INCH-POUND

MIL-PRF-29504B
12 November 2002
SUPERSEDING
MIL-T-29504A
19 December 1989

PERFORMANCE SPECIFICATION

TERMINI, FIBER OPTIC CONNECTOR, REMOVABLE, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for removable crimp and epoxy type fiber optic termini for use in connectors and other fiber optic components (see 6.1).

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

(See supplement 1 for list of specification sheets.)

AMSC N/A FSC 6060

HANDBOOKS

DEPARTMENT OF DEFENSE

MIL-HDBK-454 - General Guidelines for Electronic Equipment.

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

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

Society of Automotive Engineers (SAE)

SAE Aerospace Information Report
AIR1351 Manufacturers' Identification of Aerospace Electrical and Electronic Wiring Devices and Accessories

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

TELECOMMUNICATIONS INDUSTRY ASSOCIATION/ELECTRONIC INDUSTRIES ALLIANCE (TIA/EIA)

EIA-359	-	EIA Standard Colors for Color Identification and Coding.
TIA/EIA-455	-	Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components. (DoD adopted)
EIA/TIA-455-6	-	Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices. (DoD adopted)
TIA/EIA-455-13	-	Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies. (DoD adopted)
TIA/EIA-455-20	-	Measurement of Change in Optical Transmittance. (DoD adopted)
EIA-455-21	-	Mating Durability of Fiber Optic Interconnecting Devices. (DoD adopted)
TIA/EIA-455-32	-	Fiber Optic Circuit Discontinuities. (DoD adopted)
TIA/EIA-455-34	-	Interconnection Device Insertion Loss Test. (DoD adopted)
TIA/EIA-455-56	-	Test Method for Evaluating Fungus Resistance of Optical Fiber and Cable (DoD adopted)
EIA/TIA-455-107	-	Return Loss for Fiber Optic Components. (DoD adopted)
TIA/EIA-455-135	-	Measurement of Connector Ferrule Inside and Outside Diameter Circular Runout. (DoD adopted)

(Application for copies should be addressed to the Telecommunications Industry Association/Electronic Industries Alliance, 2500 Wilson Boulevard, Suite 300, Arlington, Virginia 22201-3834).

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), 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. REQUIREMENTS

3.1 Specification sheets. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheet. In the event of any conflict between the requirements of this specification and the specification sheet, the latter shall govern.

3.2 Qualification. Termini furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.6 and 6.3). The provisions of 4.6.4 for retention of qualification are included in this requirement.

3.3 Materials. Materials shall be as specified herein and in the applicable specification sheet. In all cases, materials selected for use shall meet all qualification requirements as specified, and be of a type and quality to assure physical, chemical, and optical compatibility with the requirements of this specification. All materials used shall be nontoxic (see 3.3.1), nonnutrient to fungus (see 3.3.5) and manufactured to good workmanship quality (see 3.8).

3.3.1 Toxic and hazardous products and formulations. The products used in the terminus construction shall not give off toxic or explosive fumes when exposed to flame. Materials used shall have no adverse effect on the health of personnel when used for the intended purpose.

3.3.2 Metals. Metals which are inherently susceptible to corrosion are prohibited. In addition, unless otherwise specified (see 3.1), metals which are inherently magnetic are prohibited.

3.3.3 Dissimilar metals. The use of dissimilar metals in intimate contact should be avoided. When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided.

3.3.4 Nonmetallic materials. Nonmetallic materials used in termini shall not be degraded by the use of solvents, adhesives or cleaning agents, nor be degraded at the specified environmental conditions.

3.3.4.1 Adhesives. Adhesives are not precluded from use in the construction of termini to this specification. The types of adhesives which may be used are defined in the associated specification sheet (see 3.1).

3.3.4.2 Sealing compounds. Sealing compounds which may flow at the maximum upper storage temperature specified herein, or may crack at the minimum lower storage temperature specified herein shall not be used.

3.3.5 Fungus resistance. When tested in accordance with 4.9.16, polymeric terminus materials shall show sparse or very restricted microbial growth and reproduction with minor or inhibited substrate utilization. There shall be little or no chemical, physical or structural change detectable.

3.3.6 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.4 Design and construction. Termini shall be of the design, construction, and physical dimensions as specified (see 3.1).

3.4.1 Optical termini. Optical terminus dimensions shall be as specified (see 3.1). The mating ends of these termini shall be shaped to prevent gouging of the insert during engagement. The terminus design shall preclude damage to the terminus retention device or to the sealing members during insertion or removal of a terminus. No terminus damage shall result from inserting termini into or removing termini from the connector with the tool specified for insertion or removal. The terminus shall terminate fibers with the properties, dimensions and dimensional tolerance specified (see 3.1).

3.4.1.1 Dummy termini. Dummy termini shall be as specified (see 3.1). Requirements for retention, insertion and removal, and environmental sealing of the dummy termini shall be equivalent to those for the in-service optical termini.

3.4.2 Terminus insertion and removal methods. Optical terminus insertion shall be accomplished by inserting the terminus through the insert of the qualification connector half (see 3.1) and by locking it in place. The individual termini shall be positively retained in the connector when installed with the terminus insertion tool and shall be capable of being removed without terminus or insert damage when using the terminus removal tool. Requirements for these tools shall be as specified (see 3.1).

3.4.3 Finishes. Finishes shall not peel or chip. Termini shall show no evidence of nicks, burrs, or other surface blemishes. Terminus parts shall not gall when inserted into the connector insert or mated with a mating terminus.

3.4.4 Interchangeability. All termini having the same PIN shall be physically and functionally interchangeable without need for modification of such items or of termination tools.

3.4.5 Intermateability. All termini of the same PIN shall be intermateable with their counterpart termini.

3.4.6 Interoperability. All termini of the same PIN shall be interoperable. Upon qualification of the first manufacturer, all subsequent manufacturers shall provide proof of interoperability with each qualified manufacturer as specified in 4.10. The termini shall meet the requirements of 3.5.1, 3.6.6 and 3.6.9 for each specified interoperability condition (see 4.10).

3.4.7 Maintainability. Termini shall require no preventative maintenance.

3.5 Optical performance requirements. Mated termini shall meet the requirements of 3.5.1 and 3.5.2 when mated using the qualification connectors specified in the associated specification sheets (see 3.1).

3.5.1 Insertion loss. When measured in accordance with 4.8.2, the initial insertion loss shall not exceed the value specified in the associated specification sheet (see 3.1). Unless otherwise specified (see 3.1), the insertion loss shall not exceed the value specified in the associated specification sheet (see 3.1) at any time during testing of the terminus.

3.5.2 Discontinuity. When measured in accordance with 4.8.3, no discontinuity shall occur. For multimode termini, a discontinuity is considered to be a reduction of optical transmittance of 0.5 dB or more for a duration of 50 microseconds or more. For single mode termini, a discontinuity is considered to be a reduction of optical transmittance of 0.5 dB or more for a duration of 100 milliseconds or more.

3.5.3 Return loss. When applicable and when measured in accordance with 4.8.4, the return loss of a multimode terminus shall be not greater than -30 dB. The return loss of a single-mode optical terminus shall be not greater than -40 dB.

3.5.4 Change in optical transmittance. When measured in accordance with 4.8.5, the change in optical transmittance during or after any specified environmental or mechanical requirement shall be not greater than 0.5 dB.

3.6 Inspection requirements.

3.6.1 Size. When examined in accordance with 4.9.3, the dimensions and dimensional tolerances for these termini shall be as specified (see 3.1).

3.6.2 Weight. When tested in accordance with 4.9.4, the weight of the termini shall be as specified (see 3.1).

3.6.3 Identification marking. When tested in accordance with 4.9.5, the termini shall be marked as specified herein (see 3.7). All marking characters on any surface of the termini shall be identifiable.

3.6.4 Terminus cleaning. After cleaning the terminus in accordance with 4.9 6, the optical insertion loss of 3.5.1 and the identification marking requirements of 3.6.3 shall be met.

3.6.5 Circular runout. When measured as specified in 4.9.7, designated surfaces must be within the total runout tolerance specified (see 3.1).

3.6.6 Terminus retention. When tested in a qualification connector (see 3.1) in accordance with 4.9.8 and subjected to axial loads of 22 pounds (98 N), termini shall be retained in their inserts and not exceed 0.015 inch (0.38 mm) displacement. Spring loaded termini may deflect more than 0.015 inch (0.38 mm) but must return to within 0.015 inch (0.38 mm) of original position after load is removed. This requirement applies only to termini with retention mechanisms.

3.6.7 Terminus engagement and separation force. When specified in the applicable specification sheet and tested in accordance with 4.9.9, the terminus engagement and separation force shall be within the limits specified (see 3.1).

3.6.8 Environmental/mechanical. When tested in accordance with 4.9.10, termini shall not exhibit visual evidence of dimensional change, opening of seals, cracking or crazing of components or finishes, identification marking impairment, fusion or seizure of mating parts, breakage of the fiber within the terminus, or other effects detrimental to terminus operation. The termini shall meet the optical requirements of 3.5.3 and 3.5.4 as specified in the associated specification sheet (see 3.1).

3.6.9 Terminus insertion and removal forces. When tested in accordance with 4.9.11, the terminus insertion force and the force required to remove unlocked termini shall be not greater than 22 pounds (98 N).

3.6.10 Fiber pull out force. When tested in accordance with 4.9.12, the minimum fiber to terminus pullout strength shall be 3.1 lbs (14 N). The terminus shall meet the optical requirements of 3.5.4 during and after the test.

3.6.11 Cable pull out force. When tested in accordance with 4.9.13, the minimum cable to terminus pullout strength shall be 22 pounds (98 N). The terminus shall show no evidence of cable jacket damage, crimp sleeve failure, distortion from bending of terminus parts or cable disengagement from the terminus. The terminus shall meet the optical requirements of 3.5.4 during and after the test.

3.6.12 Mating durability. When tested in a qualification connector (see 3.1) in accordance with 4.9.14 for 500 mating cycles, the termini shall show no evidence of defects which may be detrimental to their mechanical or optical performance. The terminus shall meet the requirements of 3.5.4 during and after the test.

3.6.13 Maintenance aging. When tested in a qualification connector (see 3.1) in accordance with 4.9.15 for 10 insertion/removal cycles, termini shall show no visible evidence of wear or deformation which may degrade their ability to perform as specified. The requirements of 3.6.9 shall be met during the test.

3.7. Marking. Removable termini shall be permanently and legibly marked with the manufacturer's symbol or trademark and the TICC bands (see figure 1). Unless otherwise specified (see 3.1), markings shall remain legible after tests. Flaking of the color bands in the crimp indenter area is acceptable provided the color of the bands is still identifiable. It shall be acceptable to laser mark the TICC band code numbers on the termini.

3.7.1 Manufacturer's symbol or trademark. When specified (see 3.1), the manufacturer's symbol or trademark shall be marked as shown on figure 1, unless otherwise specified (see 3.1), or on the fiber barrel side of the shoulder. The manufacturer shall list the symbol or trademark with SAE in accordance with AIR1351.

3.7.2 TICC bands. Each digit of the TICC shall be designated on the terminus by a color band in accordance with the following:

0	Black	4	Yellow	7	Violet
1	Brown	5	Green	8	Gray
2	Red	6	Blue	9	White
3	Orange				

The first color band shall always be yellow in color which indicates fiber optic termini and shall always be assigned a numerical value of four. Color for color bands shall be in accordance with EIA-359. Unless otherwise specified (see 3.1), colors shall remain within the specified limits during testing.

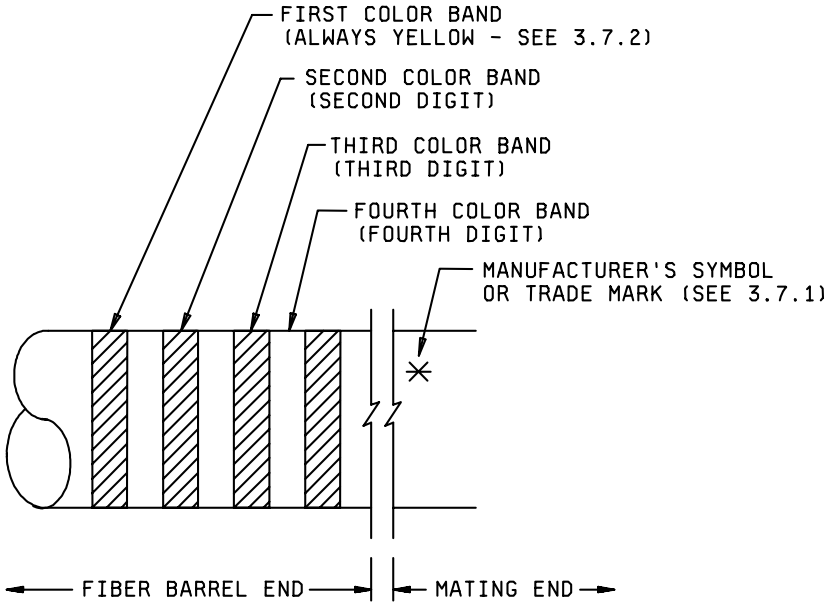


FIGURE 1. Termini identification color coding (TICC).

3.7.3 JAN and J marking. The United States Government has adopted, and is exercising legitimate control over the certification marks "JAN" and "J", respectively, to indicate that items so marked or identified are manufactured to, and meet all the requirements of specifications. Accordingly, items or the packages of items acquired to, and meeting all of the criteria specified herein and in applicable specifications shall bear the certification mark "JAN" except that items too small to bear the certification mark "JAN" shall bear the letter "J". The "JAN" or "J" shall be placed immediately before the part number except that if such location would place a hardship on the manufacturer in connection with such marking, the "JAN" or "J" may be located on the first line above or below the part number, or on the package when item size precludes markings on parts that are too small. Items furnished under contracts or orders which either permit or require deviation from the conditions or requirements specified herein or in applicable specifications shall not bear "JAN" or "J". In the event an item fails to meet the requirements of this specification and the applicable specification sheets or associated specifications, the manufacturer shall remove completely the military part number and the "JAN" or the "J" from the sample tested and also from all items and their packages represented by the sample. The "JAN" or "J" certification mark shall not be used on products acquired to contractor drawings or specifications. The United States Government has obtained Certificate of Registration Number 504,860 for the certification mark "JAN" and Registration Number 1,586,261 for the certification mark "J".

3.8 Workmanship. Termini shall be processed in such a manner as to be uniform in quality and shall be free from foreign material and burrs or sharp corners that might interfere with the termination process, damage the connector or affect mating of the termini.

4. VERIFICATION

4.1 Verification program. Requirements for the verification program shall be as required by the qualifying activity (see 6.3.3).

4.1.2 Assembly plants. Assembly plants shall be listed on, or approved for listing on, the applicable qualified products list. The qualified terminus manufacturer shall certify that the assembly plant is approved for the distribution of the manufacturer's parts. The assembly plant shall use only piece parts supplied by the qualified terminus manufacturer. No testing other than visual examination is required of certified piece parts obtained from the qualified terminus manufacturer, except when there is cause for rejection. All assemblies produced at the assembly plant shall be subjected to examination of the product to assure that the assembly process conforms with that established at the qualified manufacturing plant. Quality control requirements, including Government inspection surveillance, shall be the same as required for the qualified termini manufacturer.

4.2 Test equipment and inspection facilities. Requirements for test equipment and inspection facilities shall be as required by the qualifying activity (see 6.3.4).

4.3 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Materials Inspection (see 4.5).

b. Qualification inspection (see 4.6).

c. Conformance inspection (see 4.7).

4.4 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with the standard test conditions specified in TIA/EIA-455 or as specified herein.

4.5 Materials inspection. Materials inspection shall consist of certification supported by verification that materials used in fabricating the delivered fiber optic termini are in accordance with the requirements of 3.3 and as specified (see 3.1).

4.6 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government, on sample units produced with equipment and procedures normally used in production (see 3.2).

4.6.1 Samples. Fiber optic terminus samples complying with the requirements specified herein and in the specification sheets (see 3.1) shall be submitted for qualification certification. The manufacturer shall provide a counterpart terminus for each terminus subjected to qualifying tests requiring mating assemblies. The counterpart termini provided for this purpose shall be new, previously qualified termini or new termini submitted for qualification testing. Manufacturers not producing mating termini shall substantiate that tests were performed with qualified counterpart termini. For those tests specifying the use of mated termini, optical and mechanical test assessment shall be made using the assigned counterpart termini for those test measurements as required.

4.6.1.1 Sample size. Unless otherwise directed by the qualifying activity (see 6.3), test samples of a minimum of 16 pin termini and 16 mating socket termini of each PIN for which qualification is desired shall be selected at random.

4.6.1.2 Sample preparation. Except for the group I inspection of table I and unless otherwise specified herein, termini shall be fully assembled utilizing two lengths of cable, each at least 5 meters long, containing fiber as specified (see 3.1).

4.6.2 Inspection routine. Samples shall be subjected to the qualification inspection specified in table I. Group I and group II inspections may be performed in any order; however, group III inspections shall be performed in the order specified in the qualification connector specification (see 3.1). In cases where certain requirements are applicable only when specified (see 3.1), these tests shall be conducted in the order shown when specified in the appropriate specification sheet (see 3.1). Tests which are not specified as applicable shall not be conducted. All specimens shall be subjected to the inspections of group I. Sixteen specimens shall be subjected to the inspections of group II. Specimens as required by the qualification connector specification (see 3.1) shall be subjected to the inspections of group III.

4.6.3 Failures. One or more failures shall constitute qualification inspection failure.

4.6.4 Retention of qualification. To retain qualification, the manufacturer shall verify in coordination with the qualifying activity the capability of manufacturing products which meet the performance requirements of this specification. Refer to the qualifying activity for the guidelines necessary to retain qualification to this particular specification. The manufacturer shall immediately notify the qualifying activity at any time that the inspection data indicates failure of the qualified product to meet the performance requirements of this specification.

4.6.4.1 Termini. For termini used in qualified connectors, the tests may be conducted during the regularly scheduled retention of qualification testing with the applicable connector undergoing retention of qualification.

4.6.5 Qualification by similarity. The extent of qualification by similarity shall be as specified in the associated specification sheet and as determined by the qualifying activity.

TABLE I. Qualification inspection.

Inspection	Requirement	Test method
Group I		
Interoperability	3.4.6	4.10
Visual		
Size	3.6.1	4.9.3
Weight	3.6.2	4.9.4
Identification marking	3.6.3	4.9.5
Workmanship	3.8	-
Circular runout	3.6.5	4.9.7
Optical		
Insertion loss	3.5.1	4.8.2
Return loss	3.5.3	4.8.4
Group II		
Terminus insertion and removal forces	3.6.9	4.9.11
Terminus retention	3.6.6	4.9.8
Terminus engagement and separation force	3.6.7	4.9.9
Maintenance aging	3.6.13	4.9.15
Fiber pull out force	3.6.10	4.9.12
Cable pull out force	3.6.11	4.9.13
Mating durability	3.6.12	4.9.14
Terminus cleaning	3.6.4	4.9.6
Group III		
Environmental/mechanical	3.6.8	4.9.10
Fungus resistance	3.3.5	4.9.16

4.7 Conformance inspection. Conformance inspection shall consist of the inspection and optical tests specified for group A inspection (table II), group B inspection (table III), and group C inspection (table IV). Requirements for alternate forms of conformance inspection shall be as identified in the qualification instructions (see 6.3.5).

4.7.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspections.

4.7.1.1 Inspection lot. The inspection lot shall consist of termini offered for inspection at one time, and all of the same design as covered by one specification sheet and PIN. All of the termini in the inspection lot submitted shall have been produced during the same production period with the same materials and processes.

4.7.1.1.1 Sample unit. A sample unit shall be a terminus selected at random from the inspection lot.

4.7.1.1.2 Sample unit preparation. No preparation of the sample unit is required for group A inspections. Unless otherwise specified herein, sample unit termini for group B and C inspections shall be fully assembled utilizing a length of cable, at least 5 meters long, compatible with the terminus under test. The non terminus fiber ends of the cable shall be optically finished to permit optical assessment of the terminus.

4.7.1.1.3 Specimen. A specimen shall be a sample unit prepared in accordance with 4.7.1.1.2.

4.7.1.2 Group A inspection. Group A inspection shall consist of the inspection tests specified in table II. The inspection tests may be performed in any convenient order.

4.7.1.2.1 Sampling plan. Tests shall be performed on 100 percent of the product supplied under this specification.

4.7.1.2.2 Failures. One or more failures shall constitute group A inspection failure of the sample unit.

4.7.1.2.3 Disposition of sample units. Sample units that have failed any of the group A inspection tests shall not be shipped or submitted for group B testing.

TABLE II. Group A inspection.

Inspection	Requirement	Test method
Visual and mechanical		
Size 1/	3.6.1	4.9.3
Identification marking	3.6.3	4.9.5
Workmanship	3.8	-

1/ In-process controls may be used by the manufacturer in lieu of this group A test.

4.7.1.3 Group B inspection. Group B inspection shall consist of the inspections and optical tests specified in table III and shall be performed on sample units which have been subjected to and passed group A inspection. The maximum time from the end of one group B inspection to the beginning of the following group B inspection shall be not greater than 24 months.

TABLE III. Group B inspection.

Inspection	Requirement	Test method
Circular runout	3.6.5	4.9.7
Terminus retention	3.6.6	4.9.8
Terminus engagement and separation force	3.6.7	4.9.9

4.7.1.3.1 Sampling plan. A minimum of sixteen sