15	MM after passed SM	SM after passed MM	/3 after /14 & /15 pass
Un-terminated termini tests				
Group 1 <u>3/</u>				
Size <u>1/</u>	X	X	X	X
Weight <u>1/</u>	X			X
Identification markings <u>1/</u>	X	X	X	X
Workmanship <u>1/</u>	X	X	X	X
Circular runout <u>1/</u>	X			
Group 2 <u>2/</u>				
Terminus insertion & removal forces	X			
Terminus retention <u>1/</u>	X			
Maintenance aging	X			
Terminus cleaning	X			
Group 3 (polymeric materials only)				
Ozone	X			
Fungus resistance	X			
Termini as part of a single fiber cable tests				
Group 1				
None				
Group 2				
Fiber pull out force <u>4/</u>	X			
Cable pull out force <u>4/</u>	X		X	
Group 3				
None				

See notes at end of table.

MIL-STD-1678-4C
Change Notice 1

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TABLE 4102-I. Qualification inspections (except interoperability)- Continued.

Test performed	Full qualification M29504/14, /15	Reduced qualification allowance 10/		
		MM after passed SM	SM after passed MM	/3 after /14 & /15 pass
Termini as an integral part of a multiple termini connector				
Group 1 6/				
Interoperability 5/	X	X	X	
Optical tests				
Insertion loss (Initial)	X	X	X	
Return loss	X		X	
Group 2				
Mating durability	X		X	
Terminus cleaning	X			
Return loss 8/	X		X	
Group 3				
Mechanical tests				
Impact	X			
Vibration, swept sine 7/	X			
Vibration, random 7/	X			
Shock, MIL-DTL-901 7/	X	X	X	
Environmental tests 6/				
Thermal shock	X			
Temperature humidity cycling	X			
Temperature cycling	X		X	
Temperature life	X		X	
Flammability	X		X	
Insertion loss verification 9/	X		X	
Return loss 9/	X		X	

- 1/ These inspections are to be performed by the manufacturer at the production facility. Exception may be taken for weight, circular run out and terminus retention when approved by the qualification activity.
- 2/ Test fixture for this test is to include fiber optic; MIL-PRF-28876 connectors; both plug and receptacle for retaining the termini during testing.
- 3/ Sample size. One pair = one pin terminus and one socket terminus. A minimum sample size shall be used to ensure sufficient quantity for termini inspections as part of a single fiber cable and for termini inspections as an integral part of a multiple fiber connector.
- 4/ Each terminus is to be terminated on one end of a single fiber cable. Cable used is to have provisions compatible with termini strain relief, as applicable. A minimum sample size of 16 pin termini and 16 of the applicable counterpart socket termini, selected from the group that underwent inspections for un-terminated termini, shall be used for each of these tests. Fiber pullout. Separate test samples for the socket termini must be prepared on single fiber cable without any strain relief. The change in optical transmittance shall be met both during and after the test for socket termini. The fiber pullout test does not need to be performed on the pin terminus. Cable pullout. Separate test samples for the socket termini must be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). The change in optical transmittance shall be met both during and after the test for socket termini. The cable pullout test does not need to be performed on the pin terminus.
- 5/ Interoperability. This testing is done by DLA Land and Maritime-VTP which maintains/retains the interoperability standards. Please note that separate test samples are required for interoperability testing. These test samples will then be retained by DLA Land and Maritime as interoperability standards.
- 6/ Environmental tests. See [appendix A, table 4102 A-I](#), note 4/.
- 7/ Shock and vibration. Two connector mated pair must be tested. At least four termini pair in each connector mated pair are to be monitored for optical signal discontinuity (and for change in optical transmittance). Any other mated pair not monitored for optical signal discontinuity is to be monitored for change in optical transmittance.
- 8/ Return loss after mating durability. If failure occurs, ferrule end faces may be re-polished and test redone.
- 9/ Per [MIL-PRF-28876](#), an insertion loss verification and a return loss test is required after the conclusion of the mechanical tests and after the environmental tests. If both the mechanical tests and the environmental tests are done on the same mated pair, then only one insertion loss verification and one return loss test is performed (after the conclusion of the mechanical and environmental tests).
- 10/ Reduced qualification is allowed if full qualification (per column 2) is performed and passed on the other fiber size (i.e., single mode if multimode passed previously or if multimode if single mode passed previously).

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5. Implementation. Test samples (DUT assemblies) shall be prepared for both “Qualification, except interoperability” and for “Interoperability” as specified in 5.1 and 5.2.

5.1 Qualification, except interoperability. DUT assemblies for termini qualification shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for qualification test samples (DUT assemblies), except interoperability, shall be implemented as specified in [appendix A](#).

5.2 Interoperability. DUT assemblies for termini interoperability shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for interoperability test samples (DUT assemblies), shall be implemented as specified in [appendix B](#).

6. NOTES

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Interoperability. Separate test sample configurations are required for interoperability testing. These test sample configurations are in addition to the ones to be used for the other qualification tests.

REQUIREMENT 4102

APPENDIX A

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES
(EXCEPT INTEROPERABILITY)

A.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of MIL-PRF-29504/14 and MIL-PRF-29504/15 termini. Fabrication criteria are addressed in appendix B for test samples to be used for interoperability.

A.2 Applicable documents.

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

A.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for
- [MIL-PRF-28876](#) - Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification For

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: design, installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

A.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWCD Web Site in the Fiber Optics Recommended List section. This NSWCD Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWCD_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

REQUIREMENT 4102

APPENDIX A

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-455 - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

A.3 Test samples, un-terminated termini. Minimum number of termini required for one fiber size to perform a full qualification is provided in table 4102 A-I.

TABLE 4102 A-I. Termini allocation table for each fiber size. 1/

Test performed	Number of pin termini	Number of socket termini
Qualification, except interoperability		
Unterminated termini tests		
	96	96
Group 1	96 of 96	96 of 96
Group 2 (16 pair minimum)	16 of 96	16 of 96
Group 3 (polymeric materials only)	None	None
Termini as part of a single fiber cable tests 5/		
	32 of 96	32 of 96
Group 1	None	None
Group 2 (16 pair – minimum each test)	32	32
Fiber pullout force 2/, 3/	16 of 32	16 of 32
Cable pull out force 2/, 3/	16 of 32	16 of 32
Group 3	None	None
Termini as an integral part of a multiple termini connector		
	48 of 96	48 of 96
Group 1 (6 connector mated pair)	48 of 48	48 of 48
Group 2 (2 connector mated pair) 7/	16 of 48	16 of 48
Group 3, Mechanical (2 connector mated pair) 4/, 7/	16 of 48	16 of 48
Group 3, Environmental (2 connector mated pair) 2/, 4/	16 of 48	16 of 48
Interoperability 6/		
	47	47

1/ See A.3.1 and A.3.2 and notes with table 4102-I for further details.

2/ 16 termini from the termini designated for Group 2.

3/ If one socket terminus is tested at a time, only one pin terminus-to-ST jumper is required for the 16 socket terminus-to-ST jumper tested (see note 4/ in table 4102-I).

4/ Option of using separate test samples from group 2 for group 3 mechanical test. Otherwise, quantity is 32 (not 48) for continuing with those from Group 2 to Group 3, Mechanical. Separate test samples are used for Group 3 environmental tests.

5/ Termini-to-ST jumpers.

6/ Configuration and fabrication requirements for interoperability samples are found in APPENDIX B.

7/ From Group 1 for “Termini as an integral part of a multiple termini connector”.

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APPENDIX A

A.3.1 Quantity. Minimum of 96 pin termini and 96 socket termini for each fiber type (single mode, multimode).

NOTE: This minimum number does not include the number of termini required for interoperability (47 pin termini and 47 socket termini, see appendix B for further details on interoperability).

A.3.2 Allocation of 96 pin termini and 96 socket termini. Allocation of these 96 pin termini and 96 socket termini for remaining testing is as follows:

A.3.2.1 Un-terminated termini.

- a. Group 1 inspections: 96 pin termini and 96 socket termini.
- b. Group 2: 16 pin termini and 16 socket termini.

A.3.2.2 Termini as part of a single fiber cable.

- a. Group 2 fiber pullout: 16 pin termini and 16 socket termini.
- b. Group 2 cable pullout: 16 pin termini and 16 socket termini.

A.3.2.3 Termini as an integral part of a multiple termini connector.

- a. Interoperability: See appendix B.
- b. Group 1 Optical (Insertion loss & Return loss) then Group 2 Mating durability: 2 mated pair (16 pin termini and 16 socket termini).
- c. Group 1 Optical (Insertion loss & Return loss) then Group 3 Mechanical tests: 2 mated pair (16 pin termini and 16 socket termini).
- d. Group 1 Optical (Insertion loss & Return loss) then Group 3 Environmental tests: 2 mated pair (16 pin termini and 16 socket termini).

A.4 Test samples. Termini as part of a single fiber cable.

A.4.1 Quantity. 16 pin termini and 16 socket termini selected from the lot of un-terminated termini.

A.4.2 Configurations and fabrication.

A.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in [A.5.1](#), and [A.5.3](#) through [A.5.7](#) below. For fiber pullout, test samples for the pin and the socket termini shall be prepared on single fiber cable without any strain relief. For cable pullout, test samples for the pin and the socket termini shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.

A.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with MIL-STD-2042, Part 5. Post polish shall result in a domed ferrule end face with a PC polish for termini and for instrument end connectors.

A.4.3 Cable type. Cable used must be of same configuration as MIL-PRF-85045/16; however, this cable does not need to meet environmental specifications in MIL-PRF-85045/16. The optical fiber in the cable used must be the same or equivalent to MIL-PRF-49291/6 for multimode optical fiber or MIL-PRF-49291/7 for single mode fiber. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

A.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

A.5 Test samples. Termini as an integral part of a multiple termini connector.

A.5.1 Termination procedures. Termination procedure for the test samples shall be in accordance with [MIL-STD-2042](#), Part 5. Vendors shall be required to use these termination procedures and mark up any deviations taken (such as strip lengths). The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

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A.5.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for termini with ceramic ferrules and for ST connectors. End face geometry shall be as specified in [MIL-STD-1678-5](#).

A.5.2 Cable type. Cable used shall be MIL-PRF-85045 cable with the specification sheet conforming to table 4102 A-II. This cable is compatible with that for a MIL-PRF-28876 shell size 15 multiple termini connector.

TABLE 4102 A-II. Specification sheet for MIL-PRF-85045 cable.

Connector shell size	Number of cavities in connector insert	Specification sheet for MIL-PRF-85045 cable
15	8	/17

A.5.3 Epoxy type. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved include those in [table 4102 A-III](#).

TABLE 4102 A-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 1/, 2/	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List 3/

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^{\circ}\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See A.2.2.2.

A.5.4 Polishing steps and polishing paper used.

A.5.4.1 Polish type. The standard polish specified in Part 5 of [MIL-STD-2042](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

A.5.4.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in Part 5 of MIL-STD-2042 shall be used.

A.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples only if other steps and processes adhere to and resultant termination meets optical performance specified in Part 5 of MIL-STD-2042.

A.5.5 Connectors.

A.5.5.1 Configuration. A MIL-PRF-28876 shell size 15 connector shall be used with a fully populated 8 cavity insert. Connector configurations used for termini qualification shall conform to 4.4.1.1 of [MIL-PRF-28876](#).

A.5.5.2 Backshell (connector accessory). Backshell configurations used for termini qualification shall conform to 4.4.1.1 of MIL-PRF-28876.

A.5.5.3 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert. All eight (8) channels are to be active optically for termini qualification testing.

A.5.5.4 Fiber type. Each mated pair shall contain only one fiber type.

A.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of MIL-STD-1678-2.

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A.5.7 Fabrication. Test sample configurations (each cable assembly) shall consist of 10 meters of MIL-PRF-85045 multiple fiber cable with the DUT (termini inserted into a MIL-PRF-28876 connector) in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires the cable length from terminus-to-single ferrule connector to be 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

A.5.7.1 Single mode. Termini on cable assemblies (such as multiple fiber cable with termini inserted into a MIL-PRF-28876 connector at one end and-ST connectors at the other end) with cable containing single mode 9/125 micron optic fiber shall conform to table 4102 A-IV.

TABLE 4102 A-IV. Fabrication for cable with 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4102 A-II .
Epoxy type	Two part, heat cured, liquid type per table 4102 A-III .
Test sample quantity	4 mated pair per A.5.1 through A.5.7.
Tests performed	Full test sequence (see table 4102-I). <u>2/</u>

1/ 9.3/125 micron at 1310 nm per MIL-PRF-49291/7.

2/ Qualify multimode first. Alternative is to qualify with multimode fiber first, then qualify with single mode fiber under the qualification by similarity (see [table 4102-I](#)) with a reduced set of tests using 4 single mode mated pair.

A.5.7.2 Multimode. Termini on cable assemblies with multimode cable containing 62.5/125 micron fiber shall conform to table 4102 A-V.

TABLE 4102 A-V. Fabrication for cable with multimode fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	62.5/ 125 micron per MIL-PRF-49291/6.
Cable type	Tight buffer per table 4102 A-II .
Epoxy type	Two part, heat cured, liquid type per table 4102 A-III .
Test sample quantity	4 mated pair per A.5.1 through A.5.7 .
Tests performed	Full test sequence (see table 4102-I) <u>1/</u>

1/ Qualify single mode first. A reduced set of tests using 2 multimode mated pair is listed once qualified using a full test sequence with single mode fiber (see [table 4102-I](#)).

REQUIREMENT 4102

APPENDIX B

CONFIGURATION AND FABRICATION REQUIREMENTS FOR INTEROPERABILITY TEST SAMPLES

B.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the interoperability testing of MIL-PRF-29504/14 and MIL-PRF-29504/15 termini. In the past, the Government has partnered with termini/connector companies that were undergoing Qualified Products List testing in an effort to verify interoperability of fiber optic, multiple termini connectors that conform to MIL-PRF-28876. This partnership allows the Government to verify the interoperability of connectors with that of participating companies. DLA Land and Maritime-VTP is now the Government entity that performs the testing for interoperability. This partnership for interoperability testing is now extended to other termini/connectors including qualifying only the MIL-PRF-29504/14 & MIL-PRF-29504/15 termini.

B.2 Applicable documents.

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

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-24792](#) - Adhesive, Epoxy, Two Part, Fiber Optics
- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
- [MIL-PRF-85045](#) - Cables, Fiber Optics, (Metric), General Specification For

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase and Legacy Measurements)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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B.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWCD Web Site in the Fiber Optics Recommended List section. This NSWCD Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWCD_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

B.3 Policy pertaining to test sample submission. Vendors shall be responsible for the fabrication, submittal and replacement/refurbishment of cable assemblies (test samples) in the configurations specified below to the Government for Interoperability testing.

B.3.1 Test sample retention. One stipulation is that the test samples are to be retained by the Government for use as standards in future interoperability testing to be performed by the Government in-house personnel. Only personnel to be present during interoperability testing are Government, in-house personnel. At no time shall other parties have access to or examination of the interoperability standards.

B.3.2 Replacement/refurbishment. Another stipulation is that the vendor shall agree to replace or refurbish these interoperability standards as the need arises. Any items requiring replacement/refurbishment in this agreement shall be performed by the vendor at no cost to the Government.

B.3.3 Notification for submission. Initial notification to submit test samples for interoperability shall be made to DLA Land and Maritime-VQP Qualifications Group.

B.3.4 Arrangements to perform interoperability testing. Once approved by DLA Land and Maritime-VQP, the vendor shall make financial, test and shipping arrangements with the DLA Land and Maritime-VTP Passive Test Section.

Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime-VTP point of contact.
Shipping address:
DLA Land and Maritime
3990 East Broad St.
Bldg. 11, Section 7, VTP
Columbus OH 43213-1199

REQUIREMENT 4102

APPENDIX B

TABLE 4102 B-I. Termini interoperability test variations. ^{1/}

Test variation	Connector receptacle	Termini socket	Connector plug	Termini pin
1	X	A	X	B
2	X	B	X	A
3	X	B	X	B

X = Previously certified connector, B = Candidate termini

A = Previously certified termini

^{1/} Socket termini placed in connector receptacle, pin termini in connector plug.

TABLE 4102 B-II. Termini allocation table for each fiber size. ^{1/}

Test performed	Number of pin termini	Number of socket termini
	47	47
Interoperability of counterpart terminus ^{2/} , ^{3/}	31 of 47	31 of 47
Insertion loss (test variations per table 4101 B-I)	16 of 31	16 of 31
Insertion loss, additional (for larger shell size) ^{4/}	15 of 31	15 of 31
Insert-to-termini compatibility ^{5/}	16 of 47	16 of 47
Terminus retention force	16 of 16	16 of 16
Terminus insertion and removal forces	16 of 16	16 of 16

^{1/} See [B.4](#), [B.5](#) and notes with [table 4102-I](#) for further detail.

^{2/} Termini-to-ST jumpers.

^{3/} Candidate pin terminus-to-ST connector jumper (minimum quantity: 16 of each fiber size) and candidate pin terminus-to-ST connector jumper (minimum quantity: 16 of each fiber size) shall be tested in a connector per [B.4.6](#).

^{4/} When testing for candidate connector interoperability and to allow for the interoperability of counterpart termini to enable connector interoperability for up to shell size 23, an additional, terminated 15 pin termini and an additional, terminated 15 socket termini shall be submitted.

^{5/} Un-terminated termini.

B.4 Interoperability of counterpart terminus. Test sample and qualified termini shall be inserted into and fully populate qualified connectors for test variations performed in table 4102 B-I. Cable assemblies for connector receptacles and plugs shall be configured with single fiber cable and no backshells. Minimum number of termini required for one fiber size to perform this interoperability test shall be as specified in table 4102 B-II. Insertion loss shall be measured in accordance with MIL-STD-1678-2, Measurement 2101 using the simulated cut-back method. Tools, specified for insertion and removal of MIL-PRF-29504/14 and MIL-PRF-29504/15 termini from the connector insert cavities, shall be used successfully for terminus insertion and removal of the terminus-to-ST connector jumpers for this interoperability test.

B.4.1 Termination procedures. Termination procedure for the test samples shall be in accordance with [MIL-STD-2042](#), Part 5. Vendors shall be required to use these termination procedures and mark up any deviations taken (such as strip lengths). The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

B.4.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for termini with ceramic ferrules and for ST connectors. End face geometry shall be as specified in MIL-STD-1678-5.

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APPENDIX B

B.4.1.2 Allocation of the 47 pin termini and 47 socket termini. Allocation of the 47 pin termini and 47 socket termini (pertains to both single mode and multimode).

- a. Interoperability of counterpart terminus.
 - iii. Insertion loss. 16 pin termini and 16 socket termini.
 - iv. Insertion loss, additional. 15 pin termini and 15 socket termini.
- b. Insert-to-termini compatibility.
 - ii. Terminus retention force. 16 pin termini and 16 socket termini.
 - iii. Terminus insertion and removal forces. 16 pin termini and 16 socket termini.

B.4.2 Cable type. Interoperability test samples shall be constructed using MIL-PRF-85045/16 single fiber cable. For the 9/125 micron fiber size, M85045/16-02 shall be used. For the 62.5/125 micron fiber size, M85045/16-01 shall be used.

B.4.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

B.4.3.1 Multimode. No launch condition jumpers are required for the multimode fiber sizes. Overfilled launch conditions are used for interoperability testing.

B.4.3.2 Single mode. A mandrel diameter shall be used as the means of mode conditioning to filter out higher order modes. The technique of wrapping the fiber around a mandrel shall be performed as specified see 3.5 of [TIA-455.34](#). A diameter of 30 mm shall be used with 3 complete turns of the fiber wrapped around the mandrel.

B.4.4 Epoxy type and cure schedule. Approved epoxy meeting MIL-PRF-24792 shall be used for test sample termination. Epoxies approved include those in table 4102 B-III.

TABLE 4102 B-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^\circ\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See A.2.2.2.

B.4.5 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see [B.4.1.1](#)).

B.4.5.1 Polish type. The standard polish specified in Part 5 of MIL-STD-2042 shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

B.4.5.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in Part 5 of MIL-STD-2042 shall be used.

B.4.5.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples only if other steps and processes adhere to and resultant termination meets optical performance specified in Part 5 of MIL-STD-2042.

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APPENDIX B

B.4.6 Connectors.

B.4.6.1 Configuration. A MIL-PRF-28876 shell size 15 connector shall be used with a fully populated 8 cavity insert. All 8 channels are to be active optically for termini interoperability. Connector configurations used for termini qualification shall conform to 4.4.1.1 of [MIL-PRF-28876](#). ST connectors must be provided as the instrument end connectors for interoperability samples.

B.4.6.2 Candidate termini future use. Once qualified, these interoperability "standards" shall be used to determine interoperability of other MIL-PRF-29504/14 and MIL-PRF-29504/15 termini. At the discretion of DLA Land and Maritime-VTP, these interoperability standards can be used to determine interoperability of MIL-PRF-28876 connectors.

B.4.6.3 Submission. Connector submission is optional, but must be a qualified connector if submitted (see B.4.7.1 and [B.4.7.2](#)).

B.4.6.4 Insert cavity population. Interoperability testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

B.4.6.5 Fiber type. Each mated pair shall contain only one fiber type.

B.4.7 Fabrication of termini.

B.4.7.1 Single mode. Termini on cable assemblies (terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to [table 4102 B-IV](#). Two mated pair (2 fully populated, MIL-PRF-28876, shell size 15, key position 1, qualified connectors without backshells, connector receptacles are those with a flange mounting) shall contain a total of 16 pin termini-to-ST connector jumpers and 16 socket termini-to-ST connector jumpers.

TABLE 4102 B-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per B.4.2 .
Cable length	2 meters <u>2/</u>
Epoxy type	Two part, heat cured, liquid type per B.4.4 .
Test sample quantity	16 pin termini and 16 socket termini cable assemblies per table 4102 B-II .
Submission quantity	31 pin termini and 31 socket termini cable assemblies per note 4/ in table 4102 B-II .
Tests performed	Interoperability of counterpart termini

1/ 9.3/125 micron at 1310 nm.

2/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

B.4.7.2 Multimode. Termini on cable assemblies (terminus-to-ST connector jumpers) with multimode 62.5/125 micron cable shall conform to [table 4102 B-V](#). Two mated pair (2 fully populated, MIL-PRF-28876, Shell Size 15, key position 1, qualified connectors without backshells, connector receptacles are those with a flange mounting) shall contain a total of 16 pin termini-to-ST connector jumpers and 16 socket termini-to-ST connector jumpers.

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APPENDIX B

TABLE 4102 B-V. Fabrication for 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 um
Fiber size	62.5/125 micron
Cable type	Tight buffer per B.4.2.
Cable length	2 meters ^{1/}
Epoxy type	Two part, heat cured, liquid type per B.4.4.
Test sample quantity	16 pin termini and 16 socket termini cable assemblies per table 4102 B-II.
Submission quantity	31 pin termini and 31 socket termini cable assemblies per note 4/ in table 4102 B-II.
Tests performed	Interoperability of counterpart termini

^{1/} Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

B.5 Insert-to-termini compatibility.

B.5.1 Terminus retention force. Non-terminated pin and socket termini shall be inserted into a previously qualified connector(s) using a terminus insertion tool. An axial compressive load shall be applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. A pre-load not greater than 13.3 N (3 lbs.) may be used to seat the terminus for the initial measurement. Axial loads shall be applied at a rate of 4.4 N/s (1.0 lb./s) up to a maximum load 98 N (22.0 lbs.). The maximum load shall be maintained for at least 5 seconds. Minimum number of termini tested shall be the quantity listed for insert-to-terminus compatibility in [TABLE 4102 B-II.](#)

B.5.2 Terminus insertion and removal forces. Perform in accordance with 4.9.11 of MIL-PRF-29504.

REQUIREMENT 4103

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES FOR MIL-PRF-29504 TERMINI IN MIL-PRF-64266 CIRCULAR CONNECTORS

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (i.e., fabrication) of the fiber optic test sample (DUT assembly) for the MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/1 and /2 circular connectors. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the connector plug and connector receptacle along with an alignment sleeve retainer (ASR). For identification purposes in Requirement 4103 and for consistency with Requirements 4101 and 4102, the termini to be placed in a connector plug will be referred to as "pin termini". The termini to be placed in a connector receptacle (along with the ASR) will be referred to as "socket termini".

1.2 Inclusion of other MIL-PRF-29504 termini types. Requirement 4103 initially was based on the qualification of the MIL-PRF-29504/20 terminus with the MIL-PRF-64266 circular connector and MIL-PRF-64266 backshell. Requirement 4103 has been revised to qualify from one to four of the termini types (MIL-PRF-29504/18, /20, /26 and /27) in a MIL-PRF-64266 circular connector without a backshell. Since the MIL-PRF-29504/20 termini can be terminated with either a PC or an APC polish whereas the MIL-PRF-29504/18 terminus can be terminated with a PC polish only, the fabrication of three contact (non-lens) terminus variations are addressed (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish). Type of polish is not addressed for the two lens termini variations, the MIL-PRF-29504/26 and /27 termini. For purposes of identifying the variants of termini to be placed in the different connector insert cavity positions, MIL-PRF-29504 /26 and /27 termini are considered to be two other termini variants. A different MIL-PRF-64266 ASR is used depending upon if contact termini (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish) or if lens termini (MIL-PRF-29504/26 and /27) are placed into the MIL-PRF-64266 connector. This different ASR requirement dictates that different connectors be used for contact termini and lens termini.

1.3 Alternative qualification with termini. Requirement 4103 addresses test sample configurations and fabrication of the MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/1 and /2 circular connectors. An alternative is to use Requirement 4106 which address test sample configurations and fabrication MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/23 and /24 rectangular connectors. The MIL-PRF-29504/18, /20, /26 and /27 termini can be qualified when tested either in MIL-PRF-64266/1 and /2 circular connectors or when tested in MIL-PRF-64266/23 and /24 rectangular connectors.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.

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DEPARTMENT OF DEFENSE STANDARD

[MIL-STD-2042](#) - Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships

(Copies of these documents are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

GENERAL SERIES TECHNICAL MANUAL

[NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

3. DEFINITIONS

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable bundle, fiber optic. Single fiber cables grouped together and usually secured by lacing tape. The cable bundle can be placed in convoluted tubing, used in various protected harness configurations or used as is in an open cable harness configuration.

3.3 Cable, loose tube. A fiber optic cable design is one configured with one or more optical fibers are fitted loosely within a tube, giving the optical fibers freedom to move. This mobility and isolation from the tube minimizes the effects of external forces on the performance of the link. The isolation allows cable expansion and contraction with temperature independent of the optical fibers.

3.4 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coating (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, and allows for more roughed handling (such as better crush and impact resistance).

3.5 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.6 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

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3.7 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.8 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.9 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.10 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

4. Configurations. In the context of Requirement 4103, the component being tested (device under test or DUT) are some or all of the MIL-PRF-29504/18, /20, /26 and /27 termini, the MIL-PRF-64266 circular connector, or both termini and connector. The test sample or DUT assembly (also referred to as termini mated pair and connector mated pair, as applicable) is the DUT with the other fiber optic components that comprise these assembled components. Configurations for DUT assemblies that shall be used for qualification conform to specific type, size and other fiber optic component parameters that serve to constrain and standardize on the DUT assembly make-up. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also. Configurations used and fabrications performed shall be those as specified in 4.1 through 4.4.

4.1 Termination.

4.1.1 Termination, temperature range 1. The contact (non- lens) terminus termination process of the test sample fabrication shall be in accordance with Method 5D1 (with PC polish) or Method 5D2 (with APC polish) of MIL-STD-2042 except as specified herein. The lens termini termination process of the test sample fabrication shall be in accordance with Method 5D1 of MIL-STD-2042 up to the processes for ferrule polishing and affixing the lens holder to the ferrule except as specified herein. The processes for ferrule polishing and affixing the lens holder to the ferrule are not specified in Requirement 4103.

4.1.2 Termination, temperature range 2. The contact (non- lens) terminus termination process of the test sample fabrication shall be in accordance with Work Package 010 04 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 except as specified herein. The lens termini termination process of the test sample fabrication shall be in accordance with Work Package 010 04 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 up to the processes for ferrule polishing and affixing the lens holder to the ferrule except as specified herein. The processes for ferrule polishing and affixing the lens holder to the ferrule are not specified in Requirement 4103.

4.2 Connector accessories assembly.

4.2.1 Connector accessories assembly, temperature range 1. The connector accessories assembly process shall be in accordance with MIL-STD-2042 for insertion of termini into the connector.

4.2.2 Connector accessories assembly, temperature range 2. The connector accessories assembly process shall be in accordance with NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 for insertion of termini into the connector.

