METRIC

MIL-STD-1678-4B
31 July 2014
SUPERSEDING
MIL-STD-1678-4A
15 January 2014

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

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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, constrains 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 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 and MIL-STD-2042 in lieu of Part 1 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.

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, cable harness configurations. This part of the Standard Practice addresses component part and support equipment standardization requirements for platforms that use cable harnesses as the means to 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 (a copy may be found at web site: https://fiberoptics.nswc.navy.mil) in lieu of part 6 of this Standard Practice. Likewise, larger platforms that route truck 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, or both, as appropriate.

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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 http://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 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 Government General Series Technical Manual can be obtained at website: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), then select the "JFOWG" folder followed by the "Maintenance Documents.)

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

TIA440 - 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 configuration
Test sample fabrication requirements
Fiber optic cabling

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

4101 - 4104

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 http://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 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 Government General Series Technical Manual can be obtained at website: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), then select the "JFOWG" folder followed by the "Maintenance Documents.)

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.

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

Terminus ferrule material and fiber size	Ceramic ferrule			Metal ferrule	
Test performed 12/	SM fiber5/	MM fiber 5/	MM 100/140 after MM 6/	MM 100/140	MM Fiber
Tests for unterminated termini					
Group 1 3/					
Size 1/	X	X	X	X	X
Weight 1/	X	X		X	
Identification markings 1/	X	X		X	
Workmanship 1/	X	X		X	
Circular runout 1/	X	X		X	
Group 2 2/					
Terminus retention 1/	X	X		X	
Terminus engagement & separation forces 1/, 13/	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 4/	X	X		X	
Group 3					
Salt spray	X	X		X	
Tests for termini as an integral part of a multiple termini connector					
Group 1					
Interoperability 7/					
Optical tests					
Insertion loss (initial)	X	X	X	X	X
Return loss	X				
Group 2					
Mating durability	X	X		X	
Terminus cleaning	X	X		X	
Return loss 10/	X				
Mechanical tests 8/					
Shock, MIL-S-901 9/	X	X		X	
Shock, half-sine pulse 9/	X	X		X	
Vibration, swept sine 9/	X	X		X	
Vibration, random at temperature 9/	X	X		X	
Vibration, random at ambient 9/	X	X		X	
Insertion loss (verification)	X	X		X	
Return loss	X				
Group 3					
Environmental tests 8/					
Thermal shock	X	X		X	
Temperature life	X	X		X	
Insertion loss (verification) 11/	X	X		X	
Return loss 11/	X				

NOTES:
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.

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-TEB 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. 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).
12/ Test sequence listed is performed for each different cable strain relief (Styles 1, 2 and 3) and ferrule material (ceramic, metal) allowed under the specification sheet.
13/ Perform on socket terminus only.

NOTES

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 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).

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 6.3.3.

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 Objectives for optical performance. There was a historical, consensus obtained for optical performance. Parties involved in revision to MIL-PRF-29504/4C & /5C agreed to place/retain “conservative” optical performance requirements in MIL-PRF-29504/4 & /5 termini specification sheets. Once qualification (QPL – Qualified Products List) and/or re-qualification testing is complete, the Government could evaluate test data and determine the extent that optical performance parameters can be tightened/revised. Objectives for optical insertion loss and for optical return loss are provided in tables 4101 – II and 4101 – III, respectively.

TABLE 4101 – II. Objective for optical insertion loss performance. 1/

Fiber size (μm)	Initial insertion loss (dB)	Insertion loss verification (dB) 2/	Ferrule material
Single mode < 9/125 3/	1.0	1.75	Ceramic
Single mode 9/125	0.75	1.25	Ceramic
50/125	0.75	1.75	Ceramic
62.5/125	0.75	1.75	Ceramic
62.5/125/polyimide	1.0	1.75	Ceramic
100/140	0.75	1.75	Ceramic
100/140/polyimide	1.0	1.75	Ceramic
> 100/140	1.0	1.75	Ceramic
50/125	0.75	1.75	Metal
62.5/125	0.75	1.75	Metal
62.5/125/polyimide	1.0	2.0	Metal
100/140	0.75	1.75	Metal
100/140/polyimide	1.0	2.0	Metal
200/230	1.0	2.0	Metal

1/ Optical loss performance based on use of specified fabrication procedure.
2/ Insertion loss verification is an insertion loss performed after a series of environmental tests or mechanical tests.
3/ Performance may be different for various single mode core sizes. Requirement shown is for 5.1/125 μm fiber.

TABLE 4101 - III. Objective for optical return loss performance.

Return loss - Single mode	≥ + 40.0 dB
Return Loss – Multimode (informational)	≥ + 20.0 dB

6.3.3 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.

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 http://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.

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 can be obtained at web site: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), then select the "JFOWG" folder followed by the "Maintenance Documents" folder.)

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

TIA455 - 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 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		
Unterminated termini tests		
	80	80
Group 1	80 of 80	80 of 80
Group 2 (16 pair minimum)	16 of 80	16 of 80
Group 3 (polymeric materials only)	None	None
Termini as part of a single fiber cable tests 2/		
	16 of 80	16 of 80
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		
	48 of 80	48 of 80
Group 1 (6 connector mated pair)	48 of 48	48 of 48
Group 2 Mating durability (2 connector mated pair)	16 of 48	16 of 48
Group 3 Mechanical (2 connector mated pair) 4/	16 of 48	16 of 48
Group 3 Environmental (2 connector mated pair) 4/	16 of 48	16 of 48
Interoperability 5/		
	53	53

1/ See A.3.1 and A.3.2 and notes with table 4101-I for further detail.
2/ Termini-to-ST jumpers.
3/ 16 termini from the termini designated for Group 2.
4/ Option of using separate test samples from Group 2 for Mechanical test. Otherwise, quantity is 32 (not 48) for continuing with those from Group 2 Mating durability to Group 2, Mechanical. Separate test samples are used for Group 3 environmental tests.
5/ Configuration and fabrication requirements for interoperability samples are found in appendix B.

A.3.1 Quantity. Minimum of 80 pin termini and 80 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 80 pin termini and 80 socket termini for remaining testing is as follows:

A.3.2.1 Termini as part of a single fiber cable.

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

b. Group 3 salt spray: use test samples from Group 2 cable pullout.

A.3.2.2 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 and mechanical tests: 2 mated pair (16 pin termini and 16 socket termini).

NOTE: Alternate allowance is using 4 mated pair versus the 2 mated pair as follows:

Group 1 Optical (insertion loss & return loss) then group 2 mating durability: 2 mated pair (16 pin termini and 16 socket termini).

Group 1 Optical (insertion loss & return loss) then group 2 mechanical tests: 2 mated pair (16 pin termini and 16 socket termini).
The alternate allowance is used for the termini allocation in table 4101 A-I.

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 for Style 1 termini, epoxy inside the terminus barrel (body) for Style 2 termini, and a crimp sleeve for Style 3 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

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 1/	OFS Fitel	0MZN3	C10027	BC06815
100/140/172 1/	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 1/	64201	353ND-2g	2/
	08RC6	3700-5520	2/
Solid	06324	3/	4/
	71468		4/

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 ± 5°C for 20 minutes then cure at 225 ± 5°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-64266/12, MIL-PRF-64266/13 or MIL-PRF-64266/14 or a MIL-PRF-64266/19, MIL-PRF-64266/20 or MIL-PRF-64266/21 backshell is preferred.

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.

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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. (Only if not doing Single mode 5) 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	126 +1/-0 µm
Fiber size	9/125 micron 1/
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 µm with 1 micron maximum circular run out
Fiber size	50/ 125 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	4 mated pair per A.5.1 through A.5.6.
Tests performed	Full test sequence (see table 4101 A-I).

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). 1/
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.

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.

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

Parameter	Requirement
Ferrule hole diameter	157 +3/-0 µm
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).	

REQUIREMENT 4101
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 - TEB 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 http://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 can be obtained at web site: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), then select the "JFOWG" folder followed by the "Maintenance Documents" folder.)

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

TIA455.34 - 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-TEB Passive Test Section. Point of contact: DLA Land and Maritime-VQP will provide current DLA Land and Maritime-TEB point of contact.

Shipping address:
DLA Land and Maritime
3990 East Broad St.
Bldg 11, Section 7, TEB
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)	16 of 31	16 of 31
Insertion loss, additional (for larger shell sizes) 4/	21 of 53	21 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: 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 25, an additional, terminated 21 pin termini and an additional, terminated 21 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 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. 16 pin termini and 16 socket termini.
ii. Insertion loss, additional. 21 pin termini and 21 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.3.4.2 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 TIA455.34. 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. A copy of this document can be obtained at Web Site: https://fiberoptics.nswc.navy.mil/ in the Recommended Parts List section under Recommended Parts List.

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).

REQUIREMENT 4101

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.

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.

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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-TEB, 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. Two mated pair (2 fully populated, MIL-DTL-38999, Series III, shell size 17, 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 4101 B-III. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
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	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 2/
1/ 9.3/125 micron at 1310 nm. 2/ Interoperability test sample s shall be as fabricated with 9/125 micron fiber whether qualifying single mode with 5/125 micron fiber (where obtain qualification by similarity for other single mode sizes) or if qualifying only single mode 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 on cable assemblies (terminus-to-ST connector jumpers) with multimode 62.5/125 micron cable shall conform to table 4101 B-IV. Two mated pair (2 fully populated, MIL-DTL-38999, series III, shell size 17, 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 4101 B-IV. Fabrication for 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
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.4.4.1.
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.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. Two mated pair (2 fully populated, MIL-DTL-38999, series III, shell size 17, 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 4101 B-V. Fabrication for 100/140/172 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	175 +3/-0 µm
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 http://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).

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-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.

REQUIREMENT 4102

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 12/		
	M29504 /14, /15	MM after passed SM	SM after passed MM	/3 after /14 & /15 pass
Un-terminated termini tests				
Group 1 3/				
Size 1/	X	X	X	X
Weight 1/	X			X
Identification markings 1/	X	X	X	X
Workmanship 1/	X	X	X	X
Circular runout 1/	X			
Group 2 2/				
Terminus insertion & removal forces	X			
Terminus retention 1/	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 4/	X			
Cable pull out force 4/	X		X	
Group 3				
None				

See notes at end of table.

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

Test performed	Full qualification M29504/14, /15	Reduced qualification allowance 12/		
		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 8/				
Interoperability 7/	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 10/	X		X	
Group 3				
Mechanical tests				
Impact	X			
Vibration, swept sine 9/	X			
Vibration, random 9/	X			
Shock, MIL-S-901 9/	X	X	X	
Environmental tests 8/				
Thermal shock	X			
Temperature humidity cycling	X			
Temperature cycling	X		X	
Temperature life	X		X	
Flammability	X		X	
Insertion loss verification 11/	X		X	
Return loss 11/	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 (arimid 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/ None.
6/ None.
7/ Interoperability. This testing is done by DLA Land and Maritime-TEB 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.
8/ Environmental tests. See appendix A, table 4102 A-I, note 4/.
9/ 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.
10/ Return loss after mating durability. If failure occurs, ferrule end faces may be re-polished and test redone.
11/ 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).
12/ 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).

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

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 http://quicksearch.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

TIA455- 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".

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 pin 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 (arimid 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.

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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.

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	/13 or /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	Vendor	Part number	Grams per packet
Two-part liquid, Per MIL-PRF-24792 1/,2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5°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/ Under this part number, six packets are provided and each packet has the listed number of grams.

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.

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 1/
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). 2/
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) 1/
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).	

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-TEB 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 http://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

TIA455.34 - 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-TEB Passive Test Section.

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

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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.

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.
   i. Insertion loss. 16 pin termini and 16 socket termini.
   ii. Insertion loss, additional. 15 pin termini and 15 socket termini.
b. Insert-to-termini compatibility.
   i. Terminus retention force. 16 pin termini and 16 socket termini.
   ii. 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.3.4.2 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 TIA455.34. 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	Vendor	Part number	Grams per packet
Two-part liquid, Per MIL-PRF-24792 1/, 2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5 °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/ Under this part number, six packets are provided and each packet has the listed number of grams.

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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.

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-TEB, 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.

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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 1/
Cable type	Tight buffer per B.4.2.
Cable length	2 meters 2/
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.

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 meters1/
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-29504/20 TERMINUS

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-29504/20 terminus and, by extension for fiber optic multiple termini connector applications, the MIL-PRF-64266 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-29504/20 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 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 MIL-PRF-29504/18 termini. This appendix is based on the qualification of the MIL-PRF-29504/20 terminus. The MIL-PRF-64266 circular connector specification sheets allow performing qualification simultaneously for both MIL-PRF-29504/18 and MIL-PRF-29504/20 termini. Although titled for the MIL-PRF-29504/20 terminus only, this appendix addresses test sample fabrication and methods for both MIL-PRF-29504/18 and MIL-PRF-29504/20 termini. 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).

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.

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 http://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 DRAWINGS

NAVSEA Drawing 53711-7612822-	JFOWG Work Packages, M64266 Connector Accessories Assembly/Re-Entry with Split Backshells.
NAVSEA Drawing 53711-8283460-	Termini, Fiber Optic MIL-PRF-29504/18, Test Sample Configurations/Fabrication & Specific Methods /Practices.

(A copy of these drawings can be obtained at Web Site: 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.)

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 can be obtained at web site: https://jswag.navair.navy.mil. At the home page select “Document Library” (on left side), then select the “JFOWG” folder followed by the “Maintenance Documents” folder.)

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.

4. Configurations. In the context of Requirement 4103, the component being tested (device under test or DUT) is the MIL-PRF-29504/20 terminus. 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.

4.1.1 Termination, temperature range 1. The terminus termination process of the test sample fabrication shall be in accordance with appendix A of NAVSEA Drawing 53711-8283460.

4.1.2 Termination, temperature range 2. The 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.

4.2 Connector accessories assembly.

4.2.1 Connector accessories assembly, temperature range 1. The connector accessories assembly process shall be in accordance with appendix A of NAVSEA Drawing 53711-7612822.

4.2.2 Connector accessories assembly, temperature range 2. The connector accessories assembly process shall be in accordance with appendix C of NAVSEA Drawing 53711-7612822 or with Work Package 011 03 of NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, TM 1-1500-323-24-4.

4.3 Test sample configurations. Dependent upon the inspection/test performed (see table 4103-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 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 4103-I. Mated pair configurations for qualification, temperature range 1.

Components	Number of Components Required for Specified Shell Size			
Description 1/	23	15	13	11
Minimum number of mated pair, SM fiber size (9/125 micron)	3	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC,/20PC,/20APC 2/	72,72,72	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	3	1	1	1
Connector receptacle, M64266/1	3	1	1	1
Dust cover, connector plug, M64266/10	3	1	1	1
Dust cover, connector receptacle, M64266/11	3	1	1	1
Backshell, M64266/18, straight, banding	6	2	2	2
Minimum number of mated pair, SM fiber size (9/125 micron)	3	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC,/20PC,/20APC 2/	72,72,72	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	3	1	1	1
Connector receptacle, M64266/1	3	1	1	1
Dust cover, connector plug, M64266/10	3	1	1	1
Dust cover, connector receptacle, M64266/11	3	1	1	1
Backshell, M64266/18, straight, compression	6	2	2	2
Minimum number of mated pair, MM fiber size (62.5/125 micron)	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC,/20PC,/20APC 2/	24,24,24	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Dust cover, connector plug, M64266/10	1	1	1	1
Dust cover, connector receptacle, M64266/11	1	1	1	1
Backshell, M64266/18, 45 degrees, banding	1	1	1	1
Backshell, M64266/18, 90 degrees, banding	1	1	1	1
Minimum number of mated pair, MM fiber size (62.5/125 micron)	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC,/20PC,/20APC 2/	24,24,24	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Dust cover, connector plug, M64266/10	1	1	1	1
Dust cover, connector receptacle, M64266/11	1	1	1	1
Backshell, M64266/18, 45 degrees, compression	1	1	1	1
Backshell, M64266/18, 90 degrees, compression	1	1	1	1

Notes:
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 A for qualification fabrication, appendix C for interoperability fabrication, and appendix E for termini types positioning within the connector insert cavities. This table does not include mated pair configurations (component breakdowns) for interoperability.
2/ If MIL-PRF-29504/18 termini are not being qualified, then add the quantity specified for the MIL-PRF-64266/18 termini to that for the MIL-PRF-29504/20 termini with a domed end face and an APC polish.

See notes at end of table.

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

Components	Number of components required for specified shell size			
Description 1/	23	15	13	11
Minimum number of mated pair, SM fiber size (9/125 micron)	3	1	1	1
Number of insert cavities	18	10	6	2
Termini, /18PC,/20PC,/20APC 2/	36,36,36	4,8,8	4,4,4	0,2,2
Connector plug, M64266/2	3	1	1	1
Connector receptacle, M64266/1	3	1	1	1
Dust cover, connector plug, M64266/10	3	1	1	1
Dust cover, connector receptacle, M64266/11	3	1	1	1
Backshell, M64266/13, straight, banding, placed on connector plug 3/	3	1	1	1
Backshell, M64266/14, straight, placed on connector receptacle 3/	3	1	1	1
Minimum number of mated pair, SM fiber size (9/125 micron)	3	1	1	1
Number of insert cavities	36	10	6	2
Termini, /18PC,/20PC,/20APC 2/	72,72,72	4,8,8	4,4,4	0,2,2
Connector plug, M64266/2	3	1	1	1
Connector receptacle, M64266/1	3	1	1	1
Dust cover, connector plug, M64266/10	3	1	1	1
Dust cover, connector receptacle, M64266/11	3	1	1	1
Backshell, M64266/12, straight, convoluted tube, FEP, placed on connector plug 3/	3	1	1	1
Backshell, M64266/14, straight, placed on connector receptacle 3/	3	1	1	1
Minimum number of mated pair, MM fiber size (50/125 micron)	1	1	1	1
Number of insert cavities	18	10	6	2
Termini, /18PC,/20PC,/20APC 2/	12,12,12	4,8,8	4,4,4	0,2,2
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Dust cover, connector plug, M64266/10	1	1	1	1
Dust cover, connector receptacle, M64266/11	1	1	1	1
Backshell, M64266/13, 45 degrees, banding, placed on connector receptacle 3/	1	1	1	1
Backshell, M64266/13, 90 degrees, banding, placed on connector plug 3/	1	1	1	1
Minimum number of mated pair, MM fiber size (50/125 micron)	1	1	1	1
Number of insert cavities	36	10	6	2
Termini, /18PC,/20PC,/20APC 2/	24,24,24	4,8,8	4,4,4	0,2,2
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Dust cover, connector plug, M64266/10	1	1	1	1
Dust cover, connector receptacle, M64266/11	1	1	1	1
Backshell, M64266/12, 45 degrees, convoluted tube, PEEK, placed on connector receptacle 3/	1	1	1	1
Backshell, M64266/12, 90 degrees, convoluted tube, PEEK, placed on connector plug 3/	1	1	1	1
Minimum number of mated pair, for M64266/8 EMI retention nut qualification by similarity (62.5/125 micron) 4/	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC,/20PC,/20APC 2/	24,24,24	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Dust cover, connector plug, M64266/10	1	1	1	1
Dust cover, connector receptacle, M64266/11	1	1	1	1
EMI retention nut, M64266/8, on connector receptacle	1	1	1	1
Backshell, M64266/12 or /19, on connector plug	1	1	1	1
Minimum number of mated pair, for M64266/17 Dummy stowage receptacle qualification by similarity 5/	2	2	2	2
Number of insert cavities	N/A	N/A	N/A	N/A
Termini, /18PC,/20PC,/20APC 2/	N/A	N/A	N/A	N/A
Connector plug, M64266/2	2	2	2	2
Connector dummy stowage receptacle, M64266/1	2	2	2	2

See notes at end of table.

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

Notes:
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, and appendix E for termini types positioning within the connector insert cavities. This table does not include mated pair configurations (component breakdowns) for interoperability.
2/ If MIL-PRF-29504/18 termini are not being qualified, then add the quantity specified for the MIL-PRF-64266/18 termini to that for the MIL-PRF-29504/20 termini with a domed end face and an APC polish.
3/ For qualification of mated pair with split backshells versus solid backshells, use this table and substitute MIL-PRF-64266/19 for MIL-PRF-64266/12, substitute MIL-PRF-64266/20 for MIL-PRF-64266/13, and substitute MIL-PRF-64266/21 for MIL-PRF-64266/14. When qualifying both the solid backshells (MIL-PRF-64266/12 through /16) and split backshells (MIL-PRF-64266/19 through /21), a full set of mated pair as listed in this table must be prepared for both the solid and split backshells (see 4.7.5.2.2 of MIL-PRF-64266).
4/ Qualification by similarity is valid only if MIL-PRF-64266/12, /19 or both backshells are qualified (or currently undergoing qualification and meet requirements).
5/ Qualification by similarity is valid only if qualified to MIL-PRF-64266/1 wall mounted receptacle.

TABLE 4103-III. Mated pair configurations for interoperability.

Components	Number of components required for specified shell size			
Description 1/	23	15	13	11
Minimum number of mated pair, SM fiber size (9/125 micron), Connector interoperability 3/	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC, /20PC, /20APC 2/, 4/	24,24,24	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/xx	N/A	N/A	N/A	N/A
Minimum number of mated pair, MM fiber size (62.5/125 micron), Connector interoperability 3/	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC, /20PC, /20APC 2/, 4/	24,24,24	4,6,6	0,2,6	0,2,6
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/xx	N/A	N/A	N/A	N/A
Minimum number of mated pair, SM fiber size (9/125 micron), Backshell interoperability 5/, 6/, 11/	1	1	1	1
Number of insert cavities	N/A	N/A	N/A	N/A
Termini, /18PC, /20PC, /20APC 2/, 4/	N/A	N/A	N/A	N/A
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/18, straight, banding	2	2	N/A	N/A
Backshell, M64266/18, straight, compression	N/A	N/A	2	2
Minimum number of mated pair, MM fiber size (62.5/125 micron), Backshell interoperability 5/, 6/, 11/	1	1	1	1
Number of insert cavities	N/A	N/A	N/A	N/A
Termini, /18PC, /20PC, /20APC 2/, 4/	N/A	N/A	N/A	N/A
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/18, 45 degrees, banding placed on connector receptacle	1	1	N/A	N/A
Backshell, M64266/18, 90 degrees, banding placed on connector plug	1	1	N/A	N/A
Backshell, M64266/18, 45 degrees, compression placed on connector receptacle	N/A	N/A	1	1
Backshell, M64266/18, 90 degrees, compression placed on connector plug	N/A	N/A	1	1

See notes at end of table.

TABLE 4103-III. Mated pair configurations for interoperability. – Continued.

Components	Number of components required for specified shell size			
Description 1/	23	15	13	11
Minimum number of mated pair, SM fiber size (9/125 micron), Backshell interoperability 5/, 6/, 11/	1	1	1	1
Number of insert cavities	N/A	N/A	N/A	N/A
Termini, /18PC, /20PC, /20APC 2/, 4/	N/A	N/A	N/A	N/A
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/13, straight, banding, placed on connector plug 7/	1	1	N/A	N/A
Backshell, M64266/14, straight, banding, placed on connector receptacle 7/	1	1	N/A	N/A
Backshell, M64266/12, straight, convoluted tube, FEP, placed on connector plug 7/	N/A	N/A	1	1
Backshell, M64266/14, straight, placed on connector receptacle 7/	N/A	N/A	1	1
Minimum number of mated pair, MM fiber size (62.5/125 micron), Backshell interoperability 5/, 6/, 11/	1	1	1	1
Number of insert cavities	N/A	N/A	N/A	N/A
Termini, /18PC, /20PC, /20APC 2/, 4/	N/A	N/A	N/A	N/A
Connector plug, M64266/2	1	1	1	1
Connector receptacle, M64266/1	1	1	1	1
Backshell, M64266/13, 45 degrees, banding, placed on connector receptacle 7/	1	1	N/A	N/A
Backshell, M64266/14, 90 degrees, banding on connector plug 7/	1	1	N/A	N/A
Backshell, M64266/12, 45 degrees, convoluted tube, PEEK, placed on connector receptacle 7/	N/A	N/A	1	1
Backshell, M64266/12, 90 degrees, convoluted tube, PEEK, placed on connector plug 7/	N/A	N/A	1	1
Minimum number of mated pair for M64266/8 EMI retention nut qualification by similarity (62.5/125 micron) 8/, 9/	1	1	1	1
Number of insert cavities	36	8	4	4
Termini, /18PC, /20PC, /20APC 2/	12,12,12	2,3,3	0,1,3	0,1,3
Connector plug, M64266/2	N/A	N/A	N/A	N/A
Connector receptacle, M64266/1	1	1	1	1
EMI retention nut, M64266/8, on connector receptacle	1	1	1	1
Backshell, on connector plug	N/A	N/A	N/A	N/A
ASR, receptacle 10/	1	1	1	1

See notes at end of table.

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TABLE 4103-III. Mated pair configurations for interoperability – Continued.

Notes:
1/ This table contain 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 and appendix E for termini types positioning within the connector insert cavities. Requirement 4103 does not apply for backshell interoperability. For ASR interoperability, the same test samples are used as for the connector interoperability except for the ASR.
2/ If MIL-PRF-29504/18 termini are not being qualified, then add the quantity specified for the MIL-PRF-64266/18 termini to that for the MIL-PRF-29504/20 termini with a domed end face and an APC polish. This note is not applicable for backshell interoperability.
3/ Mated pair for MIL-PRF-64266 connector interoperability
4/ 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, shell-to-shell conductivity). Separate termini are required for other interoperability tests (terminus insertion and removal forces, terminus retention force). If performed for termini interoperability only, tests are performed in a MIL-PRF-64266 shell size 15 connector (see B.5.5.1). This note is not applicable for backshell interoperability.
5/ MIL-PRF-64266 backshell interoperability, components required. The components listed in this table are valid when either the backshell interoperability is performed as part of both connector and backshell qualification or when performed for backshell qualification only.
6/ MIL-PRF-64266 backshell interoperability, test sample configuration. Test samples shall consist of separately provided connector plugs, connector receptacles, and backshells. No mated pair with termini is required since insertion loss is not performed.
7/ MIL-PRF-64266 backshell interoperability, temperature range 2. For qualification of split backshells versus solid backshells, use this table and substitute MIL-PRF-64266/19 for MIL-PRF-64266/12, substitute MIL-PRF-64266/20 for MIL-PRF-64266/13, and substitute MIL-PRF-64266/21 for MIL-PRF-64266/14. When qualifying both the solid backshells (MIL-PRF-64266/12 through /16) and split backshells (MIL-PRF-64266/19 through /21), a full set of mated pair as listed in this table must be prepared for both the solid and split backshells (see 4.7.5.2.2 of MIL-PRF-64266).
8/ MIL-PRF-64266/8 EMI retention nut, test samples. Backshell interoperability shall be performed (and test sample fabricated) for an EMI retention nut placed on a connector receptacle with fully populated termini. For connector plug without backshell test samples, use the mated pair for connector interoperability.
9/ MIL-PRF-64266/8 EMI retention nut, qualification by similarity. Qualification by similarity is valid only if MIL-PRF-64266/12, /19 or both backshells are qualified (or currently undergoing qualification and meet requirements).
10/ ASR interoperability. Alignment Sleeve Retainer (ASR) type used for ASR interoperability (when testing with specified MIL-PRF-64266 connector, see table XVI of MIL-PRF-64266).
11/ The description provided is consistent with that for the connector interoperability. The description for backshell interoperability would be more accurate if the different cable entry angles were addressed instead.

5. Implementation. Termini shall be qualified in circular connectors. 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 or MIL-PRF-29504 /20) and ferrule end face polish (PC or APC polish) placed in each cavity position shall conform to 5.4 and 5.5. Rectangular connector test samples (DUT assemblies) shall be prepared for both “Qualification, except interoperability” and for “Interoperability” as specified in 5.6 and 5.7. 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.

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-29504/20 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 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-29504/20 for "Tests for unterminated termini" and "Tests for termini as part of a single fiber cable". There is no separate qualification for only one temperature range or fiber size. 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 Appendices A through C only address a separate MIL-PRF-29504/20 termini qualification and not one for both connectors and termini.

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 C. For reference, a consolidation of mated pair configurations required for 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 15 connectors. The insert arrangement (i.e., number of cavities in insert) for each temperature range shall conform to appendix D. When tested only for conformance to MIL-PRF-64266 or both MIL-PRF-29504 and MIL-PRF-64266, qualification except interoperability inspections shall be performed with shell size 15 connectors and with any other shell size being qualified. The insert arrangement for each shell size and for each temperature range 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 MIL-PRF-29504/18 termini. Appendix E is based on performing qualification simultaneously for both MIL-PRF-29504/18 and /20 termini. If only MIL-PRF-29504/20 termini are qualified, 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.

5.6 Rectangular connector 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 F.

5.7 Rectangular connector 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 G.

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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 H.

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 I.

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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REQUIREMENT 4103
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-29504/20 terminus for temperature range 1. Fabrication criteria are addressed in appendix B for test samples to be used for the qualification of the MIL-PRF-29504/20 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-29504/20 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".

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 http://quicksearch.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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 Government General Series Technical Manual can be obtained at website: https://jswag.navair.navy.mil. At the home page select “Document Library” (on left side), then select the “JFOWG” folder followed by the “Maintenance Documents.)

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

TIA455.34 - 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. Minimum number of termini required to perform a full MIL-PRF-29504/20 termini qualification is provided in table 4103 A-I. 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).

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TABLE 4103 A-I. Termini allocation TABLE 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				
	96	96	16	16
Group 1	96 of 96	96 of 96	16 of 16	16 of 16
Group 2 (16 pair minimum)	16 of 96	16 of 96		
Group 3 (polymeric materials only)	None	None		
Group 4	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 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		
Termini as an integral part of a multiple termini connector				
	48 of 96	48 of 96	16 of 16	16 of 16
Group 1 (6 connector mated pair, SM)	48 of 48	48 of 48	16 of 16	16 of 16
Group 2 (2 connector mated pair, SM) 4/, 8/	16 of 48	16 of 48		
Group 3, Mechanical (2 connector mated pair) 8/	16 of 48	16 of 48	16 of 16	16 of 16
Group 3, Environmental (2 connector mated pair) 4/, 8/	16 of 48	16 of 48		
Interoperability 6/				
	52	52	52	52

1/ See A.3.1 and A.3.2 and notes with the qualification table in MIL-PRF-29504/20 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 note 4/ in table 4103-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 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".

A.3.1 Quantity. Minimum of 96 pin termini and 96 socket termini for single mode fiber type and 16 pin termini and 16 socket termini for multimode fiber type.

NOTE: This minimum number 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).

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

A.3.2.1 Unterminated 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 C.
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. 32 pin termini and 32 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. 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 (arimid 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.

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 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 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). 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. This cable is compatible with that for a MIL-PRF-64266 shells size 15 multiple termini connector.

TABLE 4103 A-II. Cable compatible with connector.

Connector shell size	Number of cavities in connector insert	Specification sheet for MIL-PRF-85045 cable
15	8	/13 or /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 4103 A-III.

TABLE 4103 A-III. Epoxy types.

Epoxy type	Vendor	Part number	Grams per packet
Two-part liquid, Per MIL-PRF-24792 1/, 2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5°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/ Under this part number, six packets are provided and each packet has the listed number of grams.

A.5.4 Polishing steps and polishing paper used.

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, shell size 15 qualified flanged connector receptacle with an 8 channel (cavity) insert and a MIL-PRF-64266, shell size 15 qualified connector plug with an 8 channel (cavity) insert shall be used (for the MIL-PRF-29504/20 termini qualification).

A.5.5.2 Backshell (connector accessory). A MIL-PRF-64266/18 shall be used.

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 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.

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-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.

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A.5.7.1 Single mode. Termini on cable assemblies (such as multiple fiber cable with termini inserted into a MIL-PRF-64266 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 4103 A-IV.

TABLE 4103 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 1/
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	6 mated pair per A.5.1 through A.5.6.
Tests performed	Full test sequence 2/
1/ 9.3/125 micron at 1310 nm per MIL-PRF-49291/7. 2/ See the qualification table in MIL-PRF-29504/20.	

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.

TABLE 4103 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 4103 A-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 A-III.
Test sample quantity	2 mated pair per A.5.1 through A.5.6.
Tests performed	Limited test sequence 1/, 2/
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 2/ See the qualification table in MIL-PRF-29504/20.	

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. 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.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 http://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 can be obtained at web site: https://jswag.navair.navy.mil. At the home page select “Document Library” (on left side), then select the “JFOWG” folder followed by the “Maintenance Documents” folder.)

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

TIA455-	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. Minimum number of termini required to perform a full MIL-PRF-29504/20 termini qualification is provided in table 4103 B-I. 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).

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				
	100	100	20	20
Group 1	100 of 100	100 of 100	20 of 20	20 of 20
Group 2 (16 pair minimum)	None	None		
Group 3 (polymeric materials only)	Materials only	Materials only		
Group 4	20 of 100	20 of 100		
Termini as part of a single fiber cable tests 5/				
	40 of 100	40 of 100		
Group 1	None	None		
Group 2				
Fiber pullout force	None	None		
Cable pull out force	None	None		
Group 3 (16 pair – minimum each test)	40 of 40	40 of 40		
Salt spray 2/	20 of 40	20 of 40		
Fluid immersion 2/, 3/	20 of 40	20 of 40		
Termini as an integral part of a multiple termini connector				
	40 of 100	40 of 100	20 of 20	20 of 20
Group 1 (4 connector mated pair, SM)	40 of 40	40 of 40	20 of 20	20 of 20
Group 2	None	None		
Group 3, Mechanical (2 connector mated pair) 9/	20 of 40	20 of 40	20 of 20	20 of 20
Group 3, Environmental (2 connector mated pair) 4/, 9/	20 of 40	20 of 40		
Interoperability 6/				
	52	52	52	52

1/ See B.3.1 and B.3.2 and notes with the qualification table in MIL-PRF-29504/20 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 shall be immersed for this test.
4/ 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”.

B.3.1 Quantity. Minimum of 100 pin termini and 100 socket termini for single mode fiber type and 20 pin termini and 20 socket termini for multimode fiber type.

NOTE: This minimum number 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).

B.3.2 Allocation of 100 pin termini and 100 socket termini. Allocation of these 100 pin termini and 100 socket termini single mode testing is as follows:

B.3.2.1 Unterminated termini.

a. Group 1 inspections: 100 pin termini and 100 socket termini.
b. Group 4: 20 pin termini and 20 socket termini.

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

a. Group 3 Salt spray: 20 pin termini and 20 socket termini.
b. Group 3 fluid immersion: 20 pin termini and 20 socket termini

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

a. Interoperability: See appendix C (2 mated pair with 16 pin termini and 16 socket termini).
b. Group 1 Optical (Insertion loss & Return loss) then Group 2 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).

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

B.4.1 Quantity. 40 pin termini and 40 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 (arimid 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.

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-29504/20. 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 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). 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.

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 1/	OFS Fitel	0MZN3	C14447	None
50/125 1/	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 1/	64201	353ND-2g	2/
	08RC6	3700-5520	2/
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.

B.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.

B.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.

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 only if other steps and processes adhere to and resultant termination meets specified optical performance

B.5.5 Connectors.

B.5.5.1 Configuration. A MIL-PRF-64266, shell size 15 qualified flanged connector receptacle with a ten channel (cavity) insert and a MIL-PRF-64266, shell size 15 qualified connector plug with a ten channel (cavity) insert shall be used for the MIL-PRF-29504/20 termini qualification.

B.5.5.2 Backshell (connector accessory). A MIL-PRF-64266/12, MIL-PRF-64266/13 or MIL-PRF-64266/14 or a MIL-PRF- 64266/19, MIL-PRF-64266/20 or MIL-PRF-64266/21 shall be used.

B.5.5.3 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert. Eight of the ten channels are to be active optically for termini qualification testing.

B.5.5.4 Fiber type. Each 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 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.

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
Fiber size	9/125 micron 1/
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	4 mated pair per B.5.1 through B.5.6.
Tests performed	Full test sequence 2/, 3/
1/ 9.3/125 micron at 1310 nm. 2/ Qualification by similarity if do single mode 5. 3/ See qualification table in MIL-PRF-29504/20.	

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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.

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
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	2 mated pair per B.5.1 through B.5.6.
Tests performed	Limited test sequence. 1/, 2/
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. 2/ See qualification table in MIL-PRF-29504/20.	

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-29504/20 terminus. 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-TEB 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-29504/20 terminus.

C.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".

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, 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 http://quicksearch.dla.mil/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

TIA455.34	-	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-TEB Passive Test Section.

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

Shipping address:
DLA Land and Maritime Columbus
3990 East Broad St.
Bldg. 11, Section 7, TEB
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				
	52	52	52	52
Interoperability of counterpart terminus 2/, 3/	36 of 52	36 of 52	36 of 52	36 of 52
Insertion loss (test variations per table 4103 C-I)	16 of 36	16 of 36	16 of 36	16 of 36
Insertion loss, additional (for larger shell sizes) 4/	20 of 36	20 of 36	15 of 36	15 of 36
Insert-to-termini compatibility 5/	16 of 52	16 of 52	16 of 52	16 of 52
Terminus retention force	16 of 16	16 of 16	16 of 16	16 of 16
Terminus insertion and removal forces 6/	16 of 16	16 of 16	16 of 16	16 of 16

1/ See C.4, C.5 and notes with the qualification table in MIL-PRF-29504/20 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 C.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 20 pin termini and an additional, terminated 20 socket termini shall be submitted.
5/ Un-terminated termini.
6/ Test performed using connector in which the ASR is not inserted.

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. Minimum number of termini required for one fiber size to perform this interoperability test shall be as specified in table 4103 C-II for MIL-PRF-29504/20 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-29504/20 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 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.

C.4.1.1 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). 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).

a. Interoperability of counterpart terminus.
   i. Insertion loss. 16 pin termini and 16 socket termini.
   ii. Insertion loss, additional. 20 pin termini and 20 socket termini.

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.

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 TIA455.34. 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 4103 C-III.

TABLE 4103 C-III. Epoxy types.

Epoxy type	Vendor	Part number	Grams per packet
Two-part liquid, per MIL-PRF-24792 1/, 2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5°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/ Under this part number, six packets are provided and each packet has the listed number of grams.

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

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) as specified in 4.1.1 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 only if other steps and processes adhere to and resultant termination meets optical performance specified in Part 5 of MIL-STD-2042.

C.4.6 Connectors.

C.4.6.1 Configuration. A MIL-PRF-64266 shell size 15 connector shall be used with a fully populated 8 cavity insert for MIL-PRF-29504/20 termini qualification. All 8 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.

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

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C.4.6.3 Submission. No connector submission is required.

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 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 4103 C-IV. Two mated pair (2 fully populated, MIL-PRF-64266, shell size 15, eight cavity insert, 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 4103 C-IV. Fabrication for 9/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	9/125 micron 1/
Cable type	Tight buffer per C.4.2.
Cable length	2 meters 2/
Epoxy type	Two part, heat cured, liquid type per C.4.4.
Test sample quantity	16 pin termini and 16 socket termini cable assemblies per table 4103 C-II.
Additional quantity submission	20 pin termini and 20 socket termini cable assemblies per note 4/ 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.	

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. Two mated pair (2 fully populated, MIL-PRF-64266, shell size 15, eight cavity insert, 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 4103 C-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 C.4.2.
Cable length	2 meters 1/
Epoxy type	Two part, heat cured, liquid type per C.4.4.
Test sample quantity	16 pin termini and 16 socket termini cable assemblies per table 4103 C-II.
Additional quantity submission	20 pin termini and 20 socket termini cable assemblies per note 4/ 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.	

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

TEMPERATURE RANGES TESTED FOR EACH CONNECTOR DESIGNATION

D.1 Purpose. This appendix addresses the temperature ranges that are to be tested for each connector designation. Specifically the connector designations of interest are the shell size and the number of insert cavities.

D.2 Implementation for termini positioning. For each connector designation (i.e., shell size and number of insert cavities), testing shall be performed for temperature range 1, temperature range 2, or both temperature ranges as listed in table 4103 D-I.

TABLE 4103 D-I. Tests to be performed for each connector designation.

Shell size	Number of insert cavities	Temperature range 1	Temperature range 2
11	2	No	Yes
11	4	Yes	No
13	4	Yes	No
13	6	No	Yes
15	8	Yes	No
15	10	No	Yes
23	18	Yes	Yes
23	36	Yes	Yes

APPENDIX E

TERMINI TYPES POSITIONING IN CONNECTOR INSERT CAVITIES

E.1 Purpose. This appendix addresses the circumstance when qualification is being performed with both MIL-PRF-29504/18 and MIL-PRF-29504/20 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), and MIL-PRF-29504/20 termini (domed end face with an APC polish).

E.2 Implementation for termini positioning. The connector insert cavity positions in which active termini must be monitored shall conform to E.2.1 for qualification except interoperability and to E.2.2 for Interoperability.

E.2.1 Qualification except interoperability. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in table 4103 E-1 through table 4103 E-7, selecting the table appropriate for the shell size and insert arrangement. The connector insert cavity positions for the minimum number of active termini that must be monitored are listed and not followed by an asterisk. The other termini, whether or not active (at the option of the test laboratory), are listed and followed by an asterisk. No substitution of dummy termini shall be made for any termini that are not active. The number of active termini is further clarified in E.3.2.

E.2.1.1 End face polish with multimode fiber. For qualification test samples built with MIL-PRF-29504/20 termini on multimode fiber and used for temperature range 2 (aircraft application) tests, termini end face shall only be PC polished.

E.2.2 Interoperability. Termini shall be fully populated in the connector with the termini type in each cavity that are specified in table 4103 E-I through table 4103 E-6, selecting the table appropriate for the shell size and insert arrangement. All termini in the connector shall be active.

TABLE 4103 E-1. Two position cavity arrangement for shell size 11.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	APC

TABLE 4103 E-2. Four position cavity arrangement for shell sizes 11 and 13.

Cavity number	M29504 type	End face type
1*	/20	PC
2	/20	PC
3	/20	PC
4*	/20	APC

TABLE 4103 E-3. Six position cavity arrangement for shell size 13.

Cavity number	M29504 type	End face type
1	/18	PC
2	/20	APC
3	/20	PC
4*	/18	PC
5*	/20	APC
6	/20	PC

TABLE 4103 E-4. Eight position cavity arrangement for shell size15.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	PC
3	/18	PC
4	/20	APC
5	/20	PC
6	/20	APC
7	/18	PC
8	/20	APC

TABLE 4103 E-5. Ten position cavity arrangement for shell size 15.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	PC
3	/18	PC
4	/20	APC
5	/20	APC
6	/20	PC
7*	/20	PC
8*	/20	APC
9	/18	PC
10	/20	APC

TABLE 4103 E-6. Eighteen position cavity arrangement for shell size 23

Cavity number	M29504 type	End face type
1	/20	PC
*2**	/18	PC
3	/18	PC
4	/20	APC
*5**	/20	PC
*6**	/20	APC
*7**	/18	PC
*8**	/20	PC
9	/20	APC
10	/20	PC
*11**	/18	PC
*12**	/20	PC
*13**	/18	PC
*14**	/20	APC
15	/20	PC
16	/20	APC
*17**	/20	APC
18	/18	PC

TABLE 4103 E-7. Thirty six position cavity arrangement for shell size 23.

Cavity number	M29504 type	End face type
1	/20	PC
*2**	/18	PC
3	/18	PC
4	/20	APC
*5**	/20	PC
*6**	/20	APC
*7**	/18	PC
*8**	/20	PC
*9**	/18	PC
10	/20	PC
*11**	/18	PC
*12**	/20	PC
*13**	/18	PC
*14**	/20	APC
*15**	/20	PC
16	/20	APC
*17**	/18	PC
18	/18	PC
19 1/*	/20	APC
20*	/20	APC
21*	/20	APC
22*	/18	PC
23*	/20	PC
24*	/20	PC
25*	/20	APC
26*	/20	PC
27*	/18	PC
28*	/20	APC
29*	/20	APC
30*	/20	PC
31 2/	/20	PC
32*	/18	PC
33*	/20	APC
34*	/20	PC
35*	/18	PC
36 3/	/20	APC

1/ Cavity 19 is located below and to the right of cavity 1.
2/ Cavity 31 is located directly below cavity 1.
3/ Cavity 36 is located below and to the left of cavity 31.

E.3 NOTES.

E.3.1 Intended use.

E.3.1.1 Usage. This appendix can pertain to qualification of only MIL-PRF-29504/20 termini also. Cavity positions specified for placement with the MIL-PRF-29504/18 termini would then be populated instead with MIL-PRF-29504/20 termini containing a domed end face with an APC polish.

E.3.2 Number of active termini. The minimum number of active termini that must be monitored for each shell size to perform the “qualification except interoperability” inspections is specified in 4.7.1.2.1 of MIL-PRF-64266. For clarity and for use with this appendix, a summary is presented in table form as table 4103 E-8 in this appendix.

TABLE 4103 E-8. Number of active termini for each shell size.

Shell size	Number of insert cavities	Minimum number of active channels to monitor
11	2	2
11	4	2
13	4	4
13	6	4
15	8	8
15	10	8
23	18	8
23	36	8

APPENDIX F

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

F.1 Purpose. This appendix provides the criteria for fabrication of MIL-PRF-29504/20 terminus cable assemblies test samples to be used for the qualification of the rectangular connectors and accessories to MIL-PRF-64266/22 through MIL-PRF-64266/22/30. Fabrication criteria are addressed in appendix G for rectangular connector test samples to be used for interoperability.

F.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". There is a drawback in applying this terminology to a MIL-PRF-64266 rectangular connector. Unlike a MIL-PRF-64266 circular connector, the ASR can only be inserted into a MIL-PRF-64266 rectangular connector plug. For consistency with Requirements 4101 and 4102 and with the circular connector in Requirement 4103, the termini in the MIL-PRF-64266 rectangular connector receptacle will still be referred to as “socket termini”.

F.1.2 Qualification test samples. The components being qualified are the MIL-PRF-64266/22 through MIL-PRF-64266/30 rectangular connectors and accessories (backshells). This appendix addresses the MIL-PRF-29504/20 termini and the fabrication of MIL-PRF-29504/20 termini cable assemblies that are used in the qualification testing of these MIL-PRF-64266 rectangular connectors.

F.1.3 Temperature ranges. An integrated qualification sequence has been developed that incorporates both temperature ranges 1 and 2. No separate test samples are required for each temperature range.

F.2 Applicable documents.

F.2.1 General. The documents listed in this section are specified in sections F.3, F.4 and F.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 F.3, F.4 and F.5 of this appendix, whether or not they are listed.

F.2.2 Government documents.

F.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 http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

F.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 can be obtained at web site: https://jswag.navair.navy.mil/. At the home page select “Document Library” (on left side), then select the “JFOWG” folder followed by the “Maintenance Documents” folder.)

F.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

TIA455-	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).

F.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.

F.3 Test samples, termini cable assemblies. Minimum number of termini required to perform a full qualification is provided in table 4103 F-I.

TABLE 4103 F-I. Termini allocation table for termini cable assemblies. 1/

Test performed	Eight cavity connector			Four cavity connector	Twelve cavity connector
	SM	MM 50/125	MM 62.5/125	SM	SM
Qualification, except interoperability					
Number of termini to fabricate termini cable assemblies					
	64	32	32	32	96
Group 1 (4 connector mated pair, SM)7/	64 of 64	32 of 32	32 of 32	32 of 32	96 of 96
Group 2 Mechanical (2 connector mated pair)2/, 5/	32 of 64	32 of 32	32 of 32	16 of 32	48 of 96
Group 3, , Environmental (2 connector mated pair) 3/, 5/	32 of 64	None	None	16 of 32	48 of 96
Group 4, Material (2 connector mated pair + parts) 4/, 5/	32 of 64	None	None	None	None
Interoperability 6/					
	32	None	16	8	24

1/ See F.3.1 and notes with qualification table in MIL-PRF-64266/22 through MIL-PRF-64266/25 for further detail.

2/ Two connector mated pair from Group 1 is designated for Group 2.
3/ Two connector mated pair from Group 1 is designated for Group 3.
4/ Total number of termini listed is under the assumption that connector mated pair fabricated with Group 2 and/or Group 3 termini are used for Group 4. Separate parts are used for Group 4 Material tests.
5/ Each terminus cable assembly consists of a terminus-to-ST jumper.
6/ Configuration and fabrication requirements for interoperability samples are found in appendix G.
7/ Two mated pair for multimode (MM).

F.3.1 Quantity. Minimum of 256 MIL-PRF-29504/20 termini are required. For the eight cavity connector, a minimum quantity of 64 termini are required for single mode fiber type, 32 termini for the 50/125 micron multimode fiber type and 32 termini for 62.5/125 micron multimode fiber type. For the four and twelve cavity connectors, respectively, 32 termini and 96 termini are required for the single mode fiber type.

NOTE: This minimum number does not include the number of termini required for interoperability (see appendix G for further details on interoperability).

F.4 Test sample configuration. Termini as part of a cable assembly on single fiber cable.

F.4.1 Quantity. See F.3.1.

F.4.2 Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers. Test sample configurations (single mode and multimode on tight buffer cable) and fabrication of termini-to-ST connector jumpers shall conform as specified in F.5.1, and F.5.3 through F.5.7 below. Test samples shall be prepared on single fiber cable with strain relief (arimid 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. 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.

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

F.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.

F.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 F.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.

F.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 F-II.

F.5.2.1 Test samples used for insertion loss, shock and vibration only. Cable used must be of same configuration specified; however, this cable does not need to meet environmental specifications in MIL-PRF-29504/20. 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. Otherwise, MIL-PRF-85045/16 cable shall be used.

TABLE 4103 F-II. Tight buffer cable.

Fiber size (microns)	Cable vendor	CAGE Code	Part number	Alternate part number
9/125 1	OFS Fitel	0MZN3	C14447	None
50/125 1/	OFS Fitel	0MZN3	C10027	BC06815
62.5/125 1/	N/A	N/A	M85045/16-01	N/A

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

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

TABLE 4103 F-III. Epoxy types.

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

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.

F.5.4 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see F.5.1.1).

F.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.

F.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.

F.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 F.5.1.1).

F.5.5 Connectors.

F.5.5.1 Configurations. MIL-PRF-64266, rectangular connector receptacles with four, eight and twelve channel (cavity) inserts and MIL-PRF-64266, rectangular connector plugs with four, eight and twelve channel (cavity) inserts shall be used.

F.5.5.2 Backshell (connector accessory). MIL-PRF-64266/27, MIL-PRF-64266/28, MIL-PRF-64266 /29 and MIL-PRF-64266/30 backshells shall be used.

F.5.5.3 Insert cavity population. Qualification testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

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

F.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.

F.5.7 Summary of parameter requirements.

F.5.7.1 Single mode 9. (Only if not doing single mode 5) Termini on cable assemblies (such as terminus-to-ST connector jumpers) with single mode 9/125 micron cable shall conform to table 4101F-IV.

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 um
Fiber size	9/125 micron 1/
Cable type	Tight buffer per table 4103 B-II.
Epoxy type	Two part, heat cured, liquid type table 4103 F-III.
Test sample quantity	12 mated pair per F.5.1 through F.5.6.
Tests performed	Full test sequence 2/
1/ 9.3/125 micron at 1310 nm. 2/ See the qualification table in the applicable MIL-PRF-64266 specification sheet (MIL-PRF-64266/22 through MIL-PRF-64266/25).	

F.5.7.2 Multimode 50/125 micron. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 50/125 micron fiber shall conform to table 4103 F-V.

TABLE 4103 F-V. Fabrication for multimode 50/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
Fiber size	50/125 micron
Cable type	Tight buffer per table 4103 F-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 F-III.
Test sample quantity	2 mated pair per F.5.1 through F.5.6.
Tests performed	Limited test sequence 1/, 2/
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 qualification table in MIL-PRF-64266/22 through MIL-PRF-64266/25). 2/ See the qualification table in the applicable MIL-PRF-64266 specification sheet (MIL-PRF-64266/22 through MIL-PRF-64266/25).	

F.5.7.3 Multimode 62.5/125 micron. Termini on cable assemblies (such as terminus-to-ST connector jumpers) with multimode cable containing 62.5/125 micron fiber shall conform to table 4103 F-VI.

TABLE 4103 F-VI. Fabrication for multimode 62.5/125 micron fiber size.

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 µm
Fiber size	62.5/125 micron
Cable type	Tight buffer per table 4103 F-II.
Epoxy type	Two part, heat cured, liquid type per table 4103 F-III.
Test sample quantity	2 mated pair per F.5.1 through F.5.6.
Tests performed	Limited test sequence 1/, 2/, 3/
1/ Size, insertion loss, vibration, shock only if meets multimode requirements. 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 micron fiber size. 3/ See the qualification table in the applicable MIL-PRF-64266 specification sheet (MIL-PRF-64266/22 through MIL-PRF-64266/25).	

F.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 in table 4103 F-VII, table 4103 F-VIII and table 4103 F-IX. This requirement applies only for termini cable assemblies fabricated with single mode fiber (see F.5.1.1).

TABLE 4103 F-VII. Four position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	APC
2	/20	PC
3	/20	PC
4	/20	APC

TABLE 4103 F-VIII. Eight position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	APC
3	/20	PC
4	/20	APC
5	/20	PC
6	/20	APC
7	/20	PC
8	/20	APC

TABLE 4103 F-IX. Twelve position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	PC
3	/20	APC
4	/20	APC
5	/20	PC
6	/20	APC
7	/20	APC
8	/20	PC
9	/20	APC
10	/20	PC
11	/20	APC
12	/20	PC

APPENDIX G

CONFIGURATION AND FABRICATION REQUIREMENTS FOR INTEROPERABILITY TEST SAMPLES, RECTANGULAR CONNECTORS

G.1 Purpose. This appendix provides the criteria for fabrication of MIL-PRF-29504/20 terminus cable assemblies test samples to be used for the interoperability testing of the rectangular connectors and accessories to MIL-PRF-64266/22 through MIL-PRF-64266/30. 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-TEB 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 rectangular connectors and accessories to MIL-PRF-64266/22 through MIL-PRF-64266/30.

G.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 will be referred to as "socket termini". There is a drawback in applying this terminology to a MIL-PRF-64266 rectangular connector. Unlike a MIL-PRF-64266 circular connector, the ASR can only be inserted into a MIL-PRF-64266 rectangular connector plug. For consistency with Requirements 4101 and 4102 and with the circular connector in Requirement 4103, the termini in the MIL-PRF-64266 rectangular connector receptacle will still be referred to as “socket termini”.

G.1.2 Qualification test samples. The components being qualified are the MIL-PRF-64266/22 through MIL-PRF-64266/30 rectangular connectors and accessories (backshells). This appendix addresses the MIL-PRF-29504/20 termini and the fabrication of MIL-PRF-29504/20 termini cable assemblies that are used in the qualification testing of these MIL-PRF-64266 rectangular connectors.

G.1.3 Temperature ranges. An integrated qualification sequence has been developed that incorporates both temperature ranges 1 and 2. No separate test samples are required for each 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 and 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.

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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 http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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 (EIA/TIA)

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.)

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.

G.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.

G.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.

G.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.

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

REQUIREMENT 4103

G.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-TEB Passive Test Section.

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

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

TABLE 4103 G-I. Connector interoperability test variations. 1/

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

X = Previously Certified Termini
A = Previously Certified Connector
B = Candidate Connector
1/ Socket termini placed in connector receptacle, pin termini in connector plug.

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

Test performed	Eight cavity connector			Four cavity connector	Twelve cavity connector
	SM	MM 50/125	MM 62.5/125	SM	SM
Interoperability					
	32	None	16	8	24
Interoperability of counterpart terminus 2/	16 of 32	None	16 of 16	8 of 8	24 of 24
Insertion loss (test variations per TABLE 4103 G-I)	16 of 16	None	16 of 16	8 of 8	24 of 24
Insert-to-termini compatibility 3/	16 of 32	None	None	None	None
Terminus retention force	16 of 16	None	None	None	None
Terminus insertion and removal forces 4/	16 of 16	None	None	None	None

1/ See G.4, G.5 and notes with qualification table in MIL-PRF-64266/22 through MIL-PRF-64266/25 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.

G.4 Interoperability of counterpart terminus. Qualified termini shall be inserted into *and fully populate* rectangular connector test samples for test variations performed in table 4103 G-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 G-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-29504/20 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 (see table 6202-II of MIL-STD-1678-6).

G.4.1 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.

G.4.1.1 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.4.7.3) 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.4.1.2 Quantity of termini. Quantity: Minimum of 64 MIL-PRF-29504/20 termini are required. For the eight cavity connector, a minimum quantity of 32 termini are required for single mode fiber type, no termini for the 50/125 micron multimode fiber type and 16 termini for 62.5/125 micron multimode fiber type. For the four and twelve cavity connectors, respectively, 8 termini and 24 termini are required for the single mode fiber type.

G.4.1.3 Quantity of connectors. Minimum of one connector mated pair (one rectangular connector plug and one rectangular connector receptacle) for each cavity size.

G.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.

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

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

G.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.

G.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 4103 G-III.

TABLE 4103 G-III. Epoxy types.

Epoxy type	Vendor	Part number	Grams per packet
Two-part liquid, per MIL-PRF-24792 1/, 2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5 °C for 20 min (248 °F)
3/ Under this part number, six packets are provided and each packet has the listed number of grams.

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

G.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.

G.4.5.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in 4.1.1 shall be used.

G.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.

G.4.6 Connectors.

G.4.6.1 Configurations. MIL-PRF-64266, rectangular connector receptacles with four, eight and twelve channel (cavity) inserts and MIL-PRF-64266, rectangular connector plugs with four, eight and twelve channel (cavity) inserts shall be used. All channels are to be active optically for termini interoperability.

G.4.6.2 Candidate connector future use. Once qualified, these interoperability “standards” shall be used to determine interoperability of other MIL-PRF-64266 rectangular connectors.

G.4.6.3 Submission. At the discretion of DLA Land and Maritime-TEB, submission of termini may be required to determine interoperability of MIL-PRF-64266 connectors.

G4.6.4 Insert cavity population. Interoperability testing shall be performed on termini cable assemblies in fully populated cavities of each connector insert.

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

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

G.4.7 Fabrication of termini.

G.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 G-IV. Three mated pair (3 fully populated, MIL-PRF-64266 rectangular connectors with four, eight, and twelve cavity inserts, key position 1) shall be provided. The three mated pair with four, eight and twelve cavities shall contain a total of 4, 8 and 12, respectively, pin termini-to-ST connector jumpers and 4, 8 and 12, respectively, socket termini-to-ST connector jumpers.

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	9/125 micron 1/
Cable type	Tight buffer per G.4.2.
Cable length	2 meters 2/
Epoxy type	Two part, heat cured, liquid type per G.4.2.
Test sample quantity	Connector mated pair with 4, 8 and 12 pin termini and 4, 8 and 12 socket termini cable assemblies per table 4103 G-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.	

G.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 G-V. One mated pair (1 fully populated, MIL-PRF-64266 rectangular connector with an eight cavity insert, key position 1) shall contain a total of 8 pin termini-to-ST connector jumpers and 8 socket termini-to-ST connector jumpers.

TABLE 4103 G-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 G.4.2
Cable length	2 meters 1/
Epoxy type	Two part, heat cured, liquid type per G.4.4.
Test sample quantity	Connector mated pair with 8 pin termini and 8 socket termini cable assemblies per table 4103 G-II.
Tests performed	Interoperability of counterpart termini
1/ Two meter length (minimum) from tip of terminus ferrule to tip of instrument end connector ferrule.	

G.4.7.3 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 in table 4103 G-IV, table 4103 G-VI and table 4103 G-VIII. This requirement applies only for termini cable assemblies fabricated with single mode fiber (see G.4.1.1).

TABLE 4103 G-VI. Four position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	APC
2	/20	PC
3	/20	PC
4	/20	APC

TABLE 4103 G-VII. Eight position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	APC
3	/20	PC
4	/20	APC
5	/20	PC
6	/20	APC
7	/20	PC
8	/20	APC

TABLE 4103 G-VIII. Twelve position cavity arrangement.

Cavity number	M29504 type	End face type
1	/20	PC
2	/20	PC
3	/20	APC
4	/20	APC
5	/20	PC
6	/20	APC
7	/20	APC
8	/20	PC
9	/20	APC
10	/20	PC
11	/20	APC
12	/20	PC

G.5 Insert-to-termini compatibility.

G.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 G-II.

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

APPENDIX H

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

H.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 I for test terminus and test terminus adapter test samples to be used for interoperability.

H.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.

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 /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 http://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 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 can be obtained at web site: https://jswag.navair.navy.mil. At the home page select “Document Library” (on left side), then select the “JFOWG” folder followed by the “Maintenance Documents” folder.)

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

TIA455-	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).

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.

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

H.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 I for further details on interoperability).

TABLE 4103 H-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 8/	2	2	2	2	4	4
Minimum number of test terminus adapters 7/, 9/	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 2/, 5/	None	None	2 of 2	None	2 of 4	None
Group 3, , Environmental 3/, 5/	None	None	None	None	2 of 4	None
Group 4, Material (components + parts) 4/, 5/	None	None	2 of 2	None	2 of 4	None
Interoperability 6/						

1/ See H.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 I. See table 4103 I-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.

H.4 Test sample configurations.

H.4.1 Quantity. See H.3.1.

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 and H.5.3 through H.5.7 below. Test samples shall be prepared on single fiber cable with strain relief (arimid 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.

H.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.

H.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.

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

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 I). 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.

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 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.

H.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.

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

TABLE 4103 H-II. Epoxy types.

Epoxy type	Vendor	Part number	Grams per packet
Two-part liquid, Per MIL-PRF-24792 1/,2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5°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/ Under this part number, six packets are provided and each packet has the listed number of grams.

H.5.4 Polishing steps and polishing paper used.

H.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.

H.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.

H.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 H.5.1.1).

H.5.5 Connectors.

H.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.

H.5.5.2 Backshell (connector accessory). MIL-PRF-64266/12 through MIL-PRF-64266/16 or MIL-PRF-64266/19 through MIL-PRF-64266 /21 backshells shall be used.

H.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.

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

H.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.

H.5.7 Summary of parameter requirements.

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

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 um
Fiber size	9/125 micron 1/
Cable type	Tight buffer per H.5.2
Epoxy type	Two part, heat cured, liquid type per H.5.2.
Test sample quantity	1 mated pair for each shell size per H.5.1 through H.5.6.
Tests performed	Full test sequence 2/
1/ 9.3/125 micron at 1310 nm. 2/ Qualification table is listed in MIL-PRF-29504/21.	

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 Termini types positions in insert. Termini placed in each cavity position shall conform to appendix E. Termini positions shall vary depending upon shell size.

H.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.

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APPENDIX I

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

I.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-TEB 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.

I.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.

I.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.

I.2 Applicable documents.

I.2.1 General. The documents listed in this section are specified in sections I.3, I.4, and I.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 I.3, I.4, and I.5 of this appendix, whether or not they are listed.

I.2.2 Government documents.

I.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 http://quicksearch.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

I.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.)

I.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.

I.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.

I.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.

I.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.

I.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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I.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-TEB Passive Test Section.

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

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

TABLE 4103 I-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 I-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
Interoperability 1/						
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.

I.4 Test sample configurations. Minimum number of test terminus MQJ's required to perform a full interoperability test is provided in table 4103 I-II.

I.4.1 Quantity.

I.4.1.1 Interoperability of counterpart terminus. A 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.

I.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.

I.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 I.5.1 through I.5.7 below. Test samples shall be prepared on single fiber cable with strain relief (arimid 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.

I.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.

I.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.

I.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 4103 I-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 I-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.*

I.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 I). 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.

I.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 shall be as specified in MIL-STD-1678-5.

I.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.

I.5.3 Test methods and practices. Launch conditions and measurements for the insertion loss shall conform as specified in MIL-STD-1678-2.

I.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.

I.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 I-III.

TABLE 4103 I-III. Epoxy types.

Epoxy type	Vendor	Part number	Grams per packet
Two-part liquid, per MIL-PRF-24792 1/, 2/	CommScope	700 006 109	8
	OFS Optics	105 489 355	8
	Tra-Con, Inc.	BA-F112	2
	Tra-Con, Inc.	BB-F112	7
	Tra-Con, Inc.	BY-F112 3/	1
	Fiber Optic Center, Inc.	AB-9112 3/	2.5

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 ± 5 °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/ Under this part number, six packets are provided and each packet has the listed number of grams.

I.5.5 Polishing steps and polishing paper used. Polished ferrule end faces shall meet end face geometry requirements (see 5.1.1).

I.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.

I.5.5.2 Hand polish. Polishing steps with the process (including polishing paper) as specified in 4.1.1 shall be used.

I.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.

I.5.6 Connectors for multiple termini connector assembly.

I.5.6.1 Configurations. MIL-PRF-64266 circular connector receptacles for shell sizes 11, 13, 15 and 23, and MIL-PRF-64266 circular connector 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.

I.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.

I.5.6.3 Submission. At the discretion of DLA Land and Maritime-TEB, submission of termini may be required to determine interoperability of MIL-PRF-64266 connectors.

I.5.6.4 Insert cavity population. Interoperability testing shall be performed on test terminus MQJ’s (test termini cable assemblies) and test terminus adapters in fully populated cavities of each multiple termini connector assembly.

I.5.6.5 Fiber type. Each mated pair shall contain only one fiber type.

I.5.6.6 Instrument end connectors. ST connectors with a domed PC polish shall be provided.

REQUIREMENT 4103

I.5.7 Fabrication of termini.

I.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 I-IV. Each mated pair shall be provided.

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

Parameter	Requirement
Ferrule hole diameter	126 +1/-0 microns
Fiber size	9/125 micron 1/
Cable type	Tight buffer per I.5.2
Cable length	2 meters 2/
Epoxy type	Two part, heat cured, liquid type per I.5.4.
Test sample quantity	Mated pair for shell size 11, 13, 15 and 23 multiple termini connector assemblies, test terminus MQJ's and test terminus adapters per table 4103 I-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.	

I.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 I.5.8.1 and I.5.8.2.

I.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.

I.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 /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 /33 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.

I.6 Terminus insertion and removal forces. Perform in accordance with 4.9.11 in MIL-PRF-29504.

I.6.1 Insert-to-termini compatibility.

I.6.2 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 I-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 http://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 Government General Series Technical Manual can be obtained at website: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), then select the "JFOWG" folder followed by the "Maintenance Documents.)

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 electromagnet 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 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.

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 4/				See 4/	See 5/	
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.

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.

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 1/	*This test configuration is not required*	9/125 micron: MIL-PRF-85045 PIN M85045/16-02 2/
Multimode	50/125 micron: OFS part # C10027 1/or BC06815 1/	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 1/	100/140/172 micron: General Cable part # OC-1260	*This test configuration is not required*
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	1/	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.

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.

REQUIREMENT 4104

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 http://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).

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 electromagnet 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.

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 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 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 light weight, 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

Reviewer:
AF - 99

Preparing activity:
DLA - CC

(Project 60GP-2014-003)

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