4.3 Test sample configurations. Dependent upon the inspection/test performed (see table 4103-I for temperature range 1, table 4103-II for temperature range 2, table 4103-III for interoperability), the termini test samples shall be in one of three configurations:

- a. Un-terminated,
- b. As part of a single fiber cable (i.e., a cable assembly),
- c. As an integral part of a multiple termini connector (i.e., within a multiple termini connector that is part of a cable assembly).

The construction details for each of the three test sample configurations for "Qualification" shall be performed as listed in section 5 herein.

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4.4 Interoperability. Policy to perform testing, submission to test laboratory, test sample submission, test sample configuration and other fabrication requirements for “Interoperability” shall be performed as listed in section 5 herein.

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TABLE 4103-I. Mated pair configurations for qualification, temperature range 1.

Components	Number of components required for each two connectors (with contact termini)	Number of components required for each two connectors (with lens termini)
Description <u>1</u> /		
Minimum number of connector mated pair, SM fiber size (9/125 micron) <u>2</u> /	2	2
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Termini, MIL-PRF-29504/18 or /20 for inactive cavity positions	72	0
Connector receptacle M64266/1 (with non-lens terminus ASR)		
Shell size 15	1	0
Shell size 23	1	0
Connector receptacle, M64266/1 (with lens terminus ASR)		
Shell size 11	0	1
Shell size 13	0	1
Connector plug, M64266/2		
Shell size 11	0	1
Shell size 13	0	1
Shell size 15	1	0
Shell size 23	1	0
Dust cover, connector plug, M64266/10	2	2
Dust cover, connector receptacle, M64266/11	2	2
Backshell, connector receptacle, M64266/18	N/A	N/A
Backshell, connector plug, M64266/18	N/A	N/A
Minimum number of mated pair, MM fiber size (62.5/125 micron)	2	2
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Termini, MIL-PRF-29504/18 or /20 for inactive cavity positions	72	0
Connector receptacle, M64266/1 (with non-lens terminus ASR)		
Shell size 11	0	1
Shell size 13	0	1
Connector receptacle, M64266/1 (with lens terminus ASR)		
Shell size 11	0	1
Shell size 13	0	1
Connector plug, M64266/2 (shell sizes as specified)		
Shell size 11	0	1
Shell size 13	0	1
Shell size 15	1	0
Shell size 23	1	0
Dust cover, connector plug, M64266/10	2	2
Dust cover, connector receptacle, M64266/11	2	2
Backshell, connector receptacle, M64266/18	N/A	N/A
Backshell, connector plug, M64266/18	N/A	N/A

NOTES:

- 1/ Mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4103 including the applicable appendices. Mated pair are test samples to be tested for termini as an integral part of a multiple termini connector. Further requirements are found in appendix A for qualification fabrication, appendix C for interoperability fabrication. This table does not include mated pair configurations (component breakdowns) for interoperability.
- 2/ Quantities provided are for two connector mated pair for each terminus type (contact or lens) and each fiber type (single mode or multimode). For single mode testing, a total of eight connector mated pair are required.

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TABLE 4103-II. Mated pair configurations for qualification, temperature range 2.

Components	Number of components required for each two connectors (with contact termini)	Number of components required for each two connectors (with lens termini)
Description <u>1/</u>		
Minimum number of mated pair, SM fiber size (9/125 micron) <u>2/</u>	2	2
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Termini, MIL-PRF-29504/18 or /20 for inactive cavity positions	72	0
Connector receptacle, M64266/1 (with non-lens terminus ASR)	2	0
Shell size 15	1	0
Shell size 23	1	0
Connector receptacle, M64266/1 (with lens terminus ASR)	0	2
Shell size 11	0	1
Shell size 13	0	1
Connector plug, M64266/2	2	2
Shell size 11	0	1
Shell size 13	0	1
Shell size 15	1	0
Shell size 23	1	0
Dust cover, connector plug, M64266/10	2	2
Dust cover, connector receptacle, M64266/11	2	2
Backshell, connector receptacle, M64266/18	N/A	N/A
Backshell, connector plug, M64266/18	N/A	N/A
Minimum number of mated pair, MM fiber size (50/125 micron)	2	2
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Termini, MIL-PRF-29504/18 or /20 for inactive cavity positions	72	0
Connector receptacle, M64266/2 (with non-lens terminus ASR)	2	0
Shell size 15	1	0
Shell size 23	1	0
Connector receptacle, M64266/2 (with lens terminus ASR)	0	2
Shell size 11	0	1
Shell size 13	0	1
Connector plug, M64266/2	2	2
Shell size 11	0	1
Shell size 13	0	1
Shell size 15	1	0
Shell size 23	1	0
Dust cover, connector plug, M64266/10	2	2
Dust cover, connector receptacle, M64266/11	2	2
Backshell, connector receptacle, M64266/18	N/A	N/A
Backshell, connector plug, M64266/18	N/A	N/A

1/ Mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4103 including the applicable appendices. Further requirements are found in appendix B for qualification fabrication, appendix C for interoperability fabrication. This table does not include mated pair configurations (component breakdowns) for interoperability.

2/ Quantities provided are for two connector mated pair for each terminus type (contact or lens) and each fiber type (single mode or multimode). For single mode testing, a total of eight connector mated pair are required.

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TABLE 4103-III. Mated pair configurations for interoperability.

Components	Number of components required for each one cavity connector (with contact termini)	Number of components required for each one cavity connector (with lens termini)
Description <u>1/3/</u>		
Minimum number of mated pair, SM fiber size (9/125 micron), Counterpart termini interoperability <u>3/</u>	1	1
Number of insert cavities	4	4
Termini, MIL-PRF-29504/18	8	0
Termini, MIL-PRF-29504/20 with PC polish	0	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	0
Connector receptacle, M64266/1 (with non-lens terminus ASR)	1	0
Connector receptacle, M64266/1 (with lens terminus ASR)	0	1
Connector plug, M64266/2	1	1
Minimum number of mated pair, MM fiber size (62.5/125 micron), Counterpart termini interoperability <u>3/</u>	1	1
Number of insert cavities	4	4
Termini, MIL-PRF-29504/18	8	0
Termini, MIL-PRF-29504/20 with PC polish	0	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	0
Connector receptacle, M64266/1 (with non-lens terminus ASR)	1	0
Connector receptacle, M64266/1 (with lens terminus ASR)	0	1
Connector plug, M64266/2	1	1

1/ This table contains the mated pair configurations (component breakdowns) for interoperability. Mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4103 including the applicable appendices. For connector interoperability, further requirements are found in appendix C for interoperability fabrication.

2/ Quantities provided are for one mated pair for MIL-PRF-64266 connector interoperability for each terminus type (contact or lens) and each fiber type (single mode or multimode).

3/ Number of termini required includes only those for the termini-to-ST jumpers to be placed into the connector mated pair (to measure insertion loss). Separate termini are required for other interoperability tests (terminus insertion and removal forces, terminus retention force). Performed for termini interoperability only, tests are performed in a MIL-PRF-64266 shell size 11 circular connector.

5. Implementation. Termini may either be qualified in circular connectors (addressed in Requirement 4103) or in rectangular connectors (addressed in this Requirement 4106). Test samples (DUT assemblies) shall be prepared for both "Qualification, except interoperability" and for "Interoperability" as specified in 5.1 and 5.2. The insert arrangement for each shell size and for each temperature range shall conform to 5.3. Termini type (either MIL-PRF-29504/18, /20, /26 and /27 or some or all), and ferrule end face polish (PC or APC polish) for contact polished termini, placed in insert cavity locations shall conform to 5.4 and 5.5. Test terminus and test terminus adapters shall be prepared for both "Qualification, except interoperability" and for "Interoperability" as specified in 5.8 and 5.9. Qualification of contact termini only (MIL-PRF-29504/18 and /20) and qualification of one shell size circular connector with contact termini only is addressed in figure 4103-1. Qualification of lens termini only (MIL-PRF-29504/26 and /27) and qualification of one shell size circular connector with lens termini is addressed in figure 4103-2. Qualification of three shell size circular connectors with both contact termini (MIL-PRF-29504/18 and /20) and lens termini (MIL-PRF-29504/26 and /27) is addressed in figure 4103-3.

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5.1 Qualification, except interoperability. DUT assemblies for termini qualification shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for qualification test samples (DUT assemblies), except interoperability, shall be implemented as specified in [appendix A](#) for temperature range 1 and in [appendix B](#) for temperature range 2. Qualification of termini consists of performing tests in MIL-PRF-29504/18, /20, /26 and /27 for either temperature range 1 or temperature range 2 or for both temperature range 1 (TR1) and temperature range 2 (TR2). Qualification of connectors (including connector accessories) with or without qualifying the termini consist of performing tests in MIL-PRF-64266 for either temperature range 1 or temperature range 2 or for both temperature range 1 (TR1) and temperature range 2 (TR2). Qualification of both connectors and termini shall include tests, and the test sample configurations, listed in MIL-PRF-29504/18, /20, /26 and /27 for “Tests for unterminated termini” and “Tests for termini as part of a single fiber cable”. There is no separate qualification for only one fiber size. There are separate qualifications for each temperature range. For reference, a consolidation of mated pair configurations required for qualification by components and shell sizes are listed in [table 4103-I](#) for temperature range 1 (TR1) and in [table 4103-II](#) for temperature range 2 (TR2). Tables for number of termini required in [appendix A](#) and in [appendix B](#) address both a separate MIL-PRF-29504/18, /20, /26 and /27 termini qualification only and one that includes both MIL-PRF-64266 circular connectors and MIL-PRF-29504/18, /20, /26 and /27 termini.

5.2 Interoperability. DUT assemblies for termini interoperability shall consist of connector interoperability and ASR interoperability as specified in 4.10 of MIL-PRF-64266. Configuration and fabrication requirements for interoperability circular connector test samples (DUT assemblies), shall be implemented as specified in [appendix C](#). For reference, a consolidation of mated pair configurations required for [MIL-PRF-64266](#) circular connector interoperability by components and shell sizes are listed in [table 4103-III](#).

5.3 Qualification of termini with connector. When tested only for conformance to MIL-PRF-29504, qualification except interoperability inspections shall be performed with shell size 11 connectors with a four cavity insert. When the connector is being qualified, from one to four shell sizes may be qualified. The insert arrangement (i.e., number of cavities in insert) for each temperature range shall be as follows: Shell size 11: 4 cavity, shell size 13: 4 cavity, shell size 15: 8 cavity, shell size 23: 36 cavity. When less than four shell sizes are being qualified, then for each four connector mated pair (under termini in a multiple termini connector) a shell size 11 (or the smallest shell size being qualified) shall be substituted for each shell size not being qualified. Test performed and test sequence shall conform to [appendix D](#).

5.4 Termini types positions in insert. Termini placed in each cavity position shall conform to [appendix E](#). Termini positions shall vary, depending upon shell size, insert arrangement (number of insert cavities) and temperature range.

5.5 Inclusion of four types of termini. [Appendix E](#) is based on performing qualification simultaneously for MIL-PRF-29504/18, /20, /26 and /27 termini. From one to four termini types may be qualified. If only MIL-PRF-29504/20 termini are qualified for the contact type termini, then the cavity positions specified for MIL-PRF-29504/18 termini instead shall be filled with MIL-PRF-29504/20 termini with an APC polish.

5.6 Shell size, termini only qualification. For termini only qualification, each circular connector shall contain four termini mated pair either with contact termini or with lens termini). MIL-PRF-64266/1 and /2 shell size 11 connectors with a four cavity insert shall be used.

5.7 Shell size, circular connector qualification. For connector qualification or for combined connector and termini qualification, the specified number of shell sizes shall be used for each four connector mated pair. Cavity positions to place the termini and type of termini in those cavity position shall conform to [appendix F](#).

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5.8 Test terminus and test terminus adapter qualification, except interoperability. DUT assemblies for termini qualification shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for qualification test samples (DUT assemblies), except interoperability, shall be implemented as specified in [appendix G](#).

5.9 Test terminus and test terminus adapter interoperability. DUT assemblies for termini interoperability shall consist of interoperability of counterpart termini and of insert-to-termini compatibility. Configuration and fabrication requirements for interoperability test samples (DUT assemblies), shall be implemented as specified in [appendix H](#).

Group 1: 4 connector mated pair			
G1, then G2, G3 Mechanical		G1, then G3 Environmental	
Con 1	Con 2	Con 3	Con 4
Shell 11	Shell 11	Shell 11	Shell 11
T1-T4	T1-T4	T1 – T4	T1 – T4
M29504/18, /20	M29504/18, /20	M29504/18, /20	M29504/18, /20
ASR = F	ASR = F	ASR = F	ASR = F
Polish	Polish	Polish	Polish

- 1/ Con = connector (i.e., one connector mated pair).
- 2/ Shell 11 = Shell size 11 circular connector. For a termini only qualification, testing in a shell size 11 is specified. For qualification of a single circular connector shell size, any shell size may be selected.
- 3/ T1-T4 = Four contact termini mated pair. Contact termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Contact termini are M29504/18 and M29504/20.
- 4/ M29504/20 = termini to be qualified. For contact termini, qualify M29304/20 at a minimum.
- 5/ ASR = F, Alignment Sleeve Retainer configured with alignment sleeves to accept contact termini with a 1.25 mm diameter ferrule.
- 6/ Polish = M29504/18 with a PC polish, M29504/20 with PC polish, for single mode only M29504/20 with APC polish.
- 7/ Figure 4103-1 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of two connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock).
- 8/ If want to qualify both contact termini and lens termini for a termini only qualification, then use both figure 4103-1 and figure 4103-2.
- 9/ For a termini only qualification, qualified connectors must be used. Option to qualify in either a MIL-PRF-64266 rectangular (backplane) connector (see Requirement 4106) or in a MIL-PRF-64266 shell size 11 circular connector.
- 10/ For a connector qualification with one or two shell sizes and for contact termini only, use the test sample configuration in this figure for each shell size tested.

FIGURE 4103-1. Test samples: Contact termini only, one shell size connector with contact termini only

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Group 1: 4 connector mated pair			
G1, then G2, G3 Mechanical		G1, then G3 Environmental	
Con 1	Con 2	Con 3	Con 4
Shell 11	Shell 11	Shell 11	Shell 11
L1 – L4	L1 – L4	L1 – L4	L1 – L4
M29504/26, /27	M29504/26, /27	M29504/26, /27	M29504/26, /27
ASR = L	ASR = L	ASR = L	ASR = L
NA	NA	NA	NA

- 1/ Con = connector (i.e., one connector mated pair).
- 2/ Shell 11 = Shell size 11 circular connector. For a termini only qualification, testing in a shell size 11 is specified. For qualification of a single circular connector shell size, any shell size may be selected.
- 3/ L1 – L4 = Four lens termini mated pair. Lens termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Lens termini are M29504/26 and M29504/27.
- 4/ M29504/26, /27= termini to be qualified. For lens termini, may qualify M29504/26, /27 or both.
- 5/ ASR = L, Alignment Sleeve Retainer configured with alignment sleeves to accept lens termini with a 1.58 mm diameter lens holder.
- 6/ NA = Not Applicable (pertains to the polish on a terminus ferrule end face). Row retained for consistency with other figures.
- 7/ Figure 4103-2 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of two connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock).
- 8/ If want to qualify both contact termini and lens termini for a termini only qualification, then use both figure 4103-1 and figure 4103-2.
- 9/ For a termini only qualification, qualified connectors must be used. Option to qualify in either a MIL-PRF-64266 rectangular (backplane) connector (see Requirement 4106) or in a MIL-PRF-64266 shell size 11 circular connector.
- 10/ For a connector qualification with one or two shell sizes and for lens termini only, use the test sample configuration in this figure for each shell size tested.

FIGURE 4103-2. Test samples: Contact termini only, one shell size connector with lens termini only

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Group 1: 8 connector mated pair							
Group 1, then Group 2 + Group 3 Mech.				Group 1, then Group 3 Environmental			
With contact termini		With lens termini		With contact termini		With lens termini	
Con 1	Con 2	Con 1	Con 2	Con 3	Con 4	Con 3	Con 4
Shell 11	Shell 15	Shell 11	Shell 15	Shell 11	Shell 15	Shell 11	Shell 15
T1-T4	T1-T4	L1 – L4	L1 – L4	T1-T4	T1-T4	L1 – L4	L1 – L4
ASR = F	ASR = F	ASR = L	ASR = L	ASR = F	ASR = F	ASR = L	ASR = L
Polish	Polish	NA	NA	Polish	Polish	NA	NA

- 1/ Con = connector (i.e., one connector mated pair).
- 2/ Shell 11 = Shell size 11 circular connector. Similarly for shell 15 = shell size 15 circular connector.
- 3/ T1-T4 = Four contact termini mated pair. Contact termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Contact termini are M29504/18 and M29504/20.
- 4/ For contact termini, qualify M29504/20 at a minimum.
- 5/ L1 – L4 = Four lens termini mated pair. Lens termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Lens termini are M29504/26 and M29504/27.
- 6/ ASR = F, Alignment Sleeve Retainer configured with alignment sleeves to accept contact termini with a 1.25 mm diameter ferrule.
- 7/ ASR = L, Alignment Sleeve Retainer configured with alignment sleeves to accept lens termini with a 1.58 mm diameter lens holder.
- 8/ Polish = M29504/18 with a PC polish, M29504/20 with PC polish, for single mode only M29504/20 with APC polish.
- 9/ NA = Not Applicable (pertains to the polish on a terminus ferrule end face).
- 10/ Figure 4103-3 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of two connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock).
- 11/ Qualification by similarity for shell size 13. Qualification of three shell sizes 11, 13 and 15 with or without termini qualification. Number of test samples and shell sizes remain the same. When test both shell sizes 11 and 15, obtain qualification by similarity for shell size 13.
- 12/ Allowed figure 4103-3 deviation 1. Qualification of three shell sizes 11, 13 and 15 with contact termini only. Number of test samples remain the same (with shell sizes 11 and 15). Each test sample (connector mated pair) populated with contact termini. Each test sample has a type F ASR. . When test both shell sizes 11 and 15, obtain qualification by similarity for shell size 13. Figure 4103-3 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of four connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock)
- 13/ Allowed figure 4103-3 deviation 2. Qualification of three shell sizes 11, 13 and 15 with lens termini only. Number of test samples remain the same (with shell sizes 11 and 15). Each test sample (connector mated pair) populated with lens termini. Each test sample has a type L ASR. . When test both shell sizes 11 and 15, obtain qualification by similarity for shell size 13. Figure 4103-3 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of four connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock)
- 14/ Qualification of shell size 23. Qualification of shell size 23 shall be performed with contact termini after the termini are qualified. Follow the test sample configuration specified in figure 1. Use the MIL-PRF-29504/20 qualified termini.
- 15/ Other allowed figure 4103-3 deviations. None.

FIGURE 4103-3. Test samples: Special case: Connector –shell sizes 11, 13, & 15 with both contact and lens termini

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6. NOTES

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Interoperability. Separate test sample configurations are required for interoperability testing. These test sample configurations are in addition to the ones to be used for the other qualification tests.

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APPENDIX A

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES,
TEMPERATURE RANGE 1 (EXCEPT INTEROPERABILITY)

A.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 termini for temperature range 1. Fabrication criteria are addressed in [appendix B](#) for test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 terminus for temperature range 2. Fabrication criteria are addressed in [appendix C](#) for test samples to be used for interoperability.

A.1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) terminus used in both the connector plug and connector receptacle along with an alignment sleeve retainer (ASR). For identification purposes in this appendix of Requirement 4103 and for consistency with Requirements 4101 and 4102, the termini to be placed in a connector plug will be referred to as "pin termini". The termini to be placed in a connector receptacle (along with the ASR) will be referred to as "socket termini".

A.1.2 Inclusion of other MIL-PRF-29504 termini types. Requirement 4103 initially was based on the qualification of the MIL-PRF-29504/20 terminus with the MIL-PRF-64266 circular connector and MIL-PRF-64266 backshell. Requirement 4103 has been revised to qualify from one to four of the termini types (MIL-PRF-29504/18, /20, /26 and /27) in a MIL-PRF-64266 circular connector without a backshell. Since the MIL-PRF-29504/20 termini can be terminated with either a PC or an APC polish whereas the MIL-PRF-29504/18 terminus can be terminated with a PC polish only, the fabrication of three terminus variations are addressed (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish). Type of polish is not addressed for the MIL-PRF-29504 /26 and /27 termini. For purposes of identifying the variants of termini to be placed in the different connector insert cavity positions, MIL-PRF-29504 /26 and /27 termini are considered to be two other termini variants. A different MIL-PRF-64266 ASR is used depending upon if contact termini (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish) or if lens termini (MIL-PRF-29504 /26 and /27) are placed into the MIL-PRF-64266 connector. This different ASR requirement dictates that different connectors are used for contact termini and lens termini.

A.2 Applicable documents.

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

A.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber optic cabling systems requirements and measurements (Part 1: design, installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)

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[MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships
(Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

A.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWC DD Web Site in the Fiber Optics Recommended List section. This NSWC Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

A.3 Test samples, unterminated termini. Number of termini for both termini type (contact and lens) required to perform a full MIL-PRF-29504/18, /20, /26 and /27 termini qualification is provided in [table 4103 A-I](#).

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TABLE 4103 A-I. Termini allocation for temperature range 1 fiber sizes. ^{1/}

Test performed	Single Mode		Multimode ^{7/}	
	Number of pin termini	Number of socket termini	Number of pin termini	Number of socket termini
Qualification, except interoperability				
Un-terminated termini tests				
	64 + 3	64 + 3	24 + 3	24 + 3
Group 1	64 + 3 of 64 + 3	64 + 3 of 64 + 3	24 + 3 of 24 + 3	24 + 3 of 24 + 3
Group 2 (16 pin termini, 16 socket termini)	13/	13/		
Group 3 (polymeric materials only)	Materials only	Materials only		
Group 4	None	None		
Termini as part of a single fiber cable tests ^{5/}				
	32 + 3 of 64 + 3	32 + 3 of 64 + 3	8 + 3 of 24 + 3	8 + 3 of 24 + 3
Group 1 ^{11/}	12/	12/	8 of 8	8 of 8
Group 2 (16 termini mated pair – each test)	32 of 32	32 of 32		
Fiber pullout force ^{2/, 3/}	16 of 32	16 of 32		
Cable pull out force ^{2/, 3/}	16 of 32	16 of 32		
Group 3	None	None		
Salt spray	None	None		
Fluid immersion	None	None		
Terminus cleaning ^{9/}	9/	9/		
Radiation ^{10/}	3 of + 3	3 of + 3	3 of + 3	3 of + 3
Termini as an integral part of a multiple termini connector				
	32 of 64	32 of 64	16 of 24	16 of 24
Group 1 (8 connector mated pair, SM)	32 of 32	32 of 32	16 of 16	16 of 16
Group 2 (4 connector mated pair, SM) ^{4/, 8/}	16 of 32	16 of 32		
Group 3, Mechanical ^{8/}	4/	4/	16 of 16	16 of 16
Group 3, Environmental (4 connector mated pair) ^{4/, 8/}	16 of 32	16 of 32		
Interoperability ^{6/}				
Total number of lens termini	67	67	27	27

^{1/} See A.3.1 and A.3.2 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

^{2/} 16 termini from the termini designated for Group 2.

^{3/} If one socket terminus is tested at a time, only one pin terminus-to-ST jumper is required for the 16 socket terminus-to-ST jumper tested (see table 4103-I).

^{4/} Use same test samples from Group 2 for Group 3 Mechanical test. Separate test samples are used for Group 3 Environmental tests.

^{5/} Termini-to-ST jumpers.

^{6/} Configuration and fabrication requirements for interoperability samples are found in appendix C.

^{7/} Quantity valid only if full test sequence is performed with single mode and qualification requirements are met. Otherwise use same quantity as specified for single mode test samples.

^{8/} From Group 1 for “Termini as an integral part of a multiple termini connector”.

^{9/} Test samples from the cable pullout test shall be used.

^{10/} Separate test samples prepared in accordance with MIL-STD-1678-4 Requirement 4105 shall be used. Three test samples shall be fabricated on the specified fiber type for each lens terminus with a different wavelength lens.

^{11/} Same single mode test samples that will be used later for the cable pullout test. Separate multimode test samples shall be used.

^{12/} No additional termini required. Use 8 test samples from cable pullout test.

^{13/} No additional termini required. Use 16 termini from Group 1.

A.3.1 Quantity. Quantity of 67 pin termini and 67 socket termini for single mode fiber type and 27 pin termini and 27 socket termini for multimode fiber type.

NOTE: This minimum number quantity does not include the number of termini required for interoperability (52 pin termini and 52 socket termini, see appendix C for further details on interoperability).

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A.4 Test samples. Termini as part of a single fiber cable.

A.4.1 Quantity. See [table 4103 A-I](#) selected from the lot of un-terminated termini.

A.4.2 Configurations and fabrication.

A.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in [A.5.1](#), and [A.5.3](#), through [A.5.7](#) below. Fiber pullout test samples shall be prepared on single fiber cable without any strain relief. Cable pullout test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.

A.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with [4.1.1](#) of Requirement 4103. Post polish shall result in a domed ferrule end face with a PC polish for termini and for instrument end connectors. The one exception is that a domed end face with an APC polish shall be provided for instrument end connectors for termini with an APC polish.

A.4.3 Cable type. Cable used must be of same configuration as MIL-PRF-85045/16; however, this cable does not need to meet environmental specifications in MIL-PRF-85045/16. The fiber in the cable used must be the same or equivalent to MIL-PRF-49291/6 for multimode optical fiber or MIL-PRF-49291/7 for single mode fiber. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

A.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

A.5 Test samples. Termini as an integral part of a multiple termini connector.

A.5.1 Termination procedures. Termination procedure for the test samples shall be in accordance with [4.1.1](#) of Requirement 4103. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

A.5.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish ST connectors (or other instrumentation-end connectors) except as specified in A.4.2.2. End face geometry shall be as specified in MIL-STD-1678-5.

A.5.2 Cable type. Cable used shall be MIL-PRF-85045 cable with the specification sheet conforming to [table 4103 A-II](#).

TABLE 4103 A-II. Cable compatible with connector.

Connector shell size	Number of cavities in connector insert	Specification sheet for MIL-PRF-85045 cable
NA	NA	/16

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A.5.3 Epoxy type. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved include those in table 4103 A-III.

TABLE 4103 A-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^{\circ}\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See A.2.2.2.

A.5.4 Polishing steps and polishing paper used (applicable to contact termini only).

A.5.4.1 Polish type. The standard polish specified in [4.1.1](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

A.5.4.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with [4.1.1](#) shall be used. The standard polish as specified in [A.5.4.1](#) shall be used.

A.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

A.5.5 Connectors.

A.5.5.1 Configuration.

A.5.5.1.1 Termini qualification only. A MIL-PRF-64266 shell size 11 circular connector shall be used. The connector configuration shall consist of a MIL-PRF-64266/1 wall mounting connector receptacle and a MIL-PRF-64266/2 connector plug with a four cavity insert. The ASR shall be compatible with the termini variants being qualified.

A.5.5.1.2 Connector qualification. A MIL-PRF-64266 circular connector shall be used. The connector configuration shall consist of a MIL-PRF-64266/1 wall mounting connector receptacle and a MIL-PRF-64266/2 connector plug with the specified number of cavities in the connector insert for each shell size. The ASR shall be compatible with the termini variants being qualified.

A.5.5.2 Backshell (connector accessory). No backshell shall be used with the connector mated pair.

A.5.5.3 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert. Four channels in each connector shall be active optically for circular connector and for termini qualification testing.

A.5.5.4 Fiber type. Each connector mated pair shall contain only one fiber type.

A.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of [MIL-STD-1678-2](#).

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A.5.7 Fabrication. Test sample configurations (each cable assembly) shall consist of 10 meters of MIL-PRF-85045 single fiber cable with the DUT (connector mated pair or termini inserted into a MIL-PRF-64266 connector) in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires the cable length from terminus-to-single ferrule connector to be 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

A.5.7.1 Single mode. Termini on cable assemblies (such as terminus-to-ST jumpers) with cable containing single mode 9/125 micron optic fiber shall conform to table 4103 A-IV. Each mated pair configuration required for a combined connector and termini qualification depends on the shell size(s) being qualified (see A.5.5.1).

TABLE 4103 A-IV. Fabrication for cable with 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	125.5 +1/-0 microns/1310 nm <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4103 A-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 A-III.
Test sample quantity	8 connector mated pair per A.5.1 through A.5.6. <u>2/</u>
Tests performed	Full test sequence <u>2/</u>

1/ 9.3/125 micron at 1310 nm per MIL-PRF-49291/7.

2/ See the qualification table in [appendix D.](#)

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

A.5.7.2 Multimode. Termini on cable assemblies with multimode cable containing 62.5/125 micron fiber shall conform to table 4103 A-V. Each mated pair configuration required for a combined connector and termini qualification depends on the shell size(s) being qualified (see A.5.5.1).

TABLE 4103 A-V. Fabrication for cable with multimode fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	126 +1/-0 microns/1300 nm <u>3/</u>
Fiber size	62.5/125 micron per MIL-PRF-49291/6.
Cable type	Tight buffer per table 4103 A-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 A-III.
Test sample quantity	4 connector mated pair per A.5.1 through A.5.6. <u>2/</u>
Tests performed	Limited test sequence <u>1/</u> , <u>2/</u>

1/ Qualify single mode first. A reduced set of tests using 4 multimode connector mated pair (for each 8 single mode mated pair) is listed once qualified using a full test sequence with single mode fiber

2/ See the qualification table in [appendix D.](#)

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

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APPENDIX B

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES,
TEMPERATURE RANGE 2
(EXCEPT INTEROPERABILITY)

B.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of the MIL-PRF-29504/20 terminus for temperature range 2 (see 1.2). Fabrication criteria are addressed in appendix A for test samples to be used for the qualification of the MIL-PRF-29504/20 terminus for temperature range 1. Fabrication criteria are addressed in appendix C for test samples to be used for interoperability.

B.1.1 Consistency. The MIL-PRF-29504/20 is a genderless (really pin) terminus used in both the connector plug and connector receptacle along with an Alignment Sleeve Retainer (ASR). For identification purposes in this appendix of Requirement 4103 and for consistency with Requirements 4101 and 4102, the termini to be placed in a connector plug will be referred to as "pin termini". The termini to be placed in a connector receptacle (along with the ASR) will be referred to as "socket termini".

B.1.2 Inclusion of other MIL-PRF-29504 termini types. Requirement 4103 initially was based on the qualification of the MIL-PRF-29504/20 terminus with the MIL-PRF-64266 circular connector and MIL-PRF-64266 backshell. Requirement 4103 has been revised to qualify from one to four of the termini types (MIL-PRF-29504/18, /20, /26 and /27) in a MIL-PRF-64266 circular connector without a backshell. Since the MIL-PRF-29504/20 termini can be terminated with either a PC or an APC polish whereas the MIL-PRF-29504/18 terminus can be terminated with a PC polish only, the fabrication of three terminus variations are addressed (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish). Type of polish is not addressed for the MIL-PRF-29504 /26 and /27 termini. For purposes of identifying the variants of termini to be placed in the different connector insert cavity positions, MIL-PRF-29504 /26 and /27 termini are considered to be two other termini variants. A different MIL-PRF-64266 ASR is used depending upon if contact termini (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish) or if lens termini (MIL-PRF-29504 /26 and /27) are placed into the MIL-PRF-64266 connector. This different ASR requirement dictates that different connectors are used for contact termini and lens termini.

B.2 Applicable documents.

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

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

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DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

GENERAL SERIES TECHNICAL MANUAL

- [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

- [TIA-455](#) - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

B.3 Test samples, un-terminated termini. Number of termini for both termini type (contact and lens) required to perform a full MIL-PRF-29504/18, /20, /26 and /27 termini qualification is provided in [table 4103 B-I](#).

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TABLE 4103 B-I. Termini allocation table for temperature range 2 fiber sizes. 1/

Test performed	Single mode		Multimode 7/, 8/	
	Number of pin termini	Number of socket termini	Number of pin termini	Number of socket termini
Qualification, except interoperability				
Unterminated termini tests				
	104 + 3	104 + 3	24 + 3	24 + 3
Group 1	104 + 3 of 104 + 3	104 + 3 of 104 + 3	24 + 3 of 40 + 3	24 + 3 of 40 + 3
Group 2	13/	13/		
Group 3 (polymeric materials only)	Materials only	Materials only		
Group 4	8 of 104			
Termini as part of a single fiber cable tests 5/				
	64 + 3 of 104 + 3	64 + 3 of 104 + 3	8 + 3 of 24 + 3	8 + 3 of 24 + 3
Group 1	12/	12/	8 of 8	8 of 8
Group 2	32 of 64	32 of 64		
Fiber pullout force	16 of 32	16 of 32		
Cable pull out force, twist	16 of 32	16 of 32		
Group 3	32 of 64	32 of 64		
Salt spray 2/	16 of 32	16 of 32		
Fluid immersion 2/, 3/	16 of 32	16 of 32		
Terminus cleaning 10/	10/	10/		
Radiation 11/	3 of + 3	3 of + 3	3 of + 3	3 of + 3
Termini as an integral part of a multiple termini connector				
	32 of 104 + 3	32 of 104 + 3	16 of 24 + 3	16 of 24 + 3
Group 1 (8 connector mated pair, SM)	32 of 32	32 of 32	16 of 16	16 of 16
Group 2 (4 connector mated pair)	16 of 32	16 of 32		
Group 3, Mechanical 4/, 9/	4/	4/	16 of 16	16 of 16
Group 3, Environmental (4 connector mated pair) 4/, 9/	16 of 32	16 of 32		
Interoperability 6/				
	107	107	27	27

1/ See B.3.1 and B.3.2 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

2/ 16 termini from the termini designated for Group 3.

3/ Termini to be placed in both connector plug and connector receptacle to verify optical performance after the test. Termini shall be immersed for this test.

4/ No additional termini required. Same 4 connector mated pair from Group 2 are used. Separate test samples are used for Group 3 Environmental tests.

5/ Termini-to-ST jumpers.

6/ Configuration and fabrication requirements for interoperability samples are found in appendix C.

7/ Quantity valid only if full test sequence is performed with single mode and qualification requirements are met. Otherwise use same quantity as specified for single mode test samples.

8/ Add an additional 20 pin termini and 20 socket termini for multimode 100 size, insertion loss, vibration and shock.

9/ From Group 1 for "Termini as an integral part of a multiple termini connector".

10/ Test samples from the fluid immersion test shall be used.

11/ Lens termini only. Separate test samples prepared in accordance with MIL-STD-1678-4 Requirement 4105 shall be used. Three test samples shall be fabricated on the specified fiber type for each lens terminus with a different wavelength lens.

12/ No additional termini required. Use 8 test samples from cable pullout test.

13/ No additional test samples required. Use 16 termini from Group 1.

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B.3.1 Quantity. Quantity of 107 pin termini and 107 socket termini for single mode fiber type and 27 pin termini and 27 socket termini for multimode fiber type.

NOTE: This quantity does not include the number of termini required for interoperability (36 pin termini and 36 socket termini for each fiber type and for contact and/or lens type and an additional 16 pin termini, see appendix C for further details on interoperability).

B.4 Test samples. Termini as part of a single fiber cable.

B.4.1 Quantity. 78 pin termini and 78 socket termini selected from the lot of un-terminated termini.

B.4.2 Configurations and fabrication.

B.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in B.5.1, and B.5.3 through B.5.7 below. Fiber pullout test samples shall be prepared on single fiber cable without any strain relief. Cable pullout test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.

B.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with 4.1.2 of Requirement 4103. Post polish shall result in a domed ferrule end face with a PC polish for termini and for instrument end connectors. The one exception is that a domed end face with an APC polish shall be provided for instrument end connectors for termini with an APC polish.

B.4.3 Cable type. Cable used must be of same configuration specified in B.5.2 below; however, this cable does not need to meet environmental specifications in MIL-PRF-29504/18, /20, /26 and /27. The optic fiber in the cable used must be the same or equivalent to the approved cabling as stated in B.5.2 below. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

B.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

B.5 Test samples. Termini as an integral part of a multiple termini connector.

B.5.1 Termination procedures. Termination procedure for the test samples shall be in accordance with WP 010 04 of NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

B.5.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with either a PC polish or an APC polish (as specified for each insert cavity position, see appendix E, for termini and with a PC polish for ST connectors (or other instrumentation-end connectors) except as specified in B.3.2.2. End face geometry shall be as specified in MIL-STD-1678-1.

B.5.2 Cable type. The Government must approve cable brand and part number prior to test sample termination. Cables approved to date are those listed in table 4103 B-II.

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B.5.2.1 Test samples used for insertion loss only. Cable used must be of same configuration specified. The fiber in the cable used must be the same or equivalent to the approved cabling as stated above. NAVAIR 4.5 will determine if the fiber is equivalent. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table.

TABLE 4103 B-II. Tight buffer cable.

Fiber size (microns)	Cable vendor	CAGE Code	Part number	Alternate part number
9/125 <u>1/</u>	OFS Fitel	0MZN3	C14447	None
50/125 <u>1/</u>	OFS Fitel	0MZN3	C10027	BC06815

1/ Cable must be preconditioned prior to terminus termination and connector assembly as specified in [MIL-STD-1678-5](#) Measurement 5301.

B.5.3 Epoxy type. Approved epoxy shall be used for test sample termination. Epoxies approved to date are those in [table 4103 B-III.](#)

TABLE 4103 B-III. Epoxy types.

Epoxy type	CAGE code	Part number	Cure schedule
Two-part liquid, Epo-tek 353ND <u>1/</u>	64201	353ND-2g	<u>2/</u>
	08RC6	3700-5520	<u>2/</u>

1/ Two part, heat cured epoxy provided in 2 gram A-PAKS. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ See table 1, WP 010 02 in NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4

B.5.4 Polishing steps and polishing paper used (applicable to contact termini only).

B.5.4.1 Polish type. The standard polish specified in [4.1.1](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

B.5.4.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with [4.1.1](#) shall be used. The standard polish as specified in [B.5.4.1](#) shall be used.

B.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

B.5.5 Connectors.

B.5.5.1 Configuration.

B.5.5.1.1 Termini qualification only. A MIL-PRF-64266 shell size 11 circular connector shall be used. The connector configuration shall consist of a MIL-PRF-64266/1 wall mounting connector receptacle and a MIL-PRF-64266/2 connector plug with a four cavity insert. The ASR shall be compatible with the termini variants being qualified.

B.5.5.1.2 Connector qualification. A MIL-PRF-64266 circular connector shall be used. The connector configuration shall consist of a MIL-PRF-64266/1 wall mounting connector receptacle and a MIL-PRF-64266/2 connector plug with the specified number of cavities in the connector insert for each shell size. The ASR shall be compatible with the termini variants being qualified.

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B.5.5.2 Backshell (connector accessory). Not applicable.

B.5.5.3 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert. Four channels in each connector shall be active optically for circular connector and for termini qualification testing.

B.5.5.4 Fiber type. Each connector mated pair shall contain only one fiber type.

B.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of MIL-STD-1678-2.

B.5.7 Fabrication. At a minimum, separate sets of test samples shall be tested on cable assemblies of termini mated pair fabricated with single mode fiber and with multimode fiber. Test sample configurations shall consist of termini-to-ST connector jumpers. Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

B.5.7.1 Single mode 9. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4103 B-IV. Each mated pair configuration required for a combined connector and termini qualification depends on the shell size(s) being qualified (see B.5.5.1).

TABLE 4103 B-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	125.5 +1/-0 μ m/1500 nm <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4103 B-II .
Epoxy type	Two part, heat cured, liquid type per table 4103 B-III .
Test sample quantity	8 connector mated pair per B.5.1 through B.5.6 . <u>2/</u>
Tests performed	Full test sequence <u>2/</u>

1/ 9.3/125 micron at 1310 nm.

2/ See the qualification table in appendix D.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

B.5.7.2 Multimode. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 50/125 micron fiber shall conform to table 4103B-V. Each mated pair configuration required for a combined connector and termini qualification depends on the shell size(s) being qualified (see B.5.5.1).

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TABLE 4103 B-V. Fabrication for multimode fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	126 +1/-0 μ m/850 nm <u>3/</u>
Fiber size	50/125 micron
Cable type	Tight buffer per table 4103 B-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 B-II.
Test sample quantity	4 connector mated pair per B.5.1 through B.5.6. <u>2/</u>
Tests performed	Limited test sequence. <u>1/</u> , <u>2/</u>

1/ Qualify single mode first. A reduced set of tests using 2 connector multimode mated pair (for each 4 connector single made mated pair) is listed once qualified using a full test sequence with single mode fiber.

2/ See the qualification table in appendix D.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

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APPENDIX C

CONFIGURATION AND FABRICATION REQUIREMENTS FOR INTEROPERABILITY TEST SAMPLES

C.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the interoperability testing of the MIL-PRF-29504/18, /20, /26 and /27 termini. In the past, the Government has collaborated with termini/connector companies that were undergoing Qualified Products List testing in an effort to verify interoperability of fiber optic, multiple termini connectors that conform to MIL-PRF-28876. This partnership allows the Government to verify the interoperability of connectors with that of participating companies. DLA Land and Maritime- VTP is now the Government entity that performs the testing for interoperability. This partnership for interoperability testing is now extended to other termini/connectors including qualifying the MIL-PRF-64266 connector and the MIL-PRF-29504 termini for the MIL-PRF-64266 connector.

C.1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the connector plug and connector receptacle along with an alignment sleeve retainer (ASR). For identification purposes in this appendix of Requirement 4103 and for consistency with Requirements 4101 and 4102, the termini to be placed in a connector plug will be referred to as "pin termini". The termini to be placed in a connector receptacle (along with the ASR) will be referred to as "socket termini".

C.1.2 Exclusion of MIL-PRF-29504/20 termini. This appendix is based on performing interoperability as part of the qualification using only the MIL-PRF-29504/18 terminus when both the MIL-PRF-29504/18 terminus and the MIL-PRF-29504/20 terminus is being qualified. When only the MIL-PRF-29504/20 terminus is being qualified, then the MIL-PRF-29504/20 terminus shall be used for interoperability. The MIL-PRF-64266 circular connector specification sheets allow performing qualification simultaneously for both MIL-PRF-29504/18 and MIL-PRF-29504/20 termini. For interoperability, the MIL-PRF-29504 termini are be terminated with a PC polish. Placement of the termini in each connector cavity position does not apply as is addressed in appendix C.

C.1.3 Exclusion of MIL-PRF-29504/27 termini. This appendix is based on performing interoperability as part of the qualification using only the MIL-PRF-29504/26 terminus when both the MIL-PRF-29504/26 terminus and the MIL-PRF-29504/27 terminus is being qualified. When only the MIL-PRF-29504/27 terminus is being qualified, then the MIL-PRF-29504/27 terminus shall be used for interoperability. Placement of the termini in each connector cavity position does not apply as is addressed in appendix C.

C.2 Applicable documents.

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

C.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

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DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements And Measurements (Part 1: Design, Installation And Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Suoplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

C.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWC DD Web Site in the Fiber Optics Recommended List section. This NSWC Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

- [TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

C.3 Policy pertaining to test sample submission. Vendors shall be responsible for the fabrication, submittal and replacement/refurbishment of cable assemblies (test samples) in the configurations specified below to the Government for Interoperability testing.

C.3.1 Test sample retention. One stipulation is that the test samples are to be retained by the Government for use as standards in future interoperability testing to be performed by the Government in-house personnel. Only personnel to be present during interoperability testing are Government, in-house personnel. At no time shall other parties have access to or examination of the interoperability standards.

C.3.2 Replacement/refurbishment. Another stipulation is that the vendor shall agree to replace or refurbish these interoperability standards as the need arises. Any items requiring replacement/refurbishment in this agreement shall be performed by the vendor at no cost to the Government.

C.3.3 Notification for submission. Initial notification to submit test samples for interoperability shall be made to DLA Land and Maritime-VQP Qualifications Group.

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C.3.4 Arrangements to perform interoperability testing. Once approved by DLA Land and Maritime-VQP, the vendor shall make financial, test and shipping arrangements with the DLA Land and Maritime-VTP Passive Test Section.

Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime- VTP point of contact.

Shipping address:

DLA Land and Maritime Columbus

3990 East Broad St.

Bldg. 11, Section 7, VTP

Columbus OH 43213-1199

TABLE 4103 C-I. Termini interoperability test variations. 1/

Test variation	Connector receptacle	Termini socket	Connector plug	Termini pin
1	X	A	X	B
2	X	B	X	A
3	X	B	X	B

X = Previously Certified Connector , B = Candidate Termini

A = Previously Certified Termini

1/ Socket termini placed in connector receptacle, pin termini in connector plug.

TABLE 4103 C-II. Termini allocation table for each fiber size. 1/

Test performed	Single mode				Multimode			
	Number of pin termini		Number of socket termini		Number of pin termini		Number of socket termini	
Interoperability								
	Contact	Lens	Contact	Lens	Contact	Lens	Contact	Lens
Total number of needed lens termini	52	36	36	36	36	36	36	36
Interoperability of counterpart terminus <u>2/</u> , <u>3/</u>	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36
Insertion loss (test variations per table 4106 C-I)	4	4	4	4	4	4	4	4
Insertion loss, additional (for circular shell sizes) <u>4/</u>	32	32	32	32	32	32	32	32
Insert-to-termini compatibility <u>5/</u>	16 of 16	0	0	0	0	0	0	0
Terminus retention force	16 of 16	0	0	0	0	0	0	0
Terminus insertion and removal forces <u>6/</u>	16 of 16	0	0	0	0	0	0	0

1/ See C.4 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

2/ Termini-to-ST jumpers.

3/ Candidate pin terminus-to-ST connector jumper (minimum quantity: 4 of each fiber size and for contact and/or lens type) and candidate pin terminus-to-ST connector jumper (minimum quantity: 4 of each fiber size and for contact and/or lens type) shall be tested in a connector per C.4.6 for each fiber size and for contact and/or lens termini types.

4/ When testing for candidate connector interoperability and to allow for the interoperability of counterpart termini to enable connector interoperability for 4 mated pair of each fiber type and for each contact and/or lens type being submitted. Also allow for candidate circular connector interoperability with these counterpart termini.

5/ Un-terminated termini. A total of 16 un-terminated termini are required for each test and the same 16 un-terminated termini may be used for both tests.

6/ Test performed using connector in which the ASR is not inserted.

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APPENDIX C

C.4 Interoperability of counterpart terminus. Test sample and qualified termini shall be inserted into and fully populate qualified connectors for test variations performed in [table 4103 C-I](#). Cable assemblies for connector receptacles and plugs shall be configured with single fiber cable and no backshells. Quantity of termini required for one fiber size to perform this interoperability test shall be as specified in [table 4103 C-II](#) for MIL-PRF-29504/18, /20, /26 and /27 termini qualification. The number of termini required for a combined connector and termini qualification depends on the shell size(s) being qualified and must be determined separately (see [table 4103-I](#) and [table 4103-II](#)). Insertion loss shall be measured in accordance with MIL-STD-1678-2, Measurement 2101 using the simulated cut-back method. Tools, specified for insertion and removal of MIL-PRF-29504/18 and MIL-PRF-29504/26 termini from the connector insert cavities, shall be used successfully for terminus insertion and removal of the terminus-to-ST connector jumpers for this interoperability test.

C.4.1 Termination procedures. Termination procedure for the test samples shall be in accordance with [4.1.1](#) of Requirement 4103. Post polish for termini and for instrument end connectors shall conform to C.4.1.1. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

C.4.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish both for termini and for ST connectors (or other instrumentation-end connectors). End face geometry shall be as specified in MIL-STD-1678-1.

C.4.1.2 Allocation of the 52 pin termini and 52 socket termini (pertains to both single mode and multimode). NOTE: This allocation is from [table 4103 C-II](#) for interoperability of MIL-PRF-29504/18 (or MIL-PRF-29504/20) termini as a part of termini qualification. The number of termini required for interoperability as a part of a combined connector and termini qualification depends on the shell size(s) being qualified and must be determined separately (see [table 4103-I](#) and [table 4103-II](#)).

- a. Interoperability of counterpart terminus.
 - i. Insertion loss. 8 pin termini and 8 socket termini (for each fiber size, see [table 4103-II](#)).
 - ii. Insertion loss, additional. 28 pin termini and 28 socket termini (for each fiber size, see [table 4103-II](#)).
- b. Insert-to-termini compatibility.
 - iii. Terminus retention force. 16 pin termini and 16 socket termini.
 - iv. Terminus insertion and removal forces. 16 pin termini and 16 socket termini (same un-terminated termini may be used for both insert-to-termini compatibility tests, see [table 4103-II](#)).

C.4.2 Cable type. Interoperability test samples shall be constructed using MIL-PRF-85045/16 single fiber cable. For the 9/125 micron fiber size, M85045/16-02 shall be used. For the 62.5/125 micron fiber size, M85045/16-01 shall be used.

C.4.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

C.4.3.1 Multimode. No launch condition jumpers are required for the multimode fiber sizes. Overfilled launch conditions are used for interoperability testing.

C.4.3.2 Single mode. A mandrel diameter shall be used as the means of mode conditioning to filter out higher order modes. The technique of wrapping the fiber around a mandrel shall be performed as specified see 3.5 of [TIA-455.34](#). A diameter of 30 mm shall be used with 3 complete turns of the fiber wrapped around the mandrel.

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APPENDIX C

C.4.4 Epoxy type and cure schedule. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved are in table 4103 C-III.

TABLE 4103 C-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 1/, 2/	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List 3/

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^\circ\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See C.2.2.2.

C.4.5 Polishing steps and polishing paper used (applicable to contact termini only).

C.4.5.1 Polish type. The standard polish specified in [4.1.1](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

C.4.5.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with [4.1.1](#) shall be used. The standard polish as specified in [C.4.5.1](#) shall be used.

C.4.5.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

C.4.6 Connectors.

C.4.6.1 Configuration. A MIL-PRF-64266/1 and /2 shell size 11 circular connector shall be used with a fully populated 4 cavity insert for interoperability that is a part of termini qualification. All 4 channels are to be active optically for termini interoperability. Connector configurations used for termini qualification shall conform to 4.7.1.1 of [MIL-PRF-64266](#). The configuration required for interoperability of a combined connector and termini qualification depends on the shell size(s) being qualified. For each shell size being qualified, the connector tested for interoperability shall have the insert with the maximum number of cavities. All channels in the connector tested are to be active optically for interoperability that is a part of a combined connector and termini qualification.

C.4.6.2 Candidate termini future use. Once qualified, these interoperability "standards" shall be used to determine interoperability of other MIL-PRF-29504/18 and MIL-PRF-29504/20 termini. At the discretion of DLA Land and Maritime-VTP, these interoperability standards can be used to determine interoperability of MIL-PRF-64266 connectors.

C.4.6.3 Submission. No connector submission is required for a termini only qualification.

C.4.6.4 Insert cavity population. Interoperability testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

C.4.6.5 Fiber type. Each connector mated pair shall contain only one fiber type.

C.4.6.6 Instrument end connectors. ST connectors with a domed PC polish shall be provided.

REQUIREMENT 4103

APPENDIX C

C.4.7 Fabrication of termini.

C.4.7.1 Single mode. Termini on cable assemblies (terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4103 C-IV. One connector mated pair (1 fully populated, MIL-PRF-64266, shell size 11, four cavity insert, key position 1, qualified connectors without backshells, connector receptacle is with a flange mounting) shall contain a total of 4 pin termini-to-ST connector jumpers and 4 socket termini-to-ST connector jumpers. This connector mated pair configuration is for interoperability that is a part of MIL-PRF-29504 termini only qualification. One connector mated pair shall be provided for each fiber type and for the contact and lens termini types being qualified. A connector mated pair configuration required for interoperability that is a part of a combined connector and termini qualification or connector only qualification depends on the shell size(s) being qualified (see C.4.6.1).

TABLE 4103 C-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	125.5 +1/-0 microns <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per C.4.2.
Cable length	2 meters <u>2/</u>
Epoxy type	Two part, heat cured, liquid type per C.4.4.
Test sample quantity	4 pin termini and 4 socket termini cable assemblies per table 4103 C-II.
Additional quantity submission	2 pin termini and 32 socket termini cable assemblies per note <u>4/</u> in table 4103 C-II.
Tests performed	Interoperability of counterpart termini

1/ 9.3/125 micron at 1310 nm for the MIL-PRF-49291/7 optical fiber.

2/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

3/ Ferrule hole diameter applicable for contact termini type.

C.4.7.2 Multimode. Termini on cable assemblies (terminus-to-ST connector jumpers) with multimode 62.5/125 micron cable shall conform to table 4103 C-V. One connector mated pair (1 fully populated, MIL-PRF-64266, shell size 11, four cavity insert, key position 1, qualified connectors without backshells, connector receptacle is with a flange mounting) shall contain a total of 4 pin termini-to-ST connector jumpers and 4 socket termini-to-ST connector jumpers. This one connector mated pair configuration is for interoperability that is a part of MIL-PRF-29504/20 termini only qualification. One connector mated pair shall be provided for each fiber type and for the contact and lens termini types being qualified. A connector mated pair configuration required for interoperability that is a part of a combined connector and termini qualification or connector only qualification depends on the shell size(s) being qualified (see C.4.6.1).

TABLE 4103 C-V. Fabrication for 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 um <u>2/</u>
Fiber size	62.5/125 micron
Cable type	Tight buffer per C.4.2.
Cable length	2 meters <u>1/</u>
Epoxy type	Two part, heat cured, liquid type per C.4.4.
Test sample quantity	4 pin termini and 4 socket termini cable assemblies per table 4103 C-II.
Additional quantity submission	32 pin termini and 32 socket termini cable assemblies per note <u>4/</u> in table 4103 C-II.
Tests performed	Interoperability of counterpart termini

1/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

2/ Ferrule hole diameter applicable for contact termini type.

REQUIREMENT 4103

APPENDIX C

C.5 Insert-to-termini compatibility.

C.5.1 Terminus retention force. Un-terminated pin and socket termini shall be inserted into a previously qualified connector(s) using a terminus insertion tool. An axial compressive load shall be applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. A pre-load not greater than 13.3 N (3 lbs.) may be used to seat the terminus for the initial measurement. Axial loads shall be applied at a rate of 4.4 N/s (1.0 lb/s) up to a maximum load 98 N (22.0 lbs.). The maximum load shall be maintained for at least 5 seconds. Minimum number of termini tested shall be the quantity listed for insert-to-terminus compatibility in [table 4103 C-II](#).

C.5.2 Terminus insertion and removal forces. Perform in accordance with 4.9.11 in [MIL-PRF-29504](#).

MEASUREMENT 4103

APPENDIX D

COMBINED TERMINI AND CONNECTOR QUALIFICATION TEST SEQUENCE

D.1 Purpose. This appendix addresses a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with the MIL-PRF-64266/1 and /2 circular qualification.

D.2 Implementation for a combined qualification test. A combined qualification testing sequence for both the combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/1 and /2 circular qualification and performed for temperature range 1, temperature range 2, or both temperature ranges is listed in [table 4103 D-1](#).

TABLE 4103 D-1. Combined termini and circular test sequence.

Temperature range: test performed <u>1/</u> , <u>2/</u>	Temperature range 1 <u>3/</u>		Temperature range 2 <u>3/</u>	
	SM	MM	SM	MM
Tests for components only (un-terminated termini, circular connector)				
Group 1 <u>4/</u>				
Size <u>5/</u>	X	X	X	X
Weight <u>5/</u>	X		X	
Identification markings <u>5/</u>	X		X	
Workmanship <u>5/</u>	X		X	
Screw thread	C		C	
Circular runout <u>5/</u>	X	X	X	X
Beam interface parameters <u>18/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Group 2 <u>5/</u> , <u>6/</u> , <u>7/</u>				
Terminus insertion & removal forces	X		X	
Terminus retention <u>5/</u>	X		X	
Maintenance aging	X		X	
Terminus cleaning	X <u>24/</u> , <u>28/</u>		X <u>24/</u> , <u>28/</u>	
Lens scratches and defects	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Lens abrasion resistance	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Insert retention radial strength	C		C	
Insert retention axial strength	C		C	
Shell to shell conductivity	C		C	
Connector coupling engagement & disengagement	C		C	
Connector rear threads accessory attachment	C		C	
Dust cover engagement and disengagement torque	C		C	
Safety wire hole pullout	C		C	
Group 3 (polymeric materials)				
Ozone	X		X	
Fungus resistance	X		X	
Group 4				
Modified SO ₂ /salt spray			X	
Group 1 tests for termini as part of a single fiber cable (termini mated pair, connector used to mate) /Group 2 and 3 tests for both circular connector components and inserted termini mated pair				
Group 1 <u>14/</u> , <u>19/</u>				
Attenuation	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Polarization dependent loss	X <u>24/</u>		X <u>24/</u>	
Bandwidth		X <u>24/</u>		X <u>24/</u>
Twist	<u>21/</u>		<u>21/</u>	
Terminus cleaning	<u>21/</u>		<u>21/</u>	
Fiber-to-splice pull out force <u>8/</u>	<u>21/</u>		<u>21/</u>	

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APPENDIX D

TABLE 4103 D-I. Combined termini and circular test sequence – Continued.

Temperature range: test performed <u>1/</u> , <u>2/</u>	Temperature range 1 <u>3/</u>		Temperature range 2 <u>3/</u>	
	SM	MM	SM	MM
Group 2 (16 termini mated pair – each pull out test) <u>6/</u>				
Insertion loss (16 cable PO & 16 Fiber PO termini mated pair)	<u>22/</u>		<u>22/</u>	
Fiber pull out force <u>8/</u>	X			
Cable pull out force <u>8/</u>	X		X	
Twist <u>17/</u>	X <u>23/</u>		X <u>23/</u>	
Fiber to-terminus pull out force <u>8/</u>	<u>21/</u>		<u>21/</u>	
Group 3 (16 termini mated pair from cable pull out force)				
Salt spray <u>20/</u>			X	
Fluid immersion <u>20/</u>			X	
Terminus cleaning	X <u>24/</u>		X <u>24/</u>	
Radiation <u>15/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Tests for termini as an integral part of a multiple termini connector /tests for connector tested as a connector mated pair				
Group 1 (8 connector mated pair, <u>16/</u>)				
Interoperability <u>9/</u>	X	X	X	X
Optical tests				
Insertion loss	X	X	X	X
Return loss	X		X	
Bit error rate			X	X
Crosstalk	C		C	
Group 2 (4 connector mated pair, <u>16/</u>)				
Mating durability	X		X	
Terminus cleaning	X		X	
Return loss <u>10/</u>	X		X	
Shell-to-shell conductivity	C		C	
External bending moment	C		C	
Group 3 <u>16/</u>				
Mechanical tests <u>11/</u>				
Vibration <u>12/</u>	X		X	X
Shock, MIL-DTL-901 <u>12/</u>	X	X	X	X
Impact <u>27/</u>	C		C	
Insertion loss (verification)	C		C	
Water pressure	C		C	
Modified SO2/salt spray	C		C	
Environmental (4 connector mated pair) <u>11/</u>				
Thermal shock	X		X	X
Temperature humidity cycling	X			
Temperature cycling	X		X	
Altitude immersion			X	
Temperature life	X		X	
Insert retention radial str <u>25/</u>	C		C	
Insert retention axial str <u>25/</u>	C		C	
Freezing water	C		C	
Flammability <u>11/</u>	X			

MEASUREMENT 4103

APPENDIX D

TABLE 4103 D-I. Combined termini and circular test sequence – Continued.

Temperature range: test performed <u>1/</u> , <u>2/</u>	Temperature range 1 <u>3/</u>		Temperature range 2 <u>3/</u>	
	SM	MM	SM	MM
Group 3 <u>16/</u>				
Insertion loss verification <u>13/</u>	X		X	X
Return loss <u>13/</u>	X		X	
Sand & dust	C		C	
Connector coupling engagement & disengagement torque	C		C	
Terminus cleaning	C		C	
Identification marking	C		C	
Group 4 (4 mated pairs + parts)				
Electromagnetic effects (2mp) <u>26/</u>	C		C	
Fluid immersion (2 mated pair)	C		C	
Salt spray (2 mated pair) <u>27/</u>	C		C	
Connector coupling engagement	C		C	
Shell to shell conductivity	C		C	

Notes:

- 1/ Qualification consist of performing tests in this table for temperature range 1, for temperature range 2 or for both temperature range 1 (TR1) and temperature range 2 (TR2). There is no separate qualification for only one fiber size (SM or MM).
- 2/ "X" indicates test applies when performing a terminus qualification only, a connector qualification only or when performing a common test for a "combined" qualification (i.e., for performing a terminus qualification along with a MIL-PRF-64266 connector qualification).
"C" indicates test applies when performing a connector qualification only or when performing a connector applicable only test for a "combined" qualification.
- 3/ Assumes same terminus material and physical configuration as used in the other temperature range.
- 4/ Sample size. Sample size, test sample configuration and test sample fabrication shall conform to MIL-STD-1678-4 Requirement 4103.
 - a. Unterminated termini. One test sample is a terminus that has not been terminated (fabricated) onto the end of a fiber optic cable or optical fiber.
 - b. Termini as part of a single fiber cable. One termini mated pair = one pin terminus and one socket terminus (i.e., two pin termini for this configuration).
 - c. Termini as part of a multiple termini connector. One connector mated pair = A bundle of terminated single fiber cables inserted into a mated MIL-PRF-64266 connector plug and connector receptacle, both fully populated with contact or lens type of MIL-PRF-29504 termini.
- 5/ These inspections are to be performed by the manufacturer at the production facility. Exception may be taken for weight, circular run out, terminus retention, terminus insertion and removal forces and maintenance aging.
- 6/ Test fixture for this test is to include fiber optic MIL-PRF-64266 connectors; either plug or receptacle for retaining the termini during testing.
- 7/ Test performed using connector in which the ASR is not inserted.
- 8/ Each terminus is to be terminated on one end of a single fiber cable. Cable used is to have provisions compatible with termini strain relief, as applicable. Termini, selected from the group that underwent inspections for un-terminated termini, shall be used. A minimum sample size of 16 pin termini and 16 of the applicable counterpart socket termini (i.e., 32 pin termini for this configuration), selected from the group that underwent inspections for un-terminated termini, shall be used for each of these tests.

Fiber pullout. Separate test samples of the termini must be prepared on single fiber cable without any strain relief. The change in optical transmittance shall be met after the test.

Cable pullout. Separate test samples of the termini must be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). The change in optical transmittance shall be met after the test.

MEASUREMENT 4103

APPENDIX D

TABLE 4103 D-I. Combined termini and circular test sequence - Continued.

- 9/ Interoperability. This testing is done by DLA Land and Maritime-VTP which maintains/retains the interoperability standards. Please note that separate test samples are required for interoperability testing. These test samples will then be retained by DLA Land and Maritime as interoperability standards. Interoperability needs to be performed for one temperature range, not both when the constraints specified under note 3/ are met.
- 10/ Return loss after the mating durability. The relaxation given for PC polished termini to re-polish and redo the test is not allowed for the lens termini.
- 11/ Mechanical tests. Use the same test samples from Group 2 for Group 3 Mechanical test. Separate test samples are used for Group 3 Environmental tests. For Flammability, the test samples from the Group 2 and 3 Mechanical tests may be used in lieu of the test samples from the Group 3 Environmental tests.
- 12/ Shock and vibration. Four connector mated pair must be tested. At least two termini mated pair in each connector mated pair are to be monitored for optical signal discontinuity. At least two mated pair of each type termini shall be monitored for optical signal discontinuity. Any other termini mated pair not monitored for optical signal discontinuity is to be monitored for change in optical transmittance.
- 13/ Per MIL-PRF-64266, an insertion loss verification and a return loss test are required after the conclusion of the mechanical tests and after the environmental tests. If both the mechanical tests and the environmental tests are done on the same connector mated pair, then one insertion loss verification and one return loss test are performed after the conclusion of the mechanical and environmental tests. Each insertion loss verification shall be performed in both directions when the qualification includes a termini qualification.
- 14/ Wavelength integrity. For the optical beam characteristics inspections, perform at both 850 and 1300 for test samples with the multimode fiber size nm wavelength and at both 1310 and 1550 nm wavelength for test samples with the single mode fiber size.
- 15/ Separate test samples shall be prepared in accordance with MIL-STD-1678-4 Requirement 4105. For each temperature range, wavelength and fiber size; three single mode and three multimode test samples shall be prepared.
- 16/ For single mode mated pair, 8 connector mated pair shall be used for Group 1. From these 8 connector mated pair, each 4 connector mated pair shall be tested as specified in note 11. For multimode connector mated pair, either the same scheme may be used or the same 4 connector mated pair may be used for Groups 1, 2 and 3.
- 17/ Test samples from the cable pullout test shall be used.
- 18/ Certifications are required for the lens to show beam interface parameters are met.
- 19/ Termini selected from the group that underwent inspections for un-terminated termini shall be used for each of these tests. These termini test samples shall be prepared as specified in note 8/ for the cable pullout test. Four termini mated pair shall be used for the test samples that undergo the Group 1 tests. For each temperature range, wavelength (if applicable) and fiber size, this test sample quantity applies.
- 20/ Termini selected from the group that underwent inspections for un-terminated termini shall be used for each of these tests. These termini test samples shall be prepared as specified in note 8/ for the cable pullout test. Eight termini mated pair shall be used for the salt spray test. Sixteen termini mated pair shall be prepared for the fluid immersion test. Two termini mated pair shall be used as test samples for each of the eight categories of fluids. The eight termini mated pair from the salt spray test may be used as eight of the sixteen termini mated pair for the fluid immersion test. For each temperature range, wavelength (if applicable) and fiber size, these test sample quantities apply.
- 21/ This test is applicable only to MIL-PRF-29504/27. When qualifying with other termini (MIL-PRF-29504/18, /20, /26 or any combination of these termini), then reduced sample set is allowed for Group 1.
- 22/ This test is applicable only to MIL-PRF-29504/26.
- 23/ This test is not applicable to MIL-PRF-29504/27 in Group 2.
- 24/ This test is applicable only to MIL-PRF-29504/26 and /27.
- 25/ Tests to be performed following Life aging (Temperature life). For non-metallic inserts, perform insert retention axial strength and insert retention radial strength after conclusion of the temperature life test.
- 26/ Electromagnetic effects. Specific test practices for this test, including clarifications and further details, are found in measurement 3308 of MIL-STD-1678-3. Use of a conductive gasket for EMI testing is permitted.
- 27/ Two options for salt spray: a. Use same two mated pair from the fluid immersion test. b. Use separate mate pair.
- 28/ Test portion to clean for marking durability is applicable.

REQUIREMENT 4103

APPENDIX E

TERMINI TYPES POSITIONING IN CONNECTOR INSERT CAVITIES: TERMINI ONLY QUALIFICATION

E.1 Purpose. This appendix addresses the circumstance when qualification is being performed with termini. Specifically addressed is populating the cavity positions with MIL-PRF-29504/18 termini (domed end face with PC polish), MIL-PRF-29504/20 termini (domed end face with a PC polish), MIL-PRF-29504/20 termini (domed end face with an APC polish), MIL-PRF-29504/26 termini and MIL-PRF-29504/27 termini.

E.2 Implementation for termini positioning. The connector insert cavity positions in which termini must be placed shall conform to [E.2.1](#) for qualification of termini with single mode fiber and to [E.2.2](#) for qualification of termini with multimode fiber. This appendix pertains to qualification only of the termini or for qualification of MIL-PRF-64266 shell size sizes 11 and 13 connectors with a 4 cavity insert. A shell size 11 MIL-PRF-64266 shell size 11 circular connector shall be used for the four connectors that are numbers 1 through 4 in [table 4103 E-1](#) and [table 4103 E-2](#).

E.2.1 Qualification of test samples with single mode fiber. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in [table 4103 E-1](#), and [table 4103 E-2](#) for termini terminated with single mode fiber. No substitution of dummy termini shall be made for any termini that are not active. The position of termini for other termini test variations is further clarified in [E.3.2](#). No substitution of dummy termini shall be made for any termini in [table 4103 E-1](#) or [table 4103 E-2](#) that are not being qualified (see [E.3](#)).

E.2.2 Qualification for test samples with multimode fiber. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in [table 4103 E-3](#) and [table 4103 E-4](#) for termini terminated on multimode fiber. No substitution of dummy termini shall be made for any termini that are not active. The position of termini for other termini test variations is further clarified in [E.3](#). No substitution of dummy termini shall be made for any termini in [table 4103 E-3](#) and [table 4103 E-4](#) that are not being qualified (see [E.3](#)). For qualification test samples built with MIL-PRF-29504/20 termini on multimode fiber, termini end face shall only be PC polished.

E.2.3 Interoperability. Termini shall be fully populated in the connector as specified in appendix C. MIL-PRF-29504/20 termini shall be terminated with a PC polish. All termini in the connector shall be active.

Table 4103 E-1. Contact termini and polish types for each connector mated pair, single mode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
2	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC
3	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
4	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC

Table 4103 E-2. Lens termini and polish types for each connector mated pair, single mode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/26	M29504/27	M29504/26	M29504/27
2	M29504/27	M29504/26	M29504/27	M29504/26
3	M29504/26	M29504/27	M29504/26	M29504/27
4	M29504/27	M29504/26	M29504/27	M29504/26

Table 4103 E-3. Contact termini and polish types for each connector mated pair, multimode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/18	M29504/20 PC	M29504/20 PC	M29504/18
2	M29504/20 PC	M29504/18	M29504/18	M29504/20 PC

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Table 4103 E-4. Lens termini and polish types for each connector mated pair, multimode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/26	M29504/27	M29504/26	M29504/27
2	M29504/27	M29504/26	M29504/27	M29504/26

E.3 LIMITED QUALIFICATIONS.

E.3.1.1 Usage. This appendix pertains to qualification of one or more types of termini, i.e., contact (non-lens) and lens termini. Anywhere from one to all four termini types may be qualified at one time. [Table 4103 E-1](#) through [table 4103 E-4](#) address all four types being qualified with both single mode and multimode fiber. Eight connector mated pair are used for qualification as part of a multiple termini connector regardless of whether one, two, three or all four of MIL-PRF-29504/18, /20, /26 and /27 termini are being qualified.

E.3.1.1.1 MIL-PRF-29504/18 and /20 qualification only. For a MIL-PRF-29504/18 and /20 only qualification, connector numbers 1 through 4 shall be populated as listed in [table 4103 E-1](#) and [table 4103 E-3](#).

E.3.1.1.2 MIL-PRF-29504/26 and /27 qualification only. For a MIL-PRF-29504/26 and /27 only qualification, connector numbers 1 and 2 would be populated as listed in [table 4103 E-2](#) and [table 4103 E-4](#).

E.3.1.1.3 MIL-PRF-29504/20 qualification only. For a MIL-PRF-29504/20 only qualification, connector numbers 1 and 2 would be populated the same for single mode except connector numbers 1 and 3 cavity positions are populated with a MIL-PRF-29504/20 APC terminus and cavity position 4 populated with a MIL-PRF-29504/20 PC terminus. For connectors with multimode fiber, all cavity positions are populated with MIL-PRF-29504/20 PC termini.

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APPENDIX F

TERMINI TYPES POSITIONING IN CONNECTOR INSERT CAVITIES: CONNECTOR QUALIFICATION

F.1 Purpose. This appendix addresses the circumstance when qualification is being performed for a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/1 and /2 circular connector qualification or only one for a circular connector. Specifically addressed is populating the cavity positions with MIL-PRF-29504/18 termini (domed end face with PC polish), MIL-PRF-29504/20 termini (domed end face with a PC polish), MIL-PRF-29504/20 termini (domed end face with an APC polish), MIL-PRF-29504/26 lens termini and MIL-PRF-29504/27 lens termini. Provided is the connector shell size with cavity position to populate each type terminus.

F2 Implementation for termini positioning. The connector insert cavity positions in which termini must be populated (inserted) shall conform to [F.2.1](#) for termini mated pair with single mode fiber and to [F.2.2](#) for termini mated pair with multimode fiber.

F.2.1 Qualification for test samples with single mode fiber. Termini shall be populated in the connector with the termini type in each cavity that are specified in [table 4103F-1](#), [table 4103F-3](#) or [table 4103F-5](#), as applicable, for termini terminated on single mode fiber. Other cavity positions shall be populated with unterminated termini (to account for spring force). No substitution of dummy termini shall be made for any termini in any connector insert cavity position. The position of termini for other termini test variations is further clarified in [F.3](#). No substitution of dummy termini shall be made for any termini in [table 4103F-1](#), [table 4103F-3](#) or [table 4103F-5](#) that are not being qualified (see [F.3](#)).

F.2.2 Qualification for test samples with multimode fiber. Termini shall be populated in the connector with the termini type in each cavity that are specified in [table 4103 F-2](#), [table 4103F-4](#) or [table 4103F-6](#), as applicable, for termini terminated on multimode fiber. Other cavity positions shall be populated with unterminated termini (to account for spring force). No substitution of dummy termini shall be made for any termini in any connector insert cavity position. The position of termini for other termini test variations is further clarified in [F.3](#). No substitution of dummy termini shall be made for any termini in [table 4103 F-2](#), [table 4103F-4](#) or [table 4103F-6](#) that are not being qualified (see [F.3](#)). For qualification test samples built with MIL-PRF-29504/20 termini on multimode fiber, termini end face shall only be PC polished.

F.2.3 Interoperability. Termini shall be fully populated in the connector as specified in appendix C. MIL-PRF-29504/20 termini shall be terminated with a PC polish. All termini in the connector shall be active.

Table 4103 F-1. Shell size 15 connector with position, terminus and polish type for each termini mated pair, single mode fiber.

Connector Numbers	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
# 1, 3 1/, 2/	Terminus type	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
	Insert cavity number	1	4	5	8
# 2, 4 1/, 2/	Terminus type	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC
	Insert cavity number	1	4	5	8
# 1, 3 3/	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
	Insert cavity number	1	4	5	8
# 2, 4 3/	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
	Insert cavity number	1	4	5	8

1/ Applicable when qualifying shell size 15 once termini have been qualified.

2/ Applicable when qualifying shell size 15 and contact termini (shell size 11 is not offered).

3/ Applicable when qualifying lens termini and shell size 11 is not offered.

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Table 4103 F-2. Shell size 15 connector with position, terminus and polish type for each termini mated pair, multimode fiber.

Connector Number	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
# 1	Terminus type	M29504/18	M29504/20 PC	M29504/20 PC	M29504/18
1/, 2/	Insert cavity position	1	4	5	8
# 2	Terminus type	M29504/20 PC	M29504/18	M29504/18	M29504/20 PC
1/, 2/	Insert cavity position	1	4	5	8
# 1	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
3/	Insert cavity position	1	4	5	8
# 2	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
3/	Insert cavity position	1	4	5	8

1/ Applicable when qualifying shell size 15 once termini have been qualified.

2/ Applicable when qualifying shell size 15 and contact termini (shell size 11 is not offered).

3/ Applicable when qualifying lens termini and shell size 11 is not offered.

Table 4103 F-3. Shell size 23 connector with position, terminus and polish type for each termini mated pair, single mode fiber.

Connector Numbers	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
# 1, 3	Terminus type	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
1/, 2/	Insert cavity position	2	9	12	17
# 2, 4	Terminus type	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC
1/, 2/	Insert cavity position	2	9	12	17
# 1, 3	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
3/	Insert cavity position	2	9	12	17
# 2, 4	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
3/	Insert cavity position	2	9	12	17

1/ Applicable when qualifying shell size 23 once termini have been qualified.

2/ Applicable when qualifying shell size 23 and contact termini (shell sizes 11 and 15 are not offered).

3/ Applicable when qualifying lens termini and shell sizes 11 and 15 are not offered.

Table 4103 F-4. Shell size 23 connector with position, terminus and polish type for each termini mated pair, multimode fiber.

Connector Number	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
# 1	Terminus type	M29504/18	M29504/20 PC	M29504/20 PC	M29504/18
1/, 2/	Insert cavity position	2	9	12	17
# 2	Terminus type	M29504/20 PC	M29504/18	M29504/18	M29504/20 PC
1/, 2/	Insert cavity position	2	9	12	17
# 1	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
3/	Insert cavity position	2	9	12	17
# 2	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
3/	Insert cavity position	2	9	12	17

1/ Applicable when qualifying shell size 23 once termini have been qualified.

2/ Applicable when qualifying shell size 23 and contact termini (shell sizes 11 and 15 are not offered).

3/ Applicable when qualifying lens termini and shell sizes 11 and 15 are not offered.

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Table 4103 F-5. Shell sizes 11 and 15 connectors with position, terminus and polish type for each termini mated pair, single mode fiber.

Connector Shell size, Number	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
11, # 1	Terminus type	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
	Insert cavity position	1	2	3	4
15, # 2	Terminus type	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC
	Insert cavity position	1	4	5	8
11, # 3	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
	Insert cavity position	1	2	3	4
15, # 4	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
	Insert cavity position	1	4	5	8

Table 4103 F-6. Shell sizes 11 and 15 connectors with position, terminus and polish type for each termini mated pair, multimode fiber.

Connector Shell size, Number	Terminus Type & Position	Termini insert cavity position within connector			
		First position	Second position	Third position	Fourth position
11, # 1	Terminus type	M29504/18	M29504/20 PC	M29504/20 PC	M29504/18
	Insert cavity position	1	2	3	4
15, # 2	Terminus type	M29504/20 PC	M29504/18	M29504/18	M29504/20 PC
	Insert cavity position	1	4	5	8
11, # 3	Terminus type	M29504/26	M29504/27	M29504/26	M29504/27
	Insert cavity position	1	2	3	4
15, # 4	Terminus type	M29504/27	M29504/26	M29504/27	M29504/26
	Insert cavity position	1	4	5	8

F.3 LIMITED QUALIFICATIONS.

F.3.1.1 Usage. This appendix pertains to qualification of one or more types of termini, i.e., contact (non-lens) and lens termini. Anywhere from one to all four termini types may be qualified at one time. [Table 4103 F-1](#) through [table 4103 F-6](#) address qualification for a shell size 15 connector, qualification for a shell size 23 connector, and qualification for shell sizes 11, 13, and 15 connectors along with all four termini types being qualified. Eight connector mated pair are used for qualification as part of a multiple termini connector when both contact and lens type MIL-PRF-29504/18, /20, /26 and /27 termini are being qualified.

F.3.1.1.1 MIL-PRF-29504/18 and /20 qualification only. For a MIL-PRF-29504/18 and /20 only qualification, a shell size 11 connector is used with the first through fourth positions corresponding to insert cavity numbers one to four. When a shell size 11 connector is not being offered and a shell size 15 connector is being offered, terminus qualification along with shall size 15 connector qualification can be performed shell size 15 connectors with the connector insert cavity positions populated as specified. When shell size 11 and 15 connectors are not being offered and a shell size 23 connector is being offered, terminus qualification along with shall size 23 connector qualification can be performed in shell size 23 connectors with the connector insert cavity positions populated as specified. Likewise is the case for qualifying shall sizes 11 and 15 connectors along with termini qualification.

F.3.1.1.2 MIL-PRF-29504/26 and /27 qualification only. For a MIL-PRF-29504/26 and /27 only qualification, the same constraints apply as listed for the connector qualification with contact termini.

F.3.1.1.3 MIL-PRF-29504/20 qualification only. For a MIL-PRF-29504/20 only qualification, connectors would be populated the same for single mode except connector the first cavity position is populated with a MIL-PRF-29504/20 APC terminus and the fourth cavity position is populated with a MIL-PRF-29504/20 PC terminus. For connectors with multimode fiber, all four cavity positions (first through the fourth position with the termini mated pair being tested) are populated with MIL-PRF-29504/20 PC termini.

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APPENDIX G

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES,
TEST TERMINUS AND TEST TERMINUS ADAPTERS
(EXCEPT INTEROPERABILITY)

G.1 Purpose. This appendix provides the criteria for fabrication of MIL-PRF-29504/21 test terminus cable assemblies test samples to be used for the qualification of the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and /33 test terminus adapters. Fabrication criteria are addressed in appendix H for test terminus and test terminus adapter test samples to be used for interoperability.

G.1.1 Qualification test sample terminology. This appendix addresses the MIL-PRF-29504/21 test termini and the fabrication of MIL-PRF-29504/21 test termini cable assemblies that are used in the qualification testing. The test terminus type cable assemblies referred to as test terminus type Measurement Quality Jumpers (MQJ's) or MQJ's.

G.1.2 Temperature ranges. Only one temperature range is specified for the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and /33 test terminus adapters. No separate test samples are required for a second temperature range.

G.2 APPLICABLE DOCUMENTS.

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

G.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

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DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

GENERAL SERIES TECHNICAL MANUAL

- [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWC DD Web Site in the Fiber Optics Recommended List section. This NSWC Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

- [TIA-455](#) - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

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APPENDIX G

G.3 Test terminus MQJ's. Minimum number of test terminus MQJ's required to perform a full qualification is provided in table 4103 G-I.

G.3.1 Quantity. Minimum of eight MIL-PRF-29504/21 test termini is required for test terminus qualification and a minimum of eight MIL-PRF-29504/21 test termini are required for test terminus adapter qualification. A minimum quantity of 2 test terminus adapters (one plug style, one receptacle style) are required for each shell size test terminus adapter qualification. A minimum of two test termini are required for qualifications of each test terminus adapter shell size. NOTE: This minimum number does not include the number of test termini and test terminus adapters required for interoperability (see appendix H for further details on interoperability).

TABLE 4103 G-I. Test terminus and test terminus adapter allocation table. 1/

Test performed	Test terminus adapter Shell size				Test terminus PC polish	Test terminus APC polish
	11	13	15	23	SM	SM
Qualification, except interoperability						
Minimum number of test terminus MQJ's <u>8/</u>	2	2	2	2	4	4
Minimum number of test terminus adapters <u>7/</u> , <u>9/</u>	2	2	2	2	4	4
Group 1	2 of 2	2 of 2	2 of 2	2 of 2	4 of 4	4 of 4
Group 2 Mechanical <u>2/</u> , <u>5/</u>	None	None	2 of 2	None	2 of 4	None
Group 3, , Environmental <u>3/</u> , <u>5/</u>	None	None	None	None	2 of 4	None
Group 4, Material (components + parts) <u>4/</u> , <u>5/</u>	None	None	2 of 2	None	2 of 4	None
Interoperability <u>6/</u>						

1/ See [G.3.1](#) and notes with qualification table in MIL-PRF-29504/21 for further detail.

2/ Two test terminus MQJ's and two test terminus adapters from Group 1 are designated for Group 2.

3/ Two test terminus MQJ's two test terminus adapters from Group 1 are designated for Group 3.

4/ Total number of test terminus MQJ's or test terminus adapters listed is under the assumption that mated pair fabricated with Group 2 and/or Group 3 test terminus MQJ's are used for Group 4. Separate parts are used for Group 4 Material tests.

5/ Each test terminus MQJ consists of a terminus-to-ST jumper.

6/ Configuration and fabrication requirements for interoperability samples are found in appendix H.

See [table 4103 H-II](#) for quantities.

7/ A minimum number of two test terminus adapters include one plug type test terminus adapter and one receptacle type.

8/ A minimum of two test terminus MQJ's includes one with a PC polish and one with an APC polish.

9/ When only the test terminus is being tested, a shell size 11 test terminus adapter and multiple termini connector assembly shall be used.

G.4 Test sample configurations.

G.4.1 Quantity. See [H.3.1](#).

G.4.2 Test terminus MQJ. The test terminus MQJ consists of a MIL-PRF-85045/16 single mode, fiber optic cable with an instrument connector terminated at one end and a test terminus terminated at the other end. Fabrication of the test terminus MQJ configurations (single mode fiber, specified terminus end face polish, on tight buffer cable) shall conform as specified in [G.5.1](#) and [G.5.3](#) through [G.5.7](#) below. Test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. The method to perform the initial insertion loss test in MIL-PRF-29504/21 shall be performed during or as part of the test terminus MQJ fabrication process. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

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G.4.3 Multiple termini connector assembly. The multiple termini connector assembly consists of a MIL-PRF-64266 connector (either connector plug or connector receptacle) with terminus-to-instrument connector jumpers. The multiple termini connector is fully populated and each cavity position is tested. If available, the interoperability standards for a MIL-PRF-64266 circular connector may be used. As an alternative, separate multiple termini connector assemblies may be fabricated in accordance with appendix C of Requirement 4103.

G.4.4 Mated pair. A mated pair shall consist of a test terminus adapter mated to a multiple termini connector assembly with the test terminus MQJ inserted into the test terminus adapter.

G.5 Test sample fabrication. Termination procedure for the test samples shall be in accordance with 4.1.2 of Requirement 4103.

G.5.1 Termination procedures. Fabrication of the test terminus MQJ shall be performed in accordance with Requirement 4103 of MIL-STD-1678-4 except that the stripping dimensions shall be in accordance with figure 4 of MIL-PRF-29504/21. Test terminus MQJ shall be constructed using the ferrule end face polish specified (either with a PC polish or an APC polish). Separate test samples shall be constructed for interoperability (see appendix H). Fabrication of the multiple termini connector assembly shall be performed in accordance with MIL-STD-1678-4. Each cavity position of the multiple termini connector assembly shall meet the optical performance requirement when tested in accordance with MIL-STD-2042-6 Method 6F1. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

G.5.1.1 End face geometry. End face geometry requirement for termini cable assemblies with single mode fiber shall be a domed ferrule end face with either a PC polish or an APC polish (as specified for each insert cavity position (see H.5.8) for termini and with a PC polish for ST connectors (or other instrumentation-end connectors). End face geometry requirement for termini cable assemblies with a multimode fiber size shall be a domed ferrule end face with a PC polish for termini and with a PC polish for ST connectors (or other instrumentation-end connectors). End face geometry shall be as specified in MIL-STD-1678-5.

G.5.2 Cable type. Cable used must be of same configuration as MIL-PRF-85045/16; however, this cable does not need to meet environmental specifications in MIL-PRF-85045/16. The optical fiber in the cable used must be the same or equivalent to MIL-PRF-49291/7 for single mode fiber. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

G.5.3 Epoxy type. Approved epoxy shall be used for test sample termination. Epoxies approved to date are those in table 4103 G -II.

TABLE 4103 G -II. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 1/, 2/	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List 3/

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^{\circ}\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See G.2.2.2.

G.5.4 Polishing steps and polishing paper used.

G.5.4.1 Polish type. The standard polish specified in [NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) shall be used for termini on multimode fiber and on single mode fiber.

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G.5.4.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in the Work package for the applicable terminus type in NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall be used.

G.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced only if other steps and processes adhere to and resultant termination meets specified optical performance (see [G.5.1.1](#)).

G.5.5 Connectors.

G.5.5.1 Configurations. MIL-PRF-64266 circular connector receptacles and MIL-PRF-64266, circular connector plugs for shell sizes 11, 13, 15 and 23 shall be used.

G.5.5.2 Backshell (connector accessory). Not applicable.

G.5.5.3 Insert cavity population. Qualification testing shall be performed testing each cavity. This requires that each connector insert cavity in the multiple termini connector assembly be populated.

G.5.5.4 Fiber type. Each connector mated pair shall contain only one fiber type.

G.5.6 Launch conditions. Unless otherwise specified, test sample shall include the launch condition provision for single mode fiber sizes specified in Measurement Support Process 2203 of [MIL-STD-1678-2](#).

G.5.7 Summary of parameter requirements.

G.5.7.1 Single mode 9. Test termini MQJ's with single mode 9/125 micron cable shall conform to table 4103 G -III.

TABLE 4103 G -III. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	125.5 +1/-0 um
Fiber size	9/125 micron <u>1</u> /
Cable type	Tight buffer per G.5.2
Epoxy type	Two part, heat cured, liquid type per G.5.2 .
Test sample quantity	1 mated pair for each shell size per G.5.1 through G.5.6 .
Tests performed	Full test sequence <u>2</u> /

1/ 9.3/125 micron at 1310 nm.

2/ Qualification table is listed in MIL-PRF-29504/21.

G.5.8 Connector cavity positions for terminus polish types. Each cavity position shall be populated with either a MIL-PRF-29504/20 terminus having a domed end face with a PC polish or with a MIL-PRF-29504/20 terminus having a domed end face with an APC polish as listed [G.5.8.1](#) and [G.5.8.2](#).

G.5.8.1 Termini types positions in insert. Termini placed in each cavity position shall conform to [appendix E](#). Termini positions shall vary depending upon shell size.

G.5.8.2 Inclusion of MIL-PRF-29504/18 termini. [Appendix E](#) is based on performing qualification simultaneously for both MIL-PRF-29504/18 and MIL-PRF-29504/18/20 termini. Since only MIL-PRF-29504/20 termini are being used to qualify the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and MIL-PRF-64266/3233 test terminus adapters, then the cavity positions specified for MIL-PRF-29504/18 termini shall instead be filled with MIL-PRF-29504/20 termini with an APC polish.

REQUIREMENT 4103

APPENDIX H

CONFIGURATION AND FABRICATION REQUIREMENTS FOR INTEROPERABILITY TEST SAMPLES,
TEST TERMINUS AND TEST TERMINUS ADAPTERS

H.1 Purpose. This appendix provides the criteria for interoperability of the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and MIL-PRF-64266/33 test terminus adapters. In the past, the Government has partnered with termini/connector companies that were undergoing Qualified Products List testing in an effort to verify interoperability of fiber optic, multiple termini connectors that conform to MIL-PRF-28876. This partnership allows the Government to verify the interoperability of connectors with that of participating companies. DLA Land and Maritime-VTP is now the Government entity that performs the testing for interoperability. This partnership for interoperability testing is now extended to other termini/connectors including qualifying the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and MIL-PRF-64266/33 test terminus adapters.

H.1.1 Interoperability test sample terminology. This appendix addresses the MIL-PRF-29504/21 test termini and the fabrication of MIL-PRF-29504/21 test termini cable assemblies that are used in the interoperability portion of the qualification testing. The test terminus type cable assemblies referred to as test terminus type Measurement Quality Jumpers (MQJ's) or MQJ's.

H.1.2 Temperature ranges. Only one temperature range is specified for the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and MIL-PRF-64266/33 test terminus adapters. No separate test samples are required for a second temperature range.

H.2 Applicable documents.

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

H.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

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DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

H.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWCD Web Site in the Fiber Optics Recommended List section. This NSWCD Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWCD_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

- [TIA-455-34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

H.3 Policy pertaining to test sample submission. Vendors shall be responsible for the fabrication, submittal and replacement/refurbishment of cable assemblies (test samples) in the configurations specified below to the Government for Interoperability testing.

H.3.1 Test sample retention. One stipulation is that the test samples are to be retained by the Government for use as standards in future interoperability testing to be performed by the Government in-house personnel. Only personnel to be present during interoperability testing are Government, in-house personnel. At no time shall other parties have access to or examination of the interoperability standards.

H.3.2 Replacement/refurbishment. Another stipulation is that the vendor shall agree to replace or refurbish these interoperability standards as the need arises. Any items requiring replacement/refurbishment in this agreement shall be performed by the vendor at no cost to the Government.

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H.3.3 Notification for submission. Initial notification to submit test samples for interoperability shall be made to DLA Land and Maritime-VQP Qualifications Group.

H.3.4 Arrangements to perform interoperability testing. Once approved by DLA Land and Maritime-VQP, the vendor shall make financial, test and shipping arrangements with the DLA Land and Maritime- VTP Passive Test Section.

Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime- VTP point of contact.

Shipping address:

DLA Land and Maritime Columbus

3990 East Broad St.

Bldg. 11, Section 7, VTP

Columbus OH 43213-1199

Table 4103 H-I. Test terminus interoperability test variations.

Test variation	Connector plug or receptacle	Test terminus	Test terminus adapter ^{1/}
1	X	A	B
2	X	B	A
3	X	B	B

X = Previously Certified MIL-PRF-64266 connector

A = Previously Certified Test terminus or Test terminus adapter

B = Candidate Test terminus or Test terminus adapter

^{1/} Plug type test terminus adapter is used with the connector receptacle, receptacle type test terminus adapter is used with the connector plug.

Table 4103 H-II. Termini allocation table for interoperability.

Test performed	Test terminus adapter shell size				Test terminus PC polish	Test terminus APC polish
	11	13	15	23	SM	SM
<u>Interoperability ^{1/}</u>						
Minimum number of test terminus MQJ's ^{6/}	2	2	2	2	4	4
Minimum number of test terminus adapters ^{5/, 7/}	2	2	2	2	2	2
Interoperability of counterpart terminus ^{2/}						
Insertion loss (test variations per table 4103 I-I)	2 of 2	2 of 2	2 of 2	2 of 2	4 of 4	4 of 4
Minimum number of un-terminated test termini	None	None	16	None	None	None
Minimum number of test terminus adapters	None	None	2	None	None	None
Insert-to-termini compatibility ^{3/}						
Terminus retention force	None	None	16	None	None	None
Terminus insertion and removal forces ^{4/}	None	None	16	None	None	None

^{1/} See [G.4](#), [G.5](#) and notes with qualification table in MIL-PRF-64266/32, MIL-PRF-64266/33 and MIL-PRF-29504/21 for further detail.

^{2/} Each terminus cable assembly consists of a termini-to-ST jumper.

^{3/} Un-terminated termini.

^{4/} Test performed using connector in which the ASR is not inserted.

^{5/} A minimum number of two test terminus adapters include one plug type test terminus adapter and one receptacle type.

^{6/} A minimum of two test terminus MQJ's includes one with a PC polish and one with an APC polish.

^{7/} When only the test terminus is being tested, a shell size 11 test terminus adapter and multiple termini connector assembly shall be used.

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H.4 Test sample configurations. Minimum number of test terminus MQJ's required to perform a full interoperability test is provided in table 4103 H-II.

H.4.1 Quantity.

H.4.1.1 Interoperability of counterpart terminus. A minimum of eight MIL-PRF-29504/21 test termini are required for test terminus qualification and a minimum of eight MIL-PRF-29504/21 test termini are required for test terminus adapter qualification. A minimum quantity of 2 test terminus adapters (one plug style, one receptacle style) are required for each shell size test terminus adapter qualification. A minimum of two test termini are required for qualifications of each test terminus adapter shell size.

H.4.1.2 Insert-to-termini compatibility. A minimum of 16 un-terminated test termini are required. A minimum quantity of 2 shell size 15 test terminus adapters (one plug style, one receptacle style) are required for test terminus adapter qualification.

H.4.2 Test terminus MQJ. The test terminus MQJ consists of a MIL-PRF-85045/16 single mode, fiber optic cable with an instrument connector terminated at one end and a test terminus terminated at the other end. Fabrication of the test terminus MQJ configurations (single mode fiber, specified terminus end face polish, on tight buffer cable) shall conform as specified in H.5.1 through H.5.7 below. Test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 4 meters of cable with the DUT in the middle (at 2 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 2 meters. The method to perform the initial insertion loss test in MIL-PRF-29504/21 shall be performed during or as part of the test terminus MQJ fabrication process. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

H.4.2.1 Multiple termini connector assembly. The multiple termini connector assembly consists of a MIL-PRF-64266 connector (either connector plug or connector receptacle) with terminus-to-instrument connector jumpers. The multiple termini connector is fully populated and each cavity position is tested. If available, the interoperability standards for a MIL-PRF-64266 circular connector may be used. As an alternative, separate multiple termini connector assemblies may be fabricated in accordance with appendix C of Requirement 4103.

H.4.3 Mated pair. A mated pair shall consist of a test terminus adapter mated to a multiple termini connector assembly with the test terminus MQJ inserted into the test terminus adapter.

H.5 Interoperability of counterpart terminus. Test termini shall be inserted into each insert cavity of the test terminus adapter for test variations performed in table 4103H-I. Termini cable assemblies for connector receptacles and plugs shall be configured with single fiber cable and no backshells. Minimum number of termini required for one fiber size to perform this interoperability test shall be as specified in table 4103 H-II. An initial insertion loss shall be measured in accordance with MIL-STD-1678-2, Measurement 2101 using the simulated cut-back method. A succeeding insertion loss shall be performed using the test method to determine optical loss. No tools shall be required for insertion and removal of MIL-PRF-29504/21 test termini from the test terminus adapter.

H 5.1 Termination procedures. Fabrication of the test terminus MQJ shall be performed in accordance with Requirement 4103 of MIL-STD-1678-4 except that the stripping dimensions shall be in accordance with figure 4 of MIL-PRF-29504/21. Test terminus MQJ shall be constructed using the ferrule end face polish specified (either with a PC polish or an APC polish). Separate test samples shall be constructed for interoperability (see Appendix C). Fabrication of the multiple termini connector assembly shall be performed in accordance with MIL-STD-1678-4. Each cavity position of the multiple termini connector assembly shall meet the optical performance requirement when tested in accordance with MIL-STD-2042-6 Method 6F1. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

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H.5.1.1 End face geometry. End face geometry requirement for termini cable assemblies with single mode fiber shall be a domed ferrule end face with either a PC polish or an APC polish (as specified for each insert cavity position (see [G.5.8](#)) for termini and with a PC polish for ST connectors (or other instrumentation-end connectors). End face geometry shall be as specified in MIL-STD-1678-5.

H.5.2 Cable type. Interoperability test samples shall be constructed using MIL-PRF-85045/16 single fiber cable. For the 9/125 micron fiber size, M85045/16-02 shall be used.

H.5.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

H.5.3.1 Single mode. A mandrel diameter shall be used as the means of mode conditioning to filter out higher order modes. The technique of wrapping the fiber around a mandrel shall be performed as specified see 3.5 of [TIA-455-34](#). A diameter of 30 mm shall be used with 3 complete turns of the fiber wrapped around the mandrel.

H.5.4 Epoxy type and cure schedule. Approved epoxy meeting MIL-PRF-24792 shall be used for test sample termination. Epoxies approved include those in table 4103 H-III.

TABLE 4103 H-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^{\circ}\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See I.2.2.2.

H.5.5 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see [5.1.1](#)).

H.5.5.1 Polish type. The standard polish specified in [4.1.1](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

H.5.5.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in [4.1.1](#) shall be used.

H.5.5.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples only if other steps and processes adhere to and resultant termination meets optical performance specified in Part 5 of MIL-STD-2042.

H.5.6 Connectors for multiple termini connector assembly.

H.5.6.1 Configurations. MIL-PRF-64266 circular connector receptacles for shell sizes 11, 13, 15 and 23, and MIL-PRF-64266 circular connector plugs for shell sizes 11, 13, 15 and 23 shall be used. All channels are to be active optically for termini interoperability. Backshells shall not be used for interoperability.

H.5.6.2 Candidate connector future use. Once qualified, these interoperability "standards" may be used to determine interoperability of other MIL-PRF-64266 circular connectors.

H.5.6.3 Submission. At the discretion of DLA Land and Maritime- VTP, submission of termini may be required to determine interoperability of MIL-PRF-64266 connectors

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H.5.6.4 Insert cavity population. Interoperability testing shall be performed on test terminus MQJ's (test terminus cable assemblies) and test terminus adapters in fully populated cavities of each multiple terminus connector assembly.

H.5.6.5 Fiber type. Each mated pair shall contain only one fiber type.

H.5.6.6 Instrument end connectors. ST connectors with a domed PC polish shall be provided.

H.5.7 Fabrication of terminus.

H.5.7.1 Single mode. Termini on cable assemblies (terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4103 H-IV. Each mated pair shall be provided.

TABLE 4103 H-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	125.5 +1/-0 microns
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per I.5.2
Cable length	2 meters <u>2/</u>
Epoxy type	Two part, heat cured, liquid type per H.5.4 .
Test sample quantity	Mated pair for shell size 11, 13, 15 and 23 multiple terminus connector assemblies, test terminus MQJ's and test terminus adapters per table 4103 H-II.
Tests performed	Interoperability of counterpart terminus

1/ 9.3/125 micron at 1310 nm for the MIL-PRF-49291/7 optical fiber.

2/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

H.5.8 Connector cavity positions for terminus polish types. Each cavity position shall be populated with either a MIL-PRF-29504/20 terminus having a domed end face with a PC polish or with a MIL-PRF-29504/20 terminus having a domed end face with an APC polish as listed H.5.8.1 and H.5.8.2.

H.5.8.1 Terminus types positions in insert. Termini placed in each cavity position shall conform to [appendix E](#). Terminus positions shall vary depending upon shell size.

H.5.8.2 Exclusion of MIL-PRF-29504/18 terminus. Appendix E is based on performing qualification simultaneously for both MIL-PRF-29504/18 and /20 terminus. Since only MIL-PRF-29504/20 terminus are being used to qualify the MIL-PRF-29504/21 test terminus and the MIL-PRF-64266/32 and /33 test terminus adapters, then the cavity positions specified for MIL-PRF-29504/18 terminus shall instead be filled with MIL-PRF-29504/20 terminus with an APC polish.

H.1.6 Terminus insertion and removal forces. Perform in accordance with 4.9.11 in MIL-PRF-29504.

H.6.1 Insert-to-terminus compatibility.

H.6.2 Terminus retention force. Un-terminated pin and socket terminus shall be inserted into a previously qualified connector(s) using a terminus insertion tool. An axial compressive load shall be applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. A pre-load not greater than 13.3 N (3 lbs.) may be used to seat the terminus for the initial measurement. Axial loads shall be applied at a rate of 4.4 N/s (1.0 lb/s) up to a maximum load 98 N (22.0 lbs.). The maximum load shall be maintained for at least 5 seconds. Minimum number of terminus tested shall be the quantity listed for insert-to-terminus compatibility in table 4103 H-II.

REQUIREMENT 4104

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES FOR
MIL-PRF-24623/7 MECHANICAL SPLICE

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (fabrication) of fiber optic the test sample (DUT assembly) for the MIL-PRF-24623/7 mechanical splice. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATION

[MIL-PRF-24623](#) - Splice, Fiber Optic Cable General Specification for (Metric).

(Copies of this document are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE DRAWING

[NAVSEA Drawing 53711-8328898](#) - Mechanical Splice, Fiber Optic, Aircraft, Test Sample Configurations/Fabrication & Specific Methods/Practices.

(A copy of NAVSEA Drawing 53711-8328898 can be obtained at website: <https://fiberoptics.nswc.navy.mil/> in the NAVSEA Drawing section under Component Information. If unable to access this Web Site, request an application by e-mail to NSWC DD Warfare Systems Department at DLGR_NSWC_Foweb@navy.mil.)

DEPARTMENT OF DEFENSE PUBLICATIONS

[NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4](#) - Aircraft Fiber Optic Cabling, Technical Manual, Installation and Testing Practices.

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

3. Definitions.

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable bundle, fiber optic. Single fiber cables grouped together and secured by lacing tape. The cable bundle can be placed in convoluted tubing, used in various protected harness configurations or used as is in an open cable harness configuration.

3.3 Cable, loose tube. A fiber optic cable design is one configured with one or more optical fibers are fitted loosely within a tube, giving the optical fibers freedom to move. This mobility and isolation from the tube minimizes the effects of external forces on the performance of the link. The isolation allows cable expansion and contraction with temperature independent of the optical fibers.

3.4 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coding (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, more roughed handling (such as better crush and impact resistance).

3.5 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.6 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

3.7 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.8 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.9 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.10 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

3.11 Wire. "A usually pliable metallic strand or rod made in many lengths and diameters, sometimes clad and often electrically insulated, used chiefly for structural support or to conduct electricity." Source: American Heritage Dictionary, College Edition

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4. Configurations. In the context of Requirement 4104, the component being tested (device under test or DUT) is the MIL-PRF-24623/7 mechanical splice. The test sample or DUT assembly is the DUT with the other fiber optic components that comprise these assembled components. Configurations for DUT assemblies that shall be used for qualification conform to specific type, size and other fiber optic component parameters that serve to constrain and standardize on the DUT assembly make-up. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also.

4.1 Test sample configurations. Dependent upon the inspection/test performed, the mechanical splice test samples shall be in one of three configurations:

- a. Unterminated
- b. As part of a single fiber cable (i.e., a cable assembly)
- c. As a cable assembly outside of a cable harness

The construction details for each of the three test sample configurations for "Qualification" are listed in section 5 herein.

5. Implementation. Test samples (DUT assemblies) shall be prepared for "Qualification" as specified in 5.1 and 5.2. Test methods and practices used shall conform to 5.3.

5.1 Test sample configuration for MIL-PRF-24623/7 mechanical splice.

5.1.1 Applicable documentation.

- a. Termination procedure. For each vendor and different configuration mechanical splice offered, a separate termination procedure shall be prepared by tailoring the procedure found in WP 013 02 of NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4. This tailored procedure would then be incorporated into the applicable Fleet/Field personnel documents. The procedure found in WP 013 02 is not complete to the extent that a few process steps may be incomplete or not defined for particular mechanical splice configurations and that strip dimensions, as listed in a table format, require input from each vendor. Vendors shall be required to use this termination procedure, enter the applicable table information and mark up any deviations taken. The marked up draft shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation. Test samples shall be prepared using this tailored termination procedure.

5.1.2 Test samples, unterminated termini.

5.1.2.1 Quantity. Minimum of 52 mechanical splices for the three cable types and fiber sizes (single mode, multimode, multimode 100).

5.1.2.2 Allocation of mechanical splices. Allocation of these 52 mechanical splices for remaining testing is as follows (see [table 4104-I](#) and [table 4104-II](#)):

- a. Mechanical splice as part of a single fiber cable.
 - i. Group 1 (optical): 12 for type 1 cable, 12 for type 2 cable, 8 for type 3 cable.
 - ii. Group 2 (mechanical): 8 for type 1 cable, 4 for type 2 cable, 4 for type 3 cable.
 - iii. Group 3 (environmental): 4 for type 1 cable, 4 for type 2 cable and 4 for type 3 cable.
 - iv. Group 4 (material): 4 from Group 2 with types 1, 2 and 3 cables, and 4 from group 3 with types 1, 2 and 3 cables.
- b. Mechanical splice outside a cable harness.
 - i. Optical, vibration, shock, optical: 8 with type 1 cable, 4 with type 2 cable, and 8 with type 3 cable.

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TABLE 4104-I. Mechanical splice allocation table for each cable type and fiber size tested. 1/, 2/, 3/

Test performed/ fiber type	Number of mechanical splices/test samples for each cable type and fiber size						
	Type 1 cable			Type 2 cable		Type 3 cable	
	SM	MM	MM100	MM	MM100	SM	MM
Un-terminated mechanical splice							
Visual inspection	12	4	4	4	12	12	4
Mechanical splice as part of a single fiber cable assembly							
Group 1 (optical)	8 of 12		4 of 4	4 of 4	8 of 12	8 of 12	
Group 2 (mechanical)	4 of 8 from Group 1		4 of 4 from Group 1		4 of 8 from Group 1	4 of 8 from Group 1	
Group 3 (environmental)	4 of 8 from Group 1				4 of 8 from Group 1	4 of 8 from Group 1	
Group 4 (material)	See <u>4/</u>				See <u>4/</u>	See <u>5/</u>	
Mechanical splice outside a cable harness							
Optical, vibration, shock	4 of 12	4 of 4			4 of 12	4 of 12	4 of 4

1/ Fiber size refers to the fiber sizes listed in [table 4104-III](#).

2/ A minimum of three separate samples (per test) of each polymeric material part that is part of the mechanical splice shall be included for fungus resistance, ozone exposure and fluid immersion. Fungus resistance and ozone require only polymeric materials and not test samples (complete mechanical splices).

3/ All three cable types must be tested to meet qualification.

4/ Quantity of 4 from Group 2 and 4 from Group 3.

5/ Quantity of 4 from Group 3.

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TABLE 4104-II. Mechanical splice allocation TABLE by cable type only. 1/, 2/, 3/

Test Performed	Number of mechanical splices/test samples for each cable type		
	Type 1 cable	Type 2 cable	Type 3 cable
Un-terminated mechanical splice			
Visual inspections	20	16	16
Mechanical splice as part of a single fiber cable assembly			
Group 1 (optical)	12 of 20	12 of 16	8 of 12
Group 2 (mechanical)	8 of 12 (from Group 1)	4 of 16 (from Group 1)	4 of 8 (from Group 1)
Group 3 (environmental)	4 of 12 (from Group 1)	4 of 16 (from Group 1)	4 of 8 (from Group 1)
Group 4 (material)	4 from Group 2 4 from Group 3	4 from Group 2 4 from Group 3	4 from Group 2 4 from Group 3
Mechanical splice outside a cable harness			
Optical, vibration, shock	8 of 20	4 of 16	8 of 16

1/ Fiber size refers to the fiber sizes listed in [table 4104-III](#).

2/ A minimum of three separate samples (per test) of each polymeric material part that is part of the mechanical splice shall be included for fungus resistance, ozone exposure and fluid immersion.

3/ All three cable types must be tested to meet qualification.

5.1.3 Test samples. Mechanical splice as part of a single fiber cable and when outside the cable harness.

- a. Quantity. 52 mechanical splices from the lot of un-terminated mechanical splices.
- b. Configurations and fabrication. Test sample configurations (single mode, multimode and multimode 100 on each type cable) and fabrication of each cable assembly shall conform as specified in 1.d below.
- c. Configurations and fabrication. Test sample configurations and fabrication of mechanical splice cable assembly shall conform as specified below. Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT (i.e., the Device Under Test or mechanical splice) in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.
- d. Configuration allowance for insertion loss measurements. In general, each cable assembly (connector mated pair) shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. For insertion loss tests on cable assemblies where a cut-back must be performed, a 13 meter length of cable is required with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long.
- e. Cable type. Cable used must be the cable as specified in [table 4104-III](#).
- f. Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in [5.3](#).

5.1.4 Cabling.

- (1) Cable type. The type 1, type 2 and type 3 cable used is listed in [table 4104-III](#).

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TABLE 4104-III. Cable for each fiber type.

Fiber size	Type 1 cable	Type 2 cable	Type 3 cable
Single mode	9/125 micron: OFS part # C14447 <u>1/</u>	<i>This test configuration is not required</i>	9/125 micron: MIL-PRF-85045 PIN M85045/16-02 <u>2/</u>
Multimode	50/125 micron: OFS part # C10027 <u>1/</u> or BC06815 <u>1/</u>	62.5/125/155 micron: General Cable part # OC-1660	62.5/125 micron: MIL-PRF-85045 PIN M85045/16-01
Multimode 100	100/140/172 micron: OFS part # BC05082 <u>1/</u>	100/140/172 micron: General Cable part # OC-1260	<i>This test configuration is not required</i>

1/ Cable must be preconditioned prior to terminus termination and connector assembly as specified in MIL-STD-1678-5 Measurement 5301.

2/ Fiber size: 9/ 125 micron = 8.5-10/125 micron

5.2 Other fabrication. Other fabrication and test sample assembly requirements.

5.2.1 Epoxy cure schedule. Epo-tek 353ND shall be used when the mechanical splice uses a two-part epoxy. The cure schedule used shall be the one listed in table 4104-IV.

TABLE 4104-IV. Cure schedule for Epo-tek 353ND two part epoxy.

Step	Action	Temperature (°C)	Duration (minutes)
1	Ramp	Ambient to 80	5
2	Soak	80	10
3	Ramp	105	5
4	Soak	105	5
5	Ramp	120	5
6	Soak	120	5
7	Ramp	150	5
8	Soak	150	5
9	Ramp	<u>1/</u>	15

1/ Turn heat off and let sit in oven for 15 minutes before removal

5.3 Test methods and practices.

5.3.1 Launch conditions. Launch condition for each fiber size shall conform to Measurement Support Process 2203 of MIL-STD-1678-2.

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5.3.2 Fiber size 50/125 micron. The OFS optical fiber BF06819 or OFS fiber optic cable C16133 to be used as the launch condition cable may be provided by the Government under the constraints (Policy for Government provisioning of launch conditioning cable) listed below.

- a. Eligible parties. The Government, at their discretion, may provide the test laboratory or vendor doing the testing (the recipient) with 70 meter spool of the required launch condition cable (sufficient length of OFS C16133 fiber optic cable to terminate connectors on the ends of 32 two meter lengths of launch conditioning jumpers). Only recipients doing the testing are to receive cable. Only one provision (70 meter spool) of cable will be provided even if the recipient is testing multiple vendors.
- b. Intended use. Sole use of cable provisioned shall be for QPL testing. Cable shall not be used to fabricate MQJ (Measurement Quality Jumper) cables or other type cables.
- c. Recipient responsibilities. The recipient shall make the connector terminations and retain the terminated cable for future use. Recipients that do not complete the QPL process shall return the cable. Unused lengths shall be returned to the Government. The recipient shall bare shipping costs.
- d. Method to request launch condition cable. Requests for launch condition cable shall be made to DLA Land and Maritime-VQP Qualifications Group. Requests are to be submitted via e-mail and include the following information: Recipient (company) name, shipping address, point of contact with telephone number and e-mail address, DLA Land and Maritime test report number located on Form 19P, recipient's express mail shipping company, recipient's account number for the express mail shipping company.

5.3.3 Specific test practices. Testing shall be performed as specified in MIL-PRF-24623/7 using cited test standards (such as TIA/EIA). Specific test practices for the performance tests, including clarifications and further details, are found in [MIL-STD-1678](#).

- a. Optical tests. The optical measurements shall be performed per the applicable TIA455 series standards or otherwise cited test standards with the exception of adhering strictly to the setup and test procedure specified in the applicable 2100 series Measurements in MIL-STD-1678-2.
- b. Physical, mechanical, environmental and material performance tests. The Physical, mechanical, environmental and material performance tests shall be performed per the applicable TIA455 series or otherwise cited test standards with the exception of adhering strictly to any deviations, constraints or augmentations in the applicable 3100, 3200, 3300, 3400 series Measurements in MIL-STD-1678-3.
- c. Shock test. Standard shock fixture 4A for bulkhead mounting shall be used. Supplement test fixture that shall be used is in appendix B of Measurement 3201.
- d. Vibration test. Test fixture that shall be used is in appendix B of Measurement 3201. Backing plate is optional.

6. NOTES

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

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FIBER OPTIC TEST SAMPLE CONFIGURATIONS, LENS SPLICES AND TERMINI,
NUCLEAR RADIATION TESTING, FABRICATION FOR

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (i.e., fabrication) of the fiber optic test sample (DUT assembly) for nuclear radiation testing. The DUT assemblies are intended to be used as part of qualification testing, but also can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

2. APPLICABLE DOCUMENTS.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-29504](#) – Termini, Fiber Optic Connector, Removable, General Specification for.

[MIL-PRF-24623](#) – Splice, Fiber Optic Cable, General Specification for.

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

3. Definitions.

3.1 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to transmit light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.1.1 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.1.2 Optical fiber, single mode. A small core optical fiber where only one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.2 Splice. A splice is a generic term for a device or process which permanently joins optical fibers and cables in a protective manner and may consist of several parts.

3.3 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical fiber. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical fiber ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical fiber (waveguide) and continues in a non-waveguide mode of propagation.

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3.4 Termini. A component used in a fiber optic, multiple termini, connection that is inserted into one of the insert cavities of a multiple termini connector, provides a means to break and rejoin an optical path, and is terminated onto the end of a simplex, fiber optic cable. The term "termini" is the plural form for the word terminus.

3.5 Terminus. The singular form used for the word termini.

4. Configurations. In the context of Requirement 4105, the component being tested (device under test or DUT) is a lens component. This lens component can take the form of either a MIL-PRF-29504 lens terminus or as a MIL-PRF-24623 lens splice. The test sample or DUT assembly is the DUT with the other fiber optic components that comprise these assembled components (see 5.1). Configurations for DUT assemblies are those that shall be used for qualification of nuclear radiation testing. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also (see 5.2). Further requirements for the configurations used, fabrications performed and test sample size shall be those as specified in 4.1 and 4.2.

4.1 Termination. The terminus termination process of the test sample fabrication shall be in accordance with [APPENDIX A](#).

4.2 Number of test samples. The number of test samples (DUT assemblies) prepared shall be nine. This sample size allows testing of one DUT assembly at one of three temperatures for each of two fiber types (single mode 9/125 and multimode 50/125, see [6.2](#)) and one of three lens types (for wavelengths of 850 nm, 1310 nm, and 1550 nm). Sample size may be reduced if one lens type covers more than one wavelength.

5. Implementation. Test samples (DUT assemblies) shall be prepared for qualification, as specified in 5.1 through [5.4](#).

5.1 Qualification. DUT assemblies for termini qualification shall consist of splices or termini as part of a single optical fiber assembly (see 5.4) or DUT assembly. Configuration and fabrication requirements for qualification test samples (DUT assemblies), shall be implemented as specified in [APPENDIX A](#). Fabrication of these DUT assemblies shall be performed in accordance with 5.2 through 5.4. Qualification consists of performing nuclear radiation testing specified in the individual specification sheet for the applicable military specification. Where both temperature ranges are specified, there is no separate qualification for only one temperature range. Qualification shall be performed on each fiber size (i.e., each size of optical fiber).

5.2 Footprint. DUT assembly shall be constructed as to allow placement into the test fixture. DUT assembly must fit into the footprint with the maximum allowable length of the entire mated pair less the protruding optical fiber of 140 mm (5.5 inches) and the maximum allowable diameter of 14 mm (0.55 inches).

5.3 Fabrication. DUT assembly construction shall include steps (1) through (5).

- (1) Terminate the optical fiber with one meter pigtailed (see 5.4) at both the launch and detector (transmit and receive) ends (see 6.3).
- (2) Obtain optical transmittance measurement.
- (3) Cut fiber in the middle and terminate each end with a lens terminus.
- (4) Place each lens terminus into one end of an alignment sleeve.
- (5) Space/actively align lens termini mated pair in the alignment sleeve then epoxy into place.

5.4 Optical fiber pigtail for DUT assembly. To place each splice or termini mated pair into the can used as part of the test apparatus, the DUT assembly must be terminated with maximum 250 micron coating or buffer on the optical fiber, not a larger diameter optical fiber (900 micron buffer) or fiber optic cable (with a 2 mm outer jacket).

5.5 Policies. Policies for initial test arrangements, determining the need for access to classified information, and test laboratory assessment and audit shall conform to appendix B.

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6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Optical fiber types. The test sample configurations are specified under the assumption that only optical fiber for the single mode 9/125 micron and multimode 50/125 micron fiber sizes will be used in a lens terminus/splice application. Most applications projected are for backplane and breakaway connection applications. Current projections do not anticipate the use of the multimode 62.5/125 micron optical fiber in these applications.

6.3 Termination with optical fiber pigtails. This termination process assumes that cable with the same type optical fiber will be fusion spliced to the ends of the optical fiber pigtails. If not, then the test laboratory must specify the length of optical fiber required.

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APPENDIX A

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES

A.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of the lens splices and termini.

A.2 Applicable documents.

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

A.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-49291](#) – Fiber, Optical, General Specification For.

DEPARTMENT OF DEFENSE STANDARDS

[MIL-STD-1678-2](#) – Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)

[MIL-STD-2042](#) – Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWC DD Web Site in the Fiber Optics Recommended List section. This NSWC Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWC_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

A.3 Definitions.

A.3.1 DUT (Device Under Test). In Requirement 4105, the DUT is the lens splice or the lens terminus.

A.3.2 DUT assembly. The test sample or DUT assembly is the DUT with the other fiber optic components that comprise these assembled components. The DUT assembly includes the DUT, optical fiber, instrument end connections, epoxy, and any other components (including materials) that comprise the assembly.

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APPENDIX A

A.3.3 Instrument end connections. The instrument ends of the DUT assembly are the two optical fiber ends, one end I being attached to an optical source (transmitter) and the other end to the detector (receiver).

A.4 Test samples: Termini as part of a DUT assembly (single optical fiber assembly).

A.4.1 Quantity: See 4.2.

A.4.2 Configurations. One configuration shall be used except each DUT assembly shall be configured with a different size of optical fiber and lens type.

A.4.3 Fabrication (see 5.2). Termination procedure for the test samples shall be in accordance with 4.1.1 of [REQUIREMENT 4103](#). Where polishing of the ferrule end face is part of the termination, the post polish shall result in a domed ferrule end face with a PC polish (see MIL-STD-2042-5).

A.4.3.1 Polishing steps and polishing paper used.

A.4.3.1.1 Polish type. The standard polish specified in 4.1.1 of REQUIREMENT 4103 shall be used for termini on multimode fiber and the enhanced polish specified in 4.1.1 of REQUIREMENT 4103 shall be used for termini on single mode fiber.

A.4.3.1.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with 4.1.1 of REQUIREMENT 4103 shall be used. The standard polish as specified shall be used for multimode fiber size and enhanced polish for single mode fiber.

A.4.3.1.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

A.4.3.2 Instrument end connections. When specified, instrument ends for each DUT assembly shall be terminated with FC connectors. Instrument end connections shall be polished per A.4.3.1.

A.4.3.3 Optical fiber length. Unless otherwise specified, test sample configuration (each DUT assembly) shall consist of a one meter pigtail of MIL-PRF-49291 optical fiber on each end with the DUT in the middle.

A.4.4 Optical fiber type. The optical fiber used must be the same or equivalent to MIL-PRF-49291/12 for multimode optical fiber or MIL-PRF-49291/7 for single mode fiber. Submit request for alternate cable to DSCC-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-49291/6 and /7 optical fiber shall be used.

A.4.5 Epoxy type. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved include those in TABLE 4105 A-I.

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TABLE 4105 A-I. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^{\circ}\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See A.2.2.2.

A.5 Test methods and practices. Launch conditions and measurements for both the initial insertion loss and the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

A.5.1 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of MIL-STD-1678-2.

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APPENDIX B

POLICY FOR TEST ARRANGEMENTS, GRANTING CLASSIFIED THREAT LEVEL ACCESS,
TEST LABORATORY ASSESSMENT AND AUDIT

B.1 Purpose. Defense Logistics Agency (DLA) is responsible for making policy determinations regarding the nuclear radiation testing of fiber optic components in the optical path of the transmitted light. These fiber optic components include the optical fiber and lens components (such as lens splices and lens termini). These policies include initial test arrangements, determining the need for access to classified information, and test laboratory assessment and audit. This appendix addresses those policies along with some constraints.

B.2 Applicable documents.

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

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

[MIL-PRF-29504](#) – Termini, Fiber Optic Connector, Removable, General Specification for.

[MIL-PRF-24623](#) – Splice, Fiber Optic Cable, General Specification for.

[MIL-PRF-49291](#) – Fiber, Optical, General Specification for.

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.64](#) - FOTP-64 Procedure for Measuring Radiation-Induced Attenuation in Optical Fiber and Optical Cables.

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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APPENDIX B

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

B.3 Policy precursor: arrangements for performance of nuclear radiation testing. Request for qualification must be submitted to DLA Land and Maritime-VQP. Once approved by DLA Land and Maritime-VQP, the vendor or, test laboratory shall make financial, test and shipping arrangements with the test laboratory.

B.3.1 Constraints.

B.3.1.1 Components tested. Nuclear radiation qualification addresses in this appendix is limited to those MIL-PRF-24623, MIL-PRF-29504 and MIL-PRF-49291 fiber optic components tested as specified in [TIA-455-64](#).

B.3.1.2 Test laboratory. Unless otherwise specified, testing for steady state radiation shall be performed by the Naval Research Laboratory (NRL) Optical Sciences Division. One exception is when transient radiation testing (both prompt gamma and neutron) is specified, the same test laboratory may perform both steady state and transient radiation testing. DLA-VQP must approve in advance the use of the test laboratory (see [B.5.1](#)). The NRL Optical Sciences Division has received DLA approval.

B.3.1.3 Restrictions on source to perform optical fiber testing. Unless otherwise specified, testing of MIL-PRF-49291/6, /7, /10, /11 and /12 optical fiber shall be performed by the NRL Optical Sciences Division.

B.4 Policy: Access to nuclear radiation test classified information. The determination to allow and provide access to the information (such as classified threat levels) shall be made by DLA.

B.4.1 Restrictions. Unless otherwise specified, access will be restricted to test laboratory personnel performing the test and those making a technical determination in selecting fiber optic components in the optical path of the transmitted light (i.e., optical fiber, lens termini, lens splices).

[B.4.2.](#) Obtaining access. A request must be provided to DLA with information concerning security clearance classification and the "need to know".

B.5 Policy: Allowance of test laboratories to perform nuclear radiation testing.

B.5.1 Notification for performing nuclear radiation testing. Initial notification to perform radiation testing of MIL-PRF-24623, MIL-PRF-29504 and MIL-PRF-49291 fiber optic components shall be made to DLA Land and Maritime-VQP Qualifications Group. Once approved by DLA Land and Maritime-VQP to start the qualification process, a DLA assessment then audit will be performed. This assessment includes a review of test procedures and an audit of the test facilities. Also, this assessment shall include a DLA review to ensure that the test laboratory has the ability to store and restrict access to classified information in addition to ensuring sufficient test laboratory personnel security level clearance.

B.5.2 NRL technical support for laboratory assessment. As requested by DLA, NRL will act as the DLA technical agent for fiber optic component radiation testing. As part of this responsibility, NRL may be requested to review documentation and support any capability assessment and test laboratory audit.

REQUIREMENT 4106

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES FOR MIL-PRF-29504 TERMINI IN MIL-PRF-64266 RECTANGULAR CONNECTORS

1. Purpose. This requirement standardizes configurations, fabrication and specific methods/practices for the components to be used in the assembly (i.e., fabrication) of the fiber optic test sample (DUT assembly) for the MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/23 and /24 rectangular connectors. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication and specific methods/practices.

1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the rectangular connector plug (plug-in module connector) along with an alignment sleeve retainer (ASR) and rectangular connector receptacle (backplane connector). For identification purposes in Requirement 4106 and for consistency with Requirements 4101 and 4102, the termini placed in a connector plug (along with the ASR) are referred to as "socket termini". The termini placed in a connector receptacle (along with the ASR) are referred to as "pin termini".

1.2 Inclusion of other MIL-PRF-29504 termini types. Requirement 4106 allows from one to four of the termini types (MIL-PRF-29504/18, /20, /26 and /27) to be qualified in a MIL-PRF-64266/23 and /24 rectangular connectors. Since the MIL-PRF-29504/20 termini can be terminated with either a PC or an APC polish whereas the MIL-PRF-29504/18 terminus can be terminated with a PC polish only, the fabrication of three terminus variations are addressed (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish). Type of polish is not addressed for the two lens termini variations, MIL-PRF-29504/26 and /27 termini. For purposes of identifying the variants of termini to be placed in the different connector insert cavity positions, MIL-PRF-29504/26 and /27 termini are considered to be two other termini variants. A different MIL-PRF-64266 ASR is used depending upon if contact termini (MIL-PRF-29504/20 with an APC polish, MIL-PRF-29504/20 with a PC polish and MIL-PRF-29504/18 with a PC polish) or if lens termini (MIL-PRF-29504/26 and /27) are placed into the MIL-PRF-64266 connector. This different ASR requirement dictates that different connectors be used for contact termini and lens termini.

1.3 Alternative qualification with termini. Requirement 4106 addresses test sample configurations and fabrication of the MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/23 and /24 rectangular connectors. An alternative is to use Requirement 4103 which address test sample configurations and fabrication MIL-PRF-29504/18, /20, /26 and /27 termini when tested in MIL-PRF-64266/1 and /2 circular connectors. The MIL-PRF-29504/18, /20, /26 and /27 termini can be qualified when tested either in MIL-PRF-64266/1 and /2 circular connectors or when tested in MIL-PRF-64266/23 and /24 rectangular connectors.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.

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DEPARTMENT OF DEFENSE STANDARD

[MIL-STD-2042](#) - Fiber Optic Cable Topology Installation, Standard Methods for Naval Ships

(Copies of these documents are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

GENERAL SERIES TECHNICAL MANUAL

[NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

3. DEFINITIONS

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable bundle, fiber optic. Single fiber cables grouped together and usually secured by lacing tape. The cable bundle can be placed in convoluted tubing, used in various protected harness configurations or used as is in an open cable harness configuration.

3.3 Cable, loose tube. A fiber optic cable design is one configured with one or more optical fibers are fitted loosely within a tube, giving the optical fibers freedom to move. This mobility and isolation from the tube minimizes the effects of external forces on the performance of the link. The isolation allows cable expansion and contraction with temperature independent of the optical fibers.

3.4 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coating (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, and allows for more roughed handling (such as better crush and impact resistance).

3.5 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.6 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

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3.7 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: the core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.8 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.9 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.10 Termination. The process performed for placing a connector, terminus, splice or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

4. Configurations. In the context of Requirement 4106, the component being tested (device under test or DUT) are some or all of the MIL-PRF-29504/18, /20, /26 and /27 termini or these termini, the MIL-PRF-64266 rectangular connector specified for a backplane application, or both termini and connector. The test sample or DUT assembly (also referred to as termini mated pair and connector mated pair, as applicable) is the DUT with the other fiber optic components that comprise these assembled components. Configurations for DUT assemblies that shall be used for qualification conform to specific type, size and other fiber optic component parameters that serve to constrain and standardize on the DUT assembly make-up. Processes that shall be used for fabrication (assembly including termination) with specific methods/practices are standardized also. Configurations used and fabrications performed shall be those as specified in 4.1 through 4.4.

4.1 Termination.

4.1.1 Termination, temperature range 1. The contact (non- lens) terminus termination process of the test sample fabrication shall be in accordance with Method 5D1 (with PC polish) or Method 5D2 (with APC polish) of MIL-STD-2042 except as specified herein. The lens termini termination process of the test sample fabrication shall be in accordance with Method 5D1 of MIL-STD-2042 up to the processes for ferrule polishing and affixing the lens holder to the ferrule except as specified herein. The processes for ferrule polishing and affixing the lens holder to the ferrule are not specified in Requirement 4106.

4.1.2 Termination, temperature range 2. The contact (non- lens) terminus termination process of the test sample fabrication shall be in accordance with Work Package 010 04 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 except as specified herein. The lens termini termination process of the test sample fabrication shall be in accordance with Work Package 010 04 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 up to the processes for ferrule polishing and affixing the lens holder to the ferrule except as specified herein. The processes for ferrule polishing and affixing the lens holder to the ferrule are not specified in Requirement 4106.

4.2 Connector accessories assembly.

4.2.1 Connector accessories assembly, temperature range 1. The connector accessories assembly process shall be in accordance with MIL-STD-2042 for insertion of termini into the connector.

4.2.2 Connector accessories assembly, temperature range 2. The connector accessories assembly process shall be in accordance with NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4 for insertion of termini into the connector.

4.3 Test sample configurations. Dependent upon the inspection/test performed (see table 4106-I for temperature range 1, table 4106-II for temperature range 2, table 4106-III for interoperability), the termini test samples shall be in one of three configurations:

- a. Un-terminated,
- b. As part of a single fiber cable (i.e., a cable assembly),
- c. As an integral part of a multiple termini connector (i.e., within a multiple termini connector that is part of a cable assembly).

The construction details for each of the three test sample configurations for "Qualification" shall be performed as listed in section 5 herein.

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4.4 Interoperability. Policy to perform testing, submission to test laboratory, test sample submission, test sample configuration and other fabrication requirements for "Interoperability" shall be performed as listed in section 5 herein.

TABLE 4106-I. Connector mated pair configurations for qualification, temperature range 1.

Components	Number of components required for each four 4 cavity connectors (with contact termini)	Number of components required for each four 4 cavity connectors (with lens termini)
Description <u>1/</u>		
Number of connector mated pair, SM fiber size (9/125 micron)	4	4
Number of insert cavities	16	16
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	4	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	4
Connector receptacle (backplane connector), M64266/24	4	4
Dust cover, connector plug	N/A	N/A
Dust cover, connector receptacle	N/A	N/A
Backshell, connector receptacle, M64266/27	N/A	N/A
Backshell, connector plug, M64266/29	N/A	N/A
Number of connector mated pair, MM fiber size (62.5/125 micron)	2	2
Number of insert cavities	8	8
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	4	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	4
Termini, MIL-PRF-29504/27	0	4
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	2	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	2
Connector receptacle (backplane connector), M64266/24	2	2
Dust cover, connector plug	N/A	N/A
Dust cover, connector receptacle	N/A	N/A
Backshell, connector receptacle, M64266/27	N/A	N/A
Backshell, connector plug, M64266/29	N/A	N/A

1/ Mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4106 including the applicable appendices. Mated pair are test samples to be tested for termini as an integral part of a multiple termini connector. Further requirements are found in appendix A for qualification fabrication, appendix C for interoperability fabrication. This table does not include mated pair configurations (component breakdowns) for interoperability.

2/ Quantities provided are for four connector mated pair for each terminus type (contact or lens) and each fiber type (single mode or multimode). For single mode testing, a total of four connector mated pair are required for each terminus type. multimode testing, a total of two connector mated pair are required for each terminus type.

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TABLE 4106-II. Connectorated pair configurations for qualification, temperature range 2.

Components	Number of components required for each four 4 cavity connectors (with contact termini)	Number of components required for each four 4 cavity connectors (with lens termini)
Description <u>1/</u>		
Number of connector mated pair, SM fiber size (9/125 micron) <u>2/</u>	4	4
Number of insert cavities	16	16
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	6	0
Termini, MIL-PRF-29504/20 with APC polish	6	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	8
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	4	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	4
Connector receptacle (backplane connector), M64266/24	4	4
Dust cover, connector plug	N/A	N/A
Dust cover, connector receptacle	N/A	N/A
Backshell, connector receptacle, M64266/27	N/A	N/A
Backshell, connector plug, M64266/29	N/A	N/A
Number of connector mated pair, MM fiber size (50/125 micron)	2	2
Number of insert cavities	8	8
Termini, MIL-PRF-29504/18	4	0
Termini, MIL-PRF-29504/20 with PC polish	4	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	4
Termini, MIL-PRF-29504/27	0	4
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	2	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	2
Connector receptacle (backplane connector), M64266/24	2	2
Dust cover, connector plug	N/A	N/A
Dust cover, connector receptacle	N/A	N/A
Backshell, connector receptacle, M64266/27	N/A	N/A
Backshell, connector plug, M64266/29	N/A	N/A

1/ Mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4106 including the applicable appendices. Further requirements are found in appendix B for qualification fabrication, appendix C for interoperability fabrication. This table does not include mated pair configurations (component breakdowns) for interoperability.

2/ Quantities provided are for four connector mated pair for each terminus type (contact or lens) and each fiber type (single mode or multimode). For single mode testing, a total of four connector mated pair are required for each terminus type. For multimode testing, a total of two connector mated pair are required for each terminus type.

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TABLE 4106-III. Connector mated pair configurations for interoperability.

Components	Number of components required for each one cavity connector (with contact termini)	Number of components required for each one cavity connector (with lens termini)
Description 1/3/		
Minimum number of mated pair, SM fiber size (9/125 micron), Counterpart termini interoperability 3/	1	1
Number of insert cavities	4	4
Termini, MIL-PRF-29504/18	8	0
Termini, MIL-PRF-29504/20 with PC polish	0	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	0
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	1	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	1
Connector receptacle (backplane connector), M64266/24	1	1
Minimum number of mated pair, MM fiber size (62.5/125 micron), Counterpart termini interoperability 3/	1	1
Number of insert cavities	4	4
Termini, MIL-PRF-29504/18	8	0
Termini, MIL-PRF-29504/20 with PC polish	0	0
Termini, MIL-PRF-29504/20 with APC polish	0	0
Termini, MIL-PRF-29504/26	0	8
Termini, MIL-PRF-29504/27	0	0
Connector plug (plug-in module connector), M64266/23 (with non-lens terminus ASR)	1	0
Connector plug (plug-in module connector), M64266/23 (with lens terminus ASR)	0	1
Connector receptacle (backplane connector), M64266/24	1	1

1/ This table contain the mated pair configurations (component breakdowns) for interoperability. Connector mated pair (test sample) configurations shall be fabricated (terminated and assembled) as specified in this Requirement 4106 including the applicable appendices. For connector interoperability, further requirements are found in appendix C for interoperability fabrication.

2/ Quantities provided are for one connector mated pair for MIL-PRF-64266 connector interoperability for each terminus type (contact or lens) and each fiber type (single mode or multimode).

3/ Number of termini required includes only those for the termini-to-ST jumpers to be placed into the connector mated pair (to measure insertion loss). Separate termini are required for other interoperability tests (terminus insertion and removal forces, terminus retention force). If performed for termini interoperability only, tests may be performed in a MIL-PRF-64266 rectangular connector (see [appendix C](#)) or in a MIL-PRF-64266 circular connector (see Requirement 4103 appendix C).

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5. Implementation. Termini may be either qualified in circular connectors (addressed in Requirement 4103) or in rectangular connectors (addressed in this Requirement 4106). Test samples (DUT assemblies) shall be prepared for both "Qualification, except interoperability" and for "Interoperability" as specified in [5.1](#) and [5.2](#). Qualification of contact termini only (MIL-PRF-29504/18 and /20) and qualification of the rectangular connector with contact termini only is addressed in [figure 4106-1](#). Qualification of lens termini only (MIL-PRF-29504/26 and /27) and qualification of the rectangular connector with lens termini is addressed in [figure 4106-2](#).

5.1 Qualification, except interoperability. DUT assemblies for lens termini qualification shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini rectangular connector. Configuration and fabrication requirements for qualification test samples (DUT assemblies), except interoperability, shall be implemented as specified in [appendix A](#) for temperature range 1 and in [appendix B](#) for temperature range 2. Qualification of termini consists of performing tests in MIL-PRF-29504/18, /20, /26 and /27 for either temperature range 1 (TR1) or temperature range 2 (TR2) or for both temperature range 1 and temperature range 2. Qualification of lens termini shall include tests, and the test sample configurations, listed in MIL-PRF-29504/18, /20, /26 and /27 for "Tests for unterminated termini", "Tests for termini as part of a single fiber cable" and "Termini as a part of a multiple termini connector". For reference, a consolidation of connector mated pair configurations required for qualification by components are listed in table 4106-I for temperature range 1 and in table 4106-II for temperature range 2. Tables for number of termini required in [appendix A](#) and in [appendix B](#) address both a separate MIL-PRF-29504/18, /20, /26 and /27 termini qualification only and one that includes both MIL-PRF-64266 rectangular connectors and MIL-PRF-29504/18, /20, /26 and /27 termini.

5.2 Interoperability. DUT assemblies for lens termini interoperability shall consist of un-terminated termini, termini as part of a single fiber cable, and termini as a part of a multiple termini connector. Configuration and fabrication requirements for interoperability test samples (DUT assemblies), shall be implemented as specified in [appendix C](#).

5.3 Combined terminus and rectangular connector qualification. A qualification table addressing qualification testing for a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/23 and /24 rectangular qualification is addressed in [appendix D](#).

5.4 Termini positions in connector insert cavity. Termini placed in each cavity position for a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/23 and /24 rectangular qualification shall conform to [appendix E](#).

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Group 1: 4 connector mated pair 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/			
Group 1, then Group 2, Group 3 Mechanical		Group 1, then Group 3 Environmental	
Con 1	Con 2	Con 3	Con 4
Rect. 11	Rect. 11	Rect. 11	Rect. 11
T1-T4	T1-T4	T1 – T4	T1 – T4
M29504/18, /20	M29504/18, /20	M29504/18, /20	M29504/18, /20
ASR = F	ASR = F	ASR = F	ASR = F
Polish	Polish	Polish	Polish

1/ Con = connector (i.e., one connector mated pair).

2/ Rect. 11 = Rectangular connector (one with a circular insert that is used also in the shell size 11 circular connector).

3/ T1-T4 = Four contact termini mated pair. Contact termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Contact termini are M29504/18 and M29504/20.

4/ M29504/20 = termini to be qualified. For contact termini, qualify M29304/20 at a minimum.

5/ ASR = F, Alignment Sleeve Retainer configured with alignment sleeves to accept contact termini with a 1.25 mm diameter ferrule.

6/ Polish = M29504/18 with a PC polish, M29504/20 with PC polish, for single mode only M29504/20 with APC polish.

7/ Figure 4106-1 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of two connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same four mated pair for the one required environmental test (thermal shock).

8/ If want to qualify both contact termini and lens termini for a termini only qualification, then use both figure 4106-1 and figure 4106-2.

9/ For a termini only qualification, qualified connectors must be used. Option to qualify in either a MIL-PRF-64266 rectangular (backplane) connector or in a MIL-PRF-64266 shell size 11 circular connector (see Requirement 4103).

FIGURE 4106-1. Test samples: Contact termini only, rectangular connector with contact termini only.

Group 1: 4 connector mated pair 1/ 2/ 3/ 4/ 5/ 6/ 7/ 8/ 9/			
Group 1, then Group 2, Group 3 Mechanical		Group 1, then Group 3 Environmental	
Con 1	Con 2	Con 3	Con 4
Rect. 11	Rect. 11	Rect. 11	Rect. 11
L1 – L4	L1 – L4	L1 – L4	L1 – L4
M29504/26, /27	M29504/26, /27	M29504/26, /27	M29504/26, /27
ASR = L	ASR = L	ASR = L	ASR = L
NA	NA	NA	NA

1/ Con = connector (i.e., one connector mated pair).

2/ Rect. 11 = Rectangular connector (one with a circular insert that is used also in the shell size 11 circular connector).

3/ L1 – L4 = Four lens termini mated pair. Lens termini measured at 4 positions in each connector with 4 insert cavities (see appendix E for termini positions). Lens termini are M29504/26 and M29504/27.

4/ M29504/26, /27= termini to be qualified. For lens termini, may qualify M29504/26, /27 or both.

5/ ASR = L, Alignment Sleeve Retainer configured with alignment sleeves to accept lens termini with a 1.58 mm diameter lens holder.

6/ NA = Not Applicable (pertains to the polish on a terminus ferrule end face). Row retained for consistency with other figures.

7/ Figure 4106-2 is shown for connectors with single mode fiber. A reduced test sequence is performed on connectors with multimode fiber. A reduced test sample quantity of two connector mated pair may be used for connectors with multimode fiber. For temperature range 2, use the same two mated pair for the one required environmental test (thermal shock).

8/ If want to qualify both contact termini and lens termini for a termini only qualification, then use both figure 4106-1 and figure 4106-2.

9/ For a termini only qualification, qualified connectors must be used. Option to qualify in either a MIL-PRF-64266 rectangular (backplane) connector or in a MIL-PRF-64266 shell size 11 circular connector (see Requirement 4106).

FIGURE 4106-2. Test samples: Lens termini only, rectangular connector with lens termini only.

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6. NOTES

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Interoperability. Separate test sample configurations are required for interoperability testing. These test sample configurations are in addition to the ones to be used for the other qualification tests.

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APPENDIX A

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES,
TEMPERATURE RANGE 1 (EXCEPT INTEROPERABILITY)

A.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 termini for temperature range 1. Fabrication criteria are addressed in [appendix B](#) for test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 termini for temperature range 2. Fabrication criteria are addressed in [appendix C](#) for test samples to be used for interoperability.

A.1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the rectangular connector plug (plug-in module connector) along with an alignment sleeve retainer (ASR) and rectangular connector receptacle (backplane connector). For identification purposes in Requirement 4106 and for consistency with Requirements 4101 and 4102, the termini placed in a connector plug (along with the ASR) are referred to as "socket termini". The termini placed in a connector receptacle are referred to as "pin termini".

A.2 Applicable documents.

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

A.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber optic cabling systems requirements and measurements (Part 1: design, installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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A.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues are these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWCD Web Site in the Fiber Optics Recommended List section. This NSWCD Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWCD_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

A.3 Test samples, unterminated termini. Number of termini for both termini type (contact and lens) required to perform a full MIL-PRF-29504/18, /20, /26 and /27 termini qualification is provided in table 4106 A-I.

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TABLE 4106 A-I. Termini allocation for temperature range 1 fiber sizes. 1/

Test performed	Single mode		Multimode 7/	
	Number of pin termini	Number of socket termini	Number of pin termini	Number of socket termini
Qualification, except interoperability				
Un-terminated termini tests				
	64 + 3	64 + 3	24 + 3	24 + 3
Group 1	64 + 3 of 64 + 3	64 + 3 of 64 + 3	24 + 3 of 24 + 3	24 + 3 of 24 + 3
Group 2	13/	13/		
Group 3 (polymeric materials only)	Materials only	Materials only		
Group 4	None	None		
Termini as part of a single fiber cable tests 5/				
	32 + 3 of 64 + 3	32 + 3 of 64 + 3	8 + 3 of 24 + 3	8 + 3 of 24 + 3
Group 1 11/	12/	12/	8 of 8	8 of 8
Group 2 (16 termini mated pair – each test)	32 of 32	32 of 32		
Fiber pullout force 2/, 3/	16 of 32	16 of 32		
Cable pull out force 2/, 3/	16 of 32	16 of 32		
Group 3	None	None		
Salt spray	None	None		
Fluid immersion	None	None		
Terminus cleaning 9/	9/	9/		
Radiation 10/	3 of + 3	3 of + 3	3 of + 3	3 of + 3
Termini as an integral part of a multiple termini connector				
	32 of 64 + 3	32 of 64 + 3	16 of 24 + 3	16 of 24 + 3
Group 1 (8 connector mated pair, SM)	32 of 32	32 of 32	16 of 16	16 of 16
Group 2 (4 connector mated pair, SM) 4/, 8/	16 of 32	16 of 32		
Group 3, Mechanical 8/	4/	4/	16 of 16	16 of 16
Group 3, Environmental (4 connector mated pair) 4/, 8/	16 of 32	16 of 32		
Interoperability 6/				
Total number of lens termini	67	67	27	27

1/ See A.3.1 and A.3.2 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

2/ 16 termini from the termini designated for Group 2.

3/ If one socket terminus is tested at a time, only one pin terminus-to-ST jumper is required for the 16 socket terminus-to-ST jumper tested (see table 4106-I).

4/ Use same test samples from Group 2 for Group 3 Mechanical test. Separate test samples are used for Group 3 Environmental tests.

5/ Termini-to-ST jumpers.

6/ Configuration and fabrication requirements for interoperability samples are found in appendix C.

7/ Quantity valid only if full test sequence is performed with single mode and qualification requirements are met.

Otherwise use same quantity as specified for single mode test samples.

8/ From Group 1 for “Termini as an integral part of a multiple termini connector”.

9/ Test samples from the cable pullout test shall be used.

10/ Separate test samples prepared in accordance with MIL-STD-1678-4 Requirement 4105 shall be used. Three test samples shall be fabricated on the specified fiber type for each lens terminus with a different wavelength lens.

11/ Same single mode test samples that will be used later for the cable pullout test. Separate multimode test samples shall be used.

12/ No additional termini required. Use 8 test samples from cable pullout test.

13/ No additional termini required. Use 16 termini from Group 1.

A.3.1 Quantity. Quantity of 67 pin termini and 67 socket termini for single mode fiber type and for contact and lens type and 27 pin termini and 27 socket termini for multimode fiber type and for contact and lens type.

NOTE: This quantity does not include the number of termini required for interoperability (see appendix C for further details on interoperability).

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A.4 Test samples. Termini as part of a single fiber cable.

A4.1 Quantity. See table 4106 A-I selected from the lot of un-terminated termini.

A.4.2 Configurations and fabrication.

A.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in [A.5.1](#), and [A.5.3](#), through [A.5.7](#) below. Fiber pullout test samples shall be prepared on single fiber cable without any strain relief. Cable pullout test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.

A.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with [4.1.1](#) of Requirement 4106. Post polish shall result in a domed ferrule end face with a PC polish for instrument end connectors. The one exception is that a domed end face with an APC polish shall be provided for instrument end connectors for termini with an APC polish.

A.4.3 Cable type. Cable used must be of same configuration as MIL-PRF-85045/16; however, this cable does not need to meet environmental specifications in MIL-PRF-85045/16. The fiber in the cable used must be the same or equivalent to MIL-PRF-49291/6 for multimode optical fiber or MIL-PRF-49291/7 for single mode fiber. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

A.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

A.5 Test samples. Termini as an integral part of a multiple termini connector.

A.5.1 Termination procedures. Termination procedure for the test samples shall be in accordance with [4.1.1](#) of Requirement 4106. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

A.5.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for ST connectors (or other instrumentation-end connectors) except as specified in A.4.2.2. End face geometry shall be as specified in MIL-STD-1678-5.

A.5.2 Cable type. Cable used shall be MIL-PRF-85045 cable with the specification sheet conforming to table 4106 A-II.

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TABLE 4106 A-II. Cable compatible with connector.

Connector shell size	Number of cavities in connector insert	Specification sheet for MIL-PRF-85045 cable
NA	4	/16

A.5.3 Epoxy type. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved include those in table 4106 A-III.

TABLE 4106 A-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

- 1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.
- 2/ Curing. Preheat oven at $120 \pm 5^\circ\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).
- 3/ See A.2.2.2.

A.5.4 Polishing steps and polishing paper used (applicable to contact termini only).

A.5.4.1 Polish type. The standard polish specified in [4.1.1](#) shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

A.5.4.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with [4.1.1](#) shall be used. The standard polish as specified in [A.5.4.1](#) shall be used.

A.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

A.5.5 Connectors.

A.5.5.1 Configuration. A MIL-PRF-64266/24 qualified rectangular connector receptacle with a 4 channel (cavity) insert and a MIL-PRF-64266/23 qualified connector plug with an 4 channel (cavity) insert shall be used (for MIL-PRF-29504/18, /20, /26 and /27 termini qualification).

A.5.5.2 Backshell (connector accessory). Not applicable.

A.5.5.3 Insert cavity population. Qualification testing shall be performed on termini mated pair in fully populated cavities of each connector insert. All 4 channels are to be active optically for rectangular connector and for termini qualification testing.

A.5.5.4 Fiber type. Each connector mated pair shall contain only four termini mated pair of one fiber type.

A.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of MIL-STD-1678-2

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A.5.7 Fabrication. Test sample configurations (each cable assembly) shall consist of 10 meters of MIL-PRF-85045 single fiber cable with the DUT (connector mated pair or termini inserted into a MIL-PRF-64266 rectangular connector) in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires the cable length from terminus-to-single ferrule connector to be 5 meters. For insertion loss tests on multiple termini connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

A.5.7.1 Single mode. Termini on cable assemblies (such as terminus-to-ST jumpers) with cable containing single mode 9/125 micron optic fiber shall conform to table 4106 A-IV.

TABLE 4106 A-IV. Fabrication for cable with 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	125.5 +1/-0 microns/1310 nm <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4106 A-II.
Epoxy type	Two part, heat cured, liquid type per table 4106 A-III.
Test sample quantity	8 connector mated pair per A.5.1 through A.5.6 .
Tests performed	Full test sequence <u>2/</u>

1/ 9.3/125 micron at 1310 nm per [MIL-PRF-49291/7](#).

2/ See the qualification table in MIL-PRF-29504/18, /20, /26 and /27.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

A.5.7.2 Multimode. Termini on cable assemblies with multimode cable containing 62.5/125 micron fiber shall conform to table 4106 A-V.

TABLE 4106 A-V. Fabrication for cable with multimode fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	126 +1/-0 microns/1300 nm <u>3/</u>
Fiber size	62.5/125 micron per MIL-PRF-49291/6.
Cable type	Tight buffer per table 4106 A-II.
Epoxy type	Two part, heat cured, liquid type per table 4106 A-III.
Test sample quantity	4 connector mated pair per A.5.1 through A.5.6 .
Tests performed	Limited test sequence <u>1/</u> , <u>2/</u>

1/ Qualify single mode first. A reduced set of tests using 4 multimode connector mated pair is listed once qualified using a full test sequence with single mode fiber

2/ See the qualification table in MIL-PRF-29504/18, /20, /26 and /27.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

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APPENDIX B

CONFIGURATION AND FABRICATION REQUIREMENTS FOR QUALIFICATION TEST SAMPLES,
TEMPERATURE RANGE 2
(EXCEPT INTEROPERABILITY)

B.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 termini for temperature range 2. Fabrication criteria are addressed in appendix A for test samples to be used for the qualification of the MIL-PRF-29504/18, /20, /26 and /27 termini for temperature range 1. Fabrication criteria are addressed in [appendix C](#) for test samples to be used for interoperability.

B.1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the rectangular connector plug (plug-in module connector) along with an alignment sleeve retainer (ASR) and rectangular connector receptacle (backplane connector). For identification purposes in Requirement 4106 and for consistency with Requirements 4101 and 4102, the termini placed in a connector plug (along with the ASR) are referred to as "socket termini". The termini placed in a connector receptacle are referred to as "pin termini".

B.2 Applicable documents.

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

B.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

GENERAL SERIES TECHNICAL MANUAL

[NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4](#) - Technical Manual, Installation and Repair Practices, Aircraft Electric and Electronic Wiring

(A copy of this document is available online at: <https://mynatec.navair.navy.mil>. NATEC has three difference processes to obtain the manual, depending on if you are Government personnel (military and civilians), Contractors with a Government contract, or everyone else. If unable to access this Web Site or require further assistance, contact (1) NATEC Customer Service: 619.545.1888, (2) NATEC Website Status Hotline: 619.545.1706, or (3) NATEC Customer Service E-mail: nani_customerservice@navy.mil.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455](#) - Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components

(Copies are available online at <http://www.tiaonline.org> or from TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201).

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

B.3 Test samples, un-terminated termini. Number of termini for both termini type (contact and lens) required to perform a full MIL-PRF-29504/18, /20, /26 and /27 termini qualification is provided in table 4106 B-I.

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TABLE 4106 B-I. Termini allocation table for temperature range 2 fiber sizes. 1/

Test performed	Single mode		Multimode 7/	
	Number of pin termini	Number of socket termini	Number of pin termini	Number of socket termini
Qualification, except interoperability				
Unterminated termini tests				
	104 + 3	104 + 3	24 + 3	24 + 3
Group 1	104 + 3 of 104 + 3	104 + 3 of 104 + 3	24 + 3 of 40 + 3	24 + 3 of 40 + 3
Group 2	13/	13/		
Group 3 (polymeric materials only)	Materials only	Materials only		
Group 4	8 of 104			
Modified S02/salt spray	8 of 8			
Termini as part of a single fiber cable tests 5/				
	64 + 3 of 104 + 3	64 + 3 of 104 + 3	8 + 3 of 8 + 3	8 of 8 + 3
Group 1 8/	12/	12/	8 of 8	8 of 8
Group 2	32 of 64	32 of 64		
Fiber pullout force	16 of 32	16 of 32		
Cable pull out force, twist	16 of 32	16 of 32		
Group 3 (16 pair – minimum each test)	32 of 64	32 of 64		
Salt spray 2/	16 of 32	16 of 32		
Fluid immersion 2/, 3/	16 of 32	16 of 32		
Terminus cleaning 10/	10/	10/		
Radiation 11/	3 of + 3	3 of + 3	3 of + 3	3 of + 3
Termini as an integral part of a multiple termini connector				
	32 of 104	32 of 104	16 of 24 + 3	16 of 24 + 3
Group 1 (8 connector mated pair, SM)	32 of 32	32 of 32	16 of 16	16 of 16
Group 2 (4 connector mated pair)	16 of 32	16 of 32		
Group 3, Mechanical 4/, 9/	4/	4/	16 of 16	16 of 16
Group 3, Environmental (4 connector mated pair) 4/, 9/	16 of 32	16 of 32		
Interoperability 6/				
Total number of lens termini	107	107	27	27

1/ See B.3.1 and B.3.2 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

2/ 16 termini from the termini designated for Group 3.

3/ Termini to be placed in both connector plug and connector receptacle to verify optical performance after the test. Termini shall be immersed for this test.

4/ No additional termini required. Same 4 connector mated pair from Group 2 are used. Separate test samples are used for Group 3 Environmental tests.

5/ Termini-to-ST jumpers.

6/ Configuration and fabrication requirements for interoperability samples are found in appendix C.

7/ Quantity valid only if full test sequence is performed with single mode and qualification requirements are met. Otherwise use same quantity as specified for single mode test samples.

8/ Same single mode test samples that will be used later for the cable pullout test. Separate multimode test samples shall be used.

9/ From Group 1 for "Termini as an integral part of a multiple termini connector".

10/ Test samples from the fluid immersion test shall be used.

11/ Lens termini only. Separate test samples prepared in accordance with MIL-STD-1678-4 Requirement 4105 shall be used. Three test samples shall be fabricated on the specified fiber type for each lens terminus with a different wavelength lens.

12/ No additional termini required. Use 8 test samples from cable pullout test.

13/ No additional test samples required. Use 16 termini from Group 1.

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B.3.1 Quantity. Quantity of 107 pin termini and 107 socket termini for single mode fiber type and 27 pin termini and 27 socket termini for multimode fiber type.

NOTE: This quantity does not include the number of termini required for interoperability (36 pin termini and 36 socket termini for each fiber type and for contact and lens type and an additional 16 pin termini, see appendix C for further details on interoperability).

B.4 Test samples. Termini as part of a single fiber cable.

B.4.1 Quantity. Specified quantity of lens termini selected from the lot of un-terminated termini (see table 4106 B-I).

B.4.2 Configurations and fabrication.

B.4.2.1 Configuration. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in [B.5.1](#), and [B.5.3](#) through [B.5.7](#) below. Fiber pullout test samples shall be prepared on single fiber cable without any strain relief. Cable pullout test samples shall be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification with proposed length deviation and test setup that would allow for successful performance with the proposed deviated length must be included.

B.4.2.2 Fabrication. Termination procedure for the test samples shall be in accordance with [4.1.2](#) of Requirement 4106. Post polish shall result in a domed ferrule end face with a PC polish for instrument end connectors. The one exception is that a domed end face with an APC polish shall be provided for instrument end connectors for termini with an APC polish.

B.4.3 Cable type. Cable used must be of same configuration specified in [B.5.2](#) below; however, this cable does not need to meet environmental specifications in MIL-PRF-29504/18, /20, /26 and /27. The optic fiber in the cable used must be the same or equivalent to the approved cabling as stated in [B.5.2](#) below. Submit request for alternate cable to DLA Land and Maritime-VQP. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table. Otherwise, MIL-PRF-85045/16 cable shall be used.

B.4.4 Test methods and practices. Launch conditions and measurements for the change in optical transmittance shall conform as specified in MIL-STD-1678-2.

B.5 Test samples. Termini as an integral part of a multiple termini connector.

B.5.1 Termination procedures. Termination procedure for the test samples shall be in accordance with WP 010 04 of NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

B.5.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish for ST connectors (or other instrumentation-end connectors) except as specified in [B.3.2.2](#). End face geometry shall be as specified in MIL-STD-1678-1.

B.5.2 Cable type. The Government must approve cable brand and part number prior to test sample termination. Cables approved to date are those listed in table 4106 B-II.

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B.5.2.1 Test samples used for insertion loss only. Cable used must be of same configuration specified. The fiber in the cable used must be the same or equivalent to the approved cabling as stated above. NAVAIR 4.5 will determine if the fiber is equivalent. Requesting party must submit documentation showing equivalency for optical, mechanical, environmental, material and other applicable performance parameters for both fiber being requested and for fiber in which equivalency is being claimed. Documentation is to include specification sheets and a prepared equivalency matrix/table.

TABLE 4106 B-II. Tight buffer cable.

Fiber size (microns)	Cable vendor	CAGE Code	Part number	Alternate part number
9/125 <u>1/</u>	OFS Fitel	0MZN3	C14447	None
50/125 <u>1/</u>	OFS Fitel	0MZN3	C10027	BC06815

1/ Cable must be preconditioned prior to terminus termination and connector assembly as specified in MIL-STD-1678-5 Measurement 5301.

B.5.3 Epoxy type. Approved epoxy shall be used for test sample termination. Epoxies approved to date are those in table 4106 B-III.

TABLE 4106 B-III. Epoxy types.

Epoxy type	CAGE code	Part number	Cure schedule
Two-part liquid, Epo-tek 353ND <u>1/</u>	64201	353ND-2g	<u>2/</u>
	08RC6	3700-5520	<u>2/</u>

1/ Two part, heat cured epoxy provided in 2 gram A-PAKS. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ See table 1, WP 010 02 in NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4

B.5.4 Polishing steps and polishing paper used (applicable to contact termini only).

B.5.4.1 Polish type. The standard polish specified in 4.1.2 shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

B.5.4.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with 4.1.1 shall be used. The standard polish as specified in B.5.4.1 shall be used.

B.5.4.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

B.5.5 Connectors.

B.5.5.1 Configuration. A MIL-PRF-64266/24 qualified rectangular connector receptacle with an 4 channel (cavity) insert and a MIL-PRF-64266/23 qualified connector plug with an 4 channel (cavity) insert shall be used (for MIL-PRF-29504/18, /20, /26 and /27 termini qualification).

B.5.5.2 Backshell (connector accessory). Not applicable.

B.5.5.3 Insert cavity population. Qualification testing shall be performed on termini mated pair in fully populated cavities of each connector insert. All 4 channels are to be active optically for rectangular connector and for termini qualification testing.

B.5.5.4 Fiber type. Each connector mated pair shall contain only four termini mated pair of one fiber type.

B.5.6 Launch conditions. Unless otherwise specified (such as when test is specified with an overfilled launch for multimode fiber sizes), test sample shall include the launch condition provision for single mode fiber sizes and the restricted launch condition for multimode fiber sizes specified in Measurement Support Process 2203 of MIL-STD-1678-2.

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B.5.7 Fabrication. At a minimum, separate sets of test samples shall be tested on cable assemblies of terminus mated pair fabricated with single mode fiber and with multimode fiber. Test sample configurations shall consist of terminus-to-ST connector jumpers. Other instrumentation-end connectors may be used in lieu of ST connectors. Each cable assembly shall consist of 10 meters of cable with the DUT in the middle (at 5 meters) and single ferrule connectors on the ends to mate with the optical instrumentation. This cable assembly configuration requires each terminus-to-ST connector jumper to have a cable length of 5 meters. For insertion loss tests on multiple terminus connectors where a cut-back must be performed, a 13 meter length of cable is used with the DUT placed 8 meters from the launch end of the cable. This allows 3 cut-backs to be performed, each cut-back being one meter long. Submit request for any alternate cable length proposal to DLA Land and Maritime-VQP. A justification must be presented for any proposed length deviation and shall include test setup that would allow for successful performance with the proposed deviated length.

B.5.7.1 Single mode 9. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4106 B-IV.

TABLE 4106 B-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	125.5 +1/-0 μ m/1550 nm <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per table 4106 B-II.
Epoxy type	Two part, heat cured, liquid type per table 4106 B-III.
Test sample quantity	8 connector mated pair per B.5.1 through B.5.6 .
Tests performed	Full test sequence <u>2/</u>

1/ 9.3/125 micron at 1310 nm.

2/ See qualification table in MIL-PRF-29504/18, /20, /26 and /27.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

B.5.7.2 Multimode. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 50/125 micron fiber shall conform to table 4106B-V.

TABLE 4103 B-V. Fabrication for multimode fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	126 +1/-0 μ m/850 nm <u>3/</u>
Fiber size	50/125 micron
Cable type	Tight buffer per table 4106 B-II.
Epoxy type	Two part, heat cured, liquid type per table 4106 B-II.
Test sample quantity	4 connector mated pair per B.5.1 through B.5.6 . <u>2/</u>
Tests performed	Limited test sequence. <u>1/</u> , <u>2/</u>

1/ Qualify single mode first. A reduced set of tests using 4 multimode connector mated pair is listed once qualified using a full test sequence with single mode fiber.

2/ See qualification table in MIL-PRF-29504/18, /20, /26 and /27.

3/ Ferrule hole diameter applicable for contact termini, wavelength for lens termini.

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APPENDIX C

CONFIGURATION AND FABRICATION REQUIREMENTS
FOR INTEROPERABILITY TEST SAMPLES

C.1 Purpose. This appendix provides the criteria for fabrication of test samples to be used for the interoperability testing of the MIL-PRF-29504/18, /20, /26 and /27 termini. In the past, the Government has partnered with termini/connector companies that were undergoing Qualified Products List testing in an effort to verify interoperability of fiber optic, multiple termini connectors that conform to MIL-PRF-28876. This partnership allows the Government to verify the interoperability of connectors with that of participating companies. DLA Land and Maritime-VTP is now the Government entity that performs the testing for interoperability. This partnership for interoperability testing is now extended to other termini/connectors including qualifying only the MIL-PRF-29504/18, /20, /26 and /27 termini.

C.1.1 Consistency. The MIL-PRF-29504/18, /20, /26 and /27 are genderless (really pin) termini used in both the rectangular connector plug (plug-in module connector) along with an alignment sleeve retainer (ASR) and rectangular connector receptacle (backplane connector). For identification purposes in Requirement 4106 and for consistency with Requirements 4101 and 4102, the termini placed in a connector plug (along with the ASR) are referred to as "socket termini". The termini placed in a connector receptacle are referred to as "pin termini".

C.2 Applicable documents.

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

C.2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

- [MIL-PRF-29504](#) - Termini, Fiber Optic Connector, Removable, General Specification for.
- [MIL-PRF-64266](#) - Connectors, Fiber Optic, Circular and Rectangular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environmental Resisting, General Specification for.
- [MIL-DTL-38999](#) - Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

- [MIL-STD-1678-1](#) - Fiber Optic Cabling Systems Requirements And Measurements (Part 1: Design, Installation And Maintenance Requirements) (Part 1 of 6 Parts)
- [MIL-STD-1678-2](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)
- [MIL-STD-1678-5](#) - Fiber Optic Cabling Systems Requirements and Measurements (Part 5: Design Phase, Supplemental and Legacy Measurements)
- [MIL-STD-2042-5](#) - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships (Connectors and Interconnections) (Part 5 of 7 Parts)

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(Copies of these documents are available online at <https://quicksearch.dla.mil/> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

C.2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard practice to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Navy Shipboard Fiber Optic Recommended Components Parts List

(A copy of this list can be obtained at NSWCD Web Site in the Fiber Optics Recommended List section. This NSWCD Dahlgren fiber optic web site houses additional shipboard fiber optic lists (for tools and for test equipment) that may be applicable to the logistic support requirements for the specified part. Due to the dynamic nature of web addresses the current website URL can be obtained by e-mailing DLGR_NSWCD_FOWEB@navy.mil with the subject line "WEBSITE URL REQUEST". An automated reply will contain the current web address.)

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

[TIA-455.34](#) - FOTP-34 Interconnection Device Insertion Loss Test

(Copies of this document are available online at <http://www.tiaonline.org> or from the TIA Headquarters, 1320 N. Courthouse Road, Suite 200, Arlington, VA 22201.)

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

C.3 Policy pertaining to test sample submission. Vendors shall be responsible for the fabrication, submittal and replacement/refurbishment of cable assemblies (test samples) in the configurations specified below to the Government for Interoperability testing.

C.3.1 Test sample retention. One stipulation is that the test samples are to be retained by the Government for use as standards in future interoperability testing to be performed by the Government in-house personnel. Only personnel to be present during interoperability testing are Government, in-house personnel. At no time shall other parties have access to or examination of the interoperability standards.

C.3.2 Replacement/refurbishment. Another stipulation is that the vendor shall agree to replace or refurbish these interoperability standards as the need arises. Any items requiring replacement/refurbishment in this agreement shall be performed by the vendor at no cost to the Government.

C.3.3 Notification for submission. Initial notification to submit test samples for interoperability shall be made to DLA Land and Maritime-VQP Qualifications Group.

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C.3.4 Arrangements to perform interoperability testing. Once approved by DLA Land and Maritime-VQP, the vendor shall make financial, test and shipping arrangements with the DLA Land and Maritime-VTP Passive Test Section.

Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime- VTP point of contact.

Shipping address:
DLA Land and Maritime Columbus
3990 East Broad St.
Bldg. 11, Section 7, VTP
Columbus OH 43213-1199

TABLE 4106 C-I. Termini interoperability test variations. 1/

Test variation	Connector receptacle	Termini socket	Connector plug	Termini pin
1	X	A	X	B
2	X	B	X	A
3	X	B	X	B

X = Previously Certified Connector, B = Candidate Termini

A = Previously Certified Termini

1/ Socket termini placed in connector receptacle, pin termini in connector plug.

TABLE 4106 C-II. Termini allocation table for each fiber size. 1/

Test performed	Interoperability							
	Single mode				Multimode			
	Number of pin termini		Number of socket termini		Number of pin termini		Number of socket termini	
	Contact	Lens	Contact	Lens	Contact	Lens	Contact	Lens
Total number of needed lens termini	52	36	36	36	36	36	36	36
Interoperability of counterpart terminus 2/, 3/	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36	36 of 36
Insertion loss (test variations per table 4106 C-I)	4	4	4	4	4	4	4	4
Insertion loss, additional (for circular shell sizes) 4/	32	32	32	32	32	32	32	32
Insert-to-termini compatibility 5/	16 of 16	0	0	0	0	0	0	0
Terminus retention force	16 of 16	0	0	0	0	0	0	0
Terminus insertion and removal forces 6/	16 of 16	0	0	0	0	0	0	0

1/ See C.4 and notes with the qualification table in MIL-PRF-29504/18, /20, /26 and /27 for further detail.

2/ Termini-to-ST jumpers.

3/ Candidate pin terminus-to-ST connector jumper (minimum quantity: 4 of each fiber size and for contact and/or lens type) and candidate pin terminus-to-ST connector jumper (minimum quantity: 4 of each fiber size and for contact and/or lens type) shall be tested in a connector per C.4.6 for each fiber size and for contact and/or lens termini types.

4/ When testing for candidate connector interoperability and to allow for the interoperability of counterpart termini to enable connector interoperability for 4 mated pair of each fiber type and for each contact and/or lens type being submitted. Also allow for candidate circular connector interoperability with these counterpart termini.

5/ Un-terminated termini. A total of 16 un-terminated termini are required for each test and the same 16 un-terminated termini may be used for both tests.

6/ Test performed using connector in which the ASR is not inserted.

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C.4 Interoperability of counterpart terminus. Test sample and qualified termini shall be inserted into and fully populate qualified connectors for test variations performed in table 4106 C-I. Cable assemblies for connector receptacles and plugs shall be configured with single fiber cable and no backshells. Minimum number of termini required for one fiber size to perform this interoperability test shall be as specified in table 4106 C-II for MIL-PRF-29504/18, /20, /26 and /27 termini qualification. Insertion loss shall be measured in accordance with MIL-STD-1678-2, Measurement 2101 using the simulated cut-back method. Tools, specified for insertion and removal of MIL-PRF-29504/20 termini from the connector insert cavities, shall be used successfully for terminus insertion and removal of the terminus-to-ST connector jumpers for this interoperability test.

C.4.1 Termination procedures. Termination procedure for the test samples shall be in accordance with 4.1.1 of Requirement 4106. Post polish for termini and for instrument end connectors shall conform to C.4.1.1. Vendors shall be required to use these termination procedures and mark up any deviations taken. The marked up drafts shall be submitted before test sample fabrication. Government personnel will verify adequacy of the marked up draft submitted as part of the QPL process. Upon verification, the Government will finalize the procedures for incorporation into Government documentation.

C.4.1.1 End face geometry. End face geometry requirement shall be a domed ferrule end face with a PC polish both for termini (as applicable) and for ST connectors (or other instrumentation-end connectors). End face geometry shall be as specified in MIL-STD-1678-1.

C.4.2 Cable type. Interoperability test samples shall be constructed using MIL-PRF-85045/16 single fiber cable. For the 9/125 micron fiber size, M85045/16-02 shall be used. For the 62.5/125 micron fiber size, M85045/16-01 shall be used.

C.4.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

C.4.3.1 Multimode. No launch condition jumpers are required for the multimode fiber sizes. Overfilled launch conditions are used for interoperability testing.

C.4.3.2 Single mode. A mandrel diameter shall be used as the means of mode conditioning to filter out higher order modes. The technique of wrapping the fiber around a mandrel shall be performed as specified see 3.5 of [TIA-455.34](#). A diameter of 30 mm shall be used with 3 complete turns of the fiber wrapped around the mandrel.

C.4.4 Epoxy type and cure schedule. Approved epoxy meeting [MIL-PRF-24792](#) shall be used for test sample termination. Epoxies approved include those in table 4106 C-III.

TABLE 4106 C-III. Epoxy types.

Epoxy type	Approved Sources of Supply
Two-part liquid, Per MIL-PRF-24792 <u>1/</u> , <u>2/</u>	Vendors listed in the Navy Shipboard Fiber Optic Recommended Components Parts List <u>3/</u>

1/ Packaging. Two part, heat cured epoxy provided in packets of pre-measured quantity of resin and hardener separated by a divider. Other packaging that provides precise pre-mixed amounts is acceptable.

2/ Curing. Preheat oven at $120 \pm 5^\circ\text{C}$ for 20 minutes then cure the epoxy for a minimum of 10 minutes (maximum of 20 not 30 minutes) at 120°C (248°F).

3/ See C.2.2.2.

C.4.5 Polishing steps and polishing paper used (applicable to contact termini only).

C.4.5.1 Polish type. The standard polish specified in 4.1.1 shall be used for termini on multimode fiber and shall be used for termini on single mode fiber.

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C.4.5.2 Hand polish. Polishing steps with the process (including polishing paper), in accordance with 4.1.1 shall be used. The standard polish as specified in C.4.5.1 shall be used.

C.4.5.3 Machine polish. Test samples may be terminated using a machine polish for one or more of the polishing steps. Alternate tool (machine or polishing puck) is allowed for preparation of qualification test samples as long as required end face geometry is produced.

C.4.6 Connectors.

C.4.6.1 Configuration. A MIL-PRF-64266/24 qualified rectangular connector receptacle with an 4 channel (cavity) insert and a MIL-PRF-64266/23 qualified connector plug with an 4 channel (cavity) insert shall be used for MIL-PRF-29504/18, /20, /26 and /27 termini interoperability. All 4 channels of each connector mated pair are to be active optically for termini interoperability.

C.4.6.2 Candidate termini future use. Once qualified, these interoperability “standards” shall be used to determine interoperability of other MIL-PRF-29504/18, /20, /26 and /27 termini. At the discretion of DLA Land and Maritime-VTP, these interoperability standards can be used to determine interoperability of MIL-PRF-64266 connectors.

C.4.6.3 Submission. No connector submission is required for a termini only qualification.

C.4.6.4 Insert cavity population. Interoperability testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

C.4.6.5 Fiber type. Each connector mated pair shall contain only one fiber type.

C.4.6.6 Instrument end connectors. ST connectors with a domed PC polish shall be provided.

C.4.7 Fabrication of termini.

C.4.7.1 Single mode. Termini on cable assemblies (terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4106 C-IV. One connector mated pair (1 fully populated, MIL-PRF-64266/23 connector plug and MIL-PRF-64266/24 connector receptacle without backshells) shall contain a total of 4 pin termini-to-ST connector jumpers and 4 socket termini-to-ST connector jumpers. One connector mated pair shall be provided for each fiber type and for the contact and lens termini types being qualified. This connector mated pair configuration is for MIL-PRF-29504/18, /20, /26 and /27 termini only interoperability.

TABLE 4106 C-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	125.5 +1/-0 microns/1310 nm <u>3/</u>
Fiber size	9/125 micron <u>1/</u>
Cable type	Tight buffer per C.4.2.
Cable length	2 meters <u>2/</u>
Epoxy type	Two part, heat cured, liquid type per C.4.4.
Test sample quantity	4 pin termini and 4 socket termini cable assemblies per table 4106 C-II.
Additional quantity submission	32 pin termini and 32 socket termini cable assemblies per note 4/ in table 4106 C-II.
Tests performed	Interoperability of counterpart termini

1/ 9.3/125 micron at 1310 nm for the MIL-PRF-49291/7 optical fiber.

2/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

3/ Ferrule hole diameter applicable for contact termini type.

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C.4.7.2 Multimode. Termini on cable assemblies (terminus-to-ST connector jumpers) with multimode 62.5/125 micron cable shall conform to table 4106 C-V. One connector mated pair (1 fully populated, MIL-PRF-64266/23 connector plug and MIL-PRF-64266/24 connector receptacle without backshells) shall contain a total of 4 pin terminus-to-ST connector jumpers and 4 socket terminus-to-ST connector jumpers. One connector mated pair shall be provided for each fiber type and for the contact and lens terminus types being qualified. This connector mated pair configuration is for MIL-PRF-29504/18, /20, /26 and /27 terminus interoperability.

TABLE 4106 C-V. Fabrication for 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter/wavelength	126 +1/-0 um/1300 nm <u>2/</u>
Fiber size	62.5/125 micron
Cable type	Tight buffer per C.4.2 .
Cable length	2 meters <u>1/</u>
Epoxy type	Two part, heat cured, liquid type per C.4.4 .
Test sample quantity	4 pin terminus and 4 socket terminus cable assemblies per table 4106 C-II.
Additional quantity submission	32 pin terminus and 32 socket terminus cable assemblies per note <u>4/</u> in table 4106 C-II.
Tests performed	Interoperability of counterpart terminus

1/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.

2/ Ferrule hole diameter applicable for contact terminus type.

C.5 Insert-to-terminus compatibility.

C.5.1 Terminus retention force. Un-terminated pin and socket terminus shall be inserted into a previously qualified connector(s) using a terminus insertion tool. An axial compressive load shall be applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. A pre-load not greater than 13.3 N (3 lbs.) may be used to seat the terminus for the initial measurement. Axial loads shall be applied at a rate of 4.4 N/s (1.0 lb/s) up to a maximum load 98 N (22.0 lbs.). The maximum load shall be maintained for at least 5 seconds. Minimum number of terminus tested shall be the quantity listed for insert-to-terminus compatibility in table 4106 C-II.

C.5.2 Terminus insertion and removal forces. Perform in accordance with 4.9.11 in [MIL-PRF-29504](#).

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APPENDIX D

COMBINED TERMINI AND CONNECTOR QUALIFICATION TEST SEQUENCE

D.1 Purpose. This appendix addresses a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with the MIL-PRF-64266/23 and /24 rectangular qualification.

D.2 Implementation for a combined qualification test. A combined qualification testing sequence for both the combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/23 and /24 rectangular qualification and performed for temperature range 1, temperature range 2, or both temperature ranges is listed in table 4106 D-1. This same testing sequence is used for a MIL-PRF-29504/18, /20, /26 and /27 termini only qualification.

TABLE 4106 D-1. Combined termini and rectangular connector test sequence.

Temperature range: test performed <u>1/</u> , <u>2/</u>	Temperature range 1 <u>3/</u>		Temperature range 2 <u>3/</u>	
	SM	MM	SM	MM
Tests for components only (un-terminated termini, rectangular connector)				
Group 1 <u>4/</u>				
Size <u>5/</u>	X	X	X	X
Weight <u>5/</u>	X		X	
Identification markings <u>5/</u>	X		X	
Workmanship <u>5/</u>	X		X	
Circular runout <u>5/</u>	X	X	X	X
Beam interface parameters <u>18/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Group 2 <u>5/</u> , <u>6/</u> , <u>7/</u>				
Terminus insertion & removal forces	X		X	
Terminus retention <u>5/</u>	X		X	
Maintenance aging	X		X	
Terminus cleaning	X <u>24/</u> , <u>25/</u>		X <u>24/</u> , <u>25/</u>	
Lens scratches and defects	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Lens abrasion resistance	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Group 3 (polymeric materials)				
Ozone	X		X	
Fungus resistance	X		X	
Group 4				
Modified SO ₂ /salt spray			X	
Group 1 tests for termini as part of a single fiber cable (termini mated pair, connector used to mate) /Group 2 and 3 tests for both rectangular connector components and inserted termini mated pair				
Group 1 <u>14/</u> , <u>19/</u>				
Attenuation	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Polarization dependent loss	X <u>24/</u>		X <u>24/</u>	
Bandwidth		X <u>24/</u>		X <u>24/</u>
Twist	<u>21/</u>		<u>21/</u>	
Terminus cleaning	<u>21/</u>		<u>21/</u>	
Fiber-to-splice pull out force <u>8/</u>	<u>21/</u>		<u>21/</u>	
Group 2 (16 termini mated pair – each pull out test) <u>6/</u>				
Insertion loss (16 cable PO & 16 Fiber PO termini mated pair)	<u>22/</u>		<u>22/</u>	
Fiber pull out force <u>8/</u>	X			

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TABLE 4106 D-I. Combined termini and rectangular connector test sequence – Continued.

Temperature range: test performed <u>1/</u> , <u>2/</u>	Temperature range 1 <u>3/</u>		Temperature range 2 <u>3/</u>	
	SM	MM	SM	MM
Cable pull out force <u>8/</u>	X		X	
Twist <u>17/</u>	X <u>23/</u>		X <u>23/</u>	
Fiber to-terminus pull out force <u>8/</u>	<u>21/</u>		<u>21/</u>	
Group 3 (16 termini mated pair from cable pull out force)				
Salt spray <u>20/</u>			X	
Fluid immersion <u>20/</u>			X	
Terminus cleaning	X <u>24/</u>		X <u>24/</u>	
Radiation <u>15/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>	X <u>24/</u>
Tests for termini as an integral part of a multiple termini connector /tests for connector tested as a connector mated pair				
Group 1 (8 connector mated pair, <u>16/</u>)				
Interoperability <u>9/</u>	X	X	X	X
Optical tests				
Insertion loss	X	X	X	X
Return loss	X		X	
Bit error rate			X	X
Group 2 (4 connector mated pair, <u>16/</u>)				
Mating durability	X		X	
Terminus cleaning	X		X	
Return loss <u>10/</u>	X		X	
Group 3 <u>16/</u>				
Mechanical tests <u>11/</u>				
Vibration <u>12/</u>	X		X	X
Shock, <u>MIL-DTL-901 12/</u>	X	X	X	X
Environmental (4 connector mated pair) <u>11/</u>				
Thermal shock	X		X	X
Temperature humidity cycling	X			
Temperature cycling	X		X	
Altitude immersion			X	
Temperature life	X		X	
Flammability <u>11/</u>	X			
Insertion loss verification <u>13/</u>	X		X	X
Return loss <u>13/</u>	X		X	

- 1/ Qualification consist of performing tests in this table for temperature range 1, for temperature range 2 or for both temperature range 1 (TR1) and temperature range 2 (TR2). There is no separate qualification for only one fiber size (SM or MM).
- 2/ "X" indicates test applies when performing a terminus qualification. This test sequence is also a combined provision for performing a terminus qualification along with a MIL-PRF-64266 rectangular connector qualification.
- 3/ Assumes same terminus material and physical configuration as used in the other temperature range.

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TABLE 4106 D-I. Combined termini and rectangular test sequence - Continued.

- 4/ Sample size. Sample size, test sample configuration and test sample fabrication shall conform to MIL-STD-1678-4 Requirement 4106.
- a. Unterminated termini. One test sample is a terminus that has not been terminated (fabricated) onto the end of a fiber optic cable or optical fiber.
- b. Termini as part of a single fiber cable. One termini mated pair = one pin terminus and one socket terminus (i.e., two pin termini for this configuration).
- c. Termini as part of a multiple termini connector. One connector mated pair = A multiple fiber cable assembly with a mated MIL-PRF-64266 connector plug and connector receptacle fully populated with MIL-PRF-29504 lens termini.
- 5/ These inspections are to be performed by the manufacturer at the production facility. Exception may be taken for weight, circular run out, terminus retention, terminus insertion and removal forces and maintenance aging.
- 6/ Test fixture for this test is to include fiber optic MIL-PRF-64266 connectors; either plug or receptacle for retaining the termini during testing.
- 7/ Test performed using connector in which the ASR is not inserted.
- 8/ Each terminus is to be terminated on one end of a single fiber cable. Cable used is to have provisions compatible with termini strain relief, as applicable. Termini, selected from the group that underwent inspections for un-terminated termini, shall be used. A minimum sample size of 16 pin termini and 16 of the applicable counterpart socket termini (i.e., 32 pin termini for this configuration), selected from the group that underwent inspections for un-terminated termini, shall be used for each of these tests.
- Fiber pullout. Separate test samples of the termini must be prepared on single fiber cable without any strain relief. The change in optical transmittance shall be met after the test.
- Cable pullout. Separate test samples of the termini must be prepared on single fiber cable with strain relief (aramid yarn on cable affixed to terminus via the crimp sleeve). The change in optical transmittance shall be met after the test.
- 9/ Interoperability. This testing is done by DLA Land and Maritime-VTP which maintains/retains the interoperability standards. Please note that separate test samples are required for interoperability testing. These test samples will then be retained by DLA Land and Maritime as interoperability standards. Interoperability needs to be performed for one temperature range, not both when the constraints specified under note 3/ are met.
- 10/ Return loss after the mating durability. The relaxation given for PC polished termini to re-polish and redo the test is not allowed for the lens termini.
- 11/ Mechanical tests. Use the same test samples from Group 2 for Group 3 Mechanical test. Separate test samples are used for Group 3 Environmental tests. For Flammability, the test samples from the Group 2 and 3 Mechanical tests may be used in lieu of the test samples from the Group 3 Environmental tests.
- 12/ Shock and vibration. Two connector mated pair must be tested. At least four termini mated pair in each connector mated pair are to be monitored for optical signal discontinuity. Any other termini mated pair not monitored for optical signal discontinuity is to be monitored for change in optical transmittance.
- 13/ Per MIL-PRF-64266, an insertion loss verification and a return loss test are required after the conclusion of the mechanical tests and after the environmental tests. If both the mechanical tests and the environmental tests are done on the same connector mated pair, then one insertion loss verification and one return loss test are performed after the conclusion of the mechanical and environmental tests. Each insertion loss verification shall be performed in both directions.
- 14/ Wavelength integrity. For the optical beam characteristics inspections, perform at both 850 and 1310 for test samples with the multimode fiber size nm wavelength and at both 1310 and 1550 nm wavelength for test samples with the single mode fiber size.
- 15/ Separate test samples shall be prepared in accordance with MIL-STD-1678-4 Requirement 4105. For each temperature range, wavelength and fiber size; three single mode and three multimode test samples shall be prepared.
- 16/ For single mode mated pair, 4 connector mated pair shall be used for Group 1. From these 4 connector mated pair, each 2 connector mated pair shall be tested as specified in note 11. For multimode connector mated pair, either the same scheme may be used or the same 2 connector mated pair may be used for Groups 1, 2 and 3.
- 17/ Test samples from the cable pullout test shall be used.

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APPENDIX D

TABLE 4106 D-I. Combined termini and rectangular test sequence - Continued

- 18/ Certifications are required for the lens to show beam interface parameters are met.
- 19/ Termini selected from the group that underwent inspections for un-terminated termini shall be used for each of these tests. These termini test samples shall be prepared as specified in note 8/ for the cable pullout test. Four termini mated pair shall be used for the test samples that undergo the Group 1 tests. For each temperature range, wavelength and fiber size, this test sample quantity applies.
- 20/ Lens termini selected from the group that underwent inspections for un-terminated termini shall be used for each of these tests. These termini test samples shall be prepared as specified in note 8/ for the cable pullout test. Eight termini mated pair shall be used for the salt spray test. Sixteen termini mated pair shall be prepared for the fluid immersion test. Two termini mated pair shall be used as test samples for each of the eight categories of fluids. The eight termini mated pair from the salt spray test may be used as eight of the sixteen termini mated pair for the fluid immersion test. For each temperature range, wavelength and fiber size, these test sample quantities apply.
- 21/ This test is applicable only to MIL-PRF-29504/27. When qualifying with other termini (MIL-PRF-29504/18, /20, /26 or any combination of these termini), then reduced sample set is allowed for Group 1.
- 22/ This test is applicable only to MIL-PRF-29504/26.
- 23/ This test is not applicable to MIL-PRF-29504/27 in Group 2.
- 24/ This test is applicable only to MIL-PRF-29504/26 and /27.
- 25/ Test portion to clean for marking durability is applicable.

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APPENDIX E

TERMINI TYPES POSITIONING IN CONNECTOR INSERT CAVITIES

E.1 Purpose. This appendix addresses the circumstance when qualification is being performed for a combined MIL-PRF-29504/18, /20, /26 and /27 termini qualification along with a MIL-PRF-64266/23 and /24 rectangular qualification. Specifically addressed is populating the cavity positions with MIL-PRF-29504/18 termini (domed end face with PC polish), MIL-PRF-29504/20 termini (domed end face with a PC polish), MIL-PRF-29504/20 termini (domed end face with an APC polish), MIL-PRF-29504/26 lens termini and MIL-PRF-29504/27 lens termini. The connector number with cavity position to populate each type terminus is provided.

E.2 Implementation for termini positioning. The connector insert cavity positions in which termini must be populated (inserted) shall conform to [E.2.1](#) and [E.2.2](#) for qualification except interoperability and to [E.2.3](#) for Interoperability.

E.2.1 Qualification of test samples with single mode fiber. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in table 4106 E-1 and table 4106 E-2 for termini terminated on single mode fiber. No substitution of dummy termini shall be made for any termini that are not active. The position of termini for other termini test variations is further clarified in [E.3](#). No substitution of dummy termini shall be made for any termini in table 4106 E-1 or table 4106 E-2 that are not being qualified (see [E.3](#)).

E.2.2 Qualification of test samples with multimode fiber. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in table 4106 E-3 and table 4106 E-4 for termini terminated on multimode fiber. No substitution of dummy termini shall be made for any termini in table 4106 E-3 or table 4106 E-4 that are not being qualified (see [E.3](#)). For qualification test samples built with MIL-PRF-29504/20 termini on multimode fiber, termini end face shall only be PC polished.

E.2.3 Interoperability. Termini shall be fully populated in the connector as specified in appendix C. MIL-PRF-29504/20 termini shall be terminated with a PC polish. All termini in the connector shall be active.

Table 4106 E-1. Contact termini and polish types for each connector mated pair, single mode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
2	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC
3	M29504/18	M29504/20 PC	M29504/20 APC	M29504/18
4	M29504/20 PC	M29504/20 APC	M29504/20 PC	M29504/20 APC

Table 4106 E-2. Lens termini and polish types for each connector mated pair, single mode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/26	M29504/27	M29504/26	M29504/27
2	M29504/27	M29504/26	M29504/27	M29504/26
3	M29504/26	M29504/27	M29504/26	M29504/27
4	M29504/27	M29504/26	M29504/27	M29504/26

Table 4106 E-3. Contact termini and polish types for each connector mated pair, multimode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/18	M29504/20 PC	M29504/20 PC	M29504/18
2	M29504/20 PC	M29504/18	M29504/18	M29504/20 PC

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APPENDIX E

Table 4106 E-4. Lens termini and polish types for each connector mated pair, multimode fiber.

Connector Number	Termini insert cavity position within connector			
	1	2	3	4
1	M29504/26	M29504/27	M29504/26	M29504/27
2	M29504/27	M29504/26	M29504/27	M29504/26

E.3 LIMITED QUALIFICATIONS.

E.3.1.1 Usage. This appendix pertains to qualification of one or more types of termini, i.e., contact (non-lens) and lens termini. Anywhere from one to all four termini types may be qualified at one time. Table 4106 E-1 through table 4106 E-4 address all four types being qualified. Eight connector mated pair are used for qualification as part of a multiple termini connector regardless of whether one, two, three or all four of MIL-PRF-29504/18, /20, /26 and /27 termini are being qualified.

E.3.1.1.1 MIL-PRF-29504/18 and /20 qualification only. For a MIL-PRF-29504/18 and /20 only qualification, connector numbers 1 through 4 shall be populated as listed in table 4106 E-1 and table 4106 E-3.

E.3.1.1.2 MIL-PRF-29504/26 and /27 qualification only. For a MIL-PRF-29504/26 and /27 only qualification, connector numbers 1 through 4 would be populated as listed in table 4106 E-2 and table 4106 E-4.

E.3.1.1.3 MIL-PRF-29504/20 qualification only. For a MIL-PRF-29504/20 only qualification, connector numbers 1 through 4 would be populated the same for single mode except connector numbers 1 and 3 cavity position number 1 is populated with a MIL-PRF-29504/20 APC terminus and cavity position 4 populated with a MIL-PRF-29504/20 PC terminus. For connectors with multimode fiber, all cavity positions are populated with MIL-PRF-29504/20 PC termini.

FIBER AND CABLE REQUIREMENTS

4201

REQUIREMENT 4201

FIBER OPTIC TEST SAMPLE CONFIGURATIONS, FABRICATION, AND SPECIFIC METHODS/PRACTICES
FOR MIL-PRF-49291 OPTICAL FIBER

1. PURPOSE

1.1 Purpose. This requirement standardizes configurations, fabrication, and specific methods/practices for the components to be used in the assembly (fabrication) of fiber optic the test sample (DUT assembly) for the MIL-PRF-49291 optical fiber. The DUT assemblies are intended to be used as part of qualification testing, but can be used in developmental, prototype, production, rework, and modification programs on military platform fiber optic cable assemblies. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified for DUT assembly configurations, fabrication, and specific methods/practices.

1.2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice 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 practice, whether or not they are listed.

2.2 Government documents.

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

DEPARTMENT OF DEFENSE SPECIFICATION

[MIL-PRF-49291](#) - Fiber, Optical, (Metric), General Specification for.

(Copies of this document are available online at <https://quicksearch.dla.mil> or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

3. DEFINITIONS

3.1 Cable, fiber optic. A fiber optic cable is a cable that contains optical fibers. The cable may be of a tight buffer or a loose tube design.

3.2 Cable bundle, fiber optic. Single fiber cables grouped together and secured by lacing tape. The cable bundle can be placed in convoluted tubing, used in various protected harness configurations or used as is in an open cable harness configuration.

3.3 Cable, loose tube. A fiber optic cable design is one configured with one or more optical fibers are fitted loosely within a tube, giving the optical fibers freedom to move. This mobility and isolation from the tube minimizes the effects of external forces on the performance of the link. The isolation allows cable expansion and contraction with temperature independent of the optical fibers.

3.4 Cable, tight buffer. A fiber optic cable design is one configured with an additional protective coding (additional buffer layer) is applied directly over a coated (buffered) fiber. Buffer material helps preserve the fiber's inherent strength and provides increased mechanical protection. A tight buffer cable allows cable placement in tighter bends, more roughed handling (such as better crush and impact resistance).

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3.5 Cabling, fiber optic. Fiber optic cabling is a term used to include single fiber cable, multiple fiber cable, fiber optic cable bundles and fiber optic cable harnesses. The (optical) fiber is the optical conduit or waveguide transmission media, whereas metallic conductor (wire) is used in an electrical cable. Cable structure is added to make the fibers easier to handle and maintain. The fiber is a thin piece of glass (with a diameter usually around 125 micrometers) that contains and transports the light signals.

3.6 Connector, fiber optic. A device that permits repeated mating and couples the optical power between two optical fibers or two groups of optical fibers. A fiber optic connector must maintain fiber alignment without significant loss of optical power.

3.7 Optical fiber. An optical fiber is a thin cylindrical dielectric (non-conductive) waveguide used to send light energy for communication. Optical fibers consist of three parts: The core, the cladding, and the coating or buffer. The choice of optical fiber materials and fiber design depends on operating conditions and intended application.

3.8 Optical fiber, multimode. A multimode optical fiber is one that supports the propagation of more than one bound mode (electromagnetic wave).

3.9 Optical fiber, single mode. A small core optical fiber where one bounded electromagnetic wave of light will propagate at the wavelength of interest.

3.10 Termination. The process performed for placing a connector, terminus, splice, or other device at the end of an optical waveguide. This placement optically minimizes leakage/losses and reflection. Terminations are used to join or connect two adjacent optical waveguide ends or to terminate the fiber at either a source (electrical to optical conversion) or receiver (optical to electrical conversion) where the light leaves the optical waveguide and continues in a non-waveguide mode of propagation.

3.11 Wire. "A usually pliable metallic strand or rod made in many lengths and diameters, sometimes clad and often electrically insulated, used chiefly for structural support or to conduct electricity." Source: American Heritage Dictionary, College Edition.

4. Configurations. In the context of Requirement 4201, the component being tested (device under test or DUT) is the MIL-PRF-49291 optical fiber. The test sample or DUT assembly is the DUT in the configuration of the optical fiber that remains on the spool, the various different lengths of optical fiber cut from each spool, or both. Point in the test sequence that the DUT assembly lengths of optical fiber are cut from the spool is addressed in 4.1. Point in the test sequence that the DUT assemblies of optical fiber remaining on the spool are placed in loose coils is addressed in 4.2.

4.1 Cut lengths from spools. Prior to the start of testing for Group 1, cut specified quantities and lengths of optical fiber from each spool (see 5.1). For environmental testing, it is recommended to place these lengths in pans so that each grouping of test samples (cut lengths) can be removed quickly from the environmental chamber at the specified time. Record lengths cut from the spool so that length of optical fiber remaining on the spool is known.

4.2 Place optical fiber on spools into loose coils. Prior to the start of testing for Group 3, remove the optical fiber from the spools and place them in loose coils. None of the loose coils shall exceed the minimum long term bend diameter of the optical fiber. Recommendation is to place loose coils into pans (see 6.2.1).

4.3 Pans used for environmental testing. Pans used shall be light weight, be sufficiently large so as not to exceed the minimum long term bend diameter of the optical fiber and not retain heat (see 6.2.1). The floors of the pans shall contain drainage holes to allow any condensation drainage from the pans. Pans shall be sufficiently small as to allow pans to be "staggered" or partially covered so that no condensation from higher elevation pans run into those lower in the environmental chamber.

5. Implementation. Test samples (DUT assemblies) shall be prepared for "Qualification" as specified in 5.1. DUT assemblies for optical fiber qualification shall consist of optical fiber on spools (or for the environmental testing in loose coils) and cut lengths of optical fiber.

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5.1 Optical fiber lengths cut from spool. Sample lengths are to be prepared (cut) before Group 1. Place cut lengths in pans recommended if undergoing environmental testing (see 6.2.2). For each test listed below, the quantity and length for each test are specified.

- a. Mechanical strippability. Each spool, 2 samples, 3 foot long.
- b. Mechanical strippability-post temperature-humidity. Each spool, 2 samples, 3 foot long.
- c. Mechanical strippability-post life aging. Each spool, 2 samples, 3 foot long.
- d. Dynamic tensile strength. Each spool, 30 samples, 6.5 foot long (no humidity).
- e. Nuclear radiation resistance. Each spool, 1 sample, 200 meters long on spool.
- f. Fungus resistance. Each spool, 1 sample, 1 foot long.

6. NOTES

6.1 Intent behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Intent behind configurations.

6.2.1 Placement of loose coils and cut lengths in pans for environmental testing. Recommendation is made to place the loose coils in pans for testing. Except for ends of fiber, the loose coil is not disturbed after coiling. This eases handling and transport. Cut lengths may be placed in different pans for easy removal at various test times, or segregated in groups in the same pan. One type pan that is lightweight, retained little heat and exceeds bend diameter requirements is a large, aluminum foil type turkey pan.

6.2.2 Placement of fiber optic connectors onto fiber ends. For loose coils of cable undergoing environmental testing, termination of optical fiber ends with instrument port compatible connectors is recommended. Other means of connection or joining; including use of bare fiber adapters, mechanically only crimped connectors, mechanical splices, and fusion splices; were found to be added sources of error for a variety of reasons. Total cost for troubleshooting outweighed time and expense for connector termination.

CONCLUDING MATERIAL

Custodians:
Army - CR
Navy - SH
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 60GP-2019-003)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at <https://assist.dla.mil/>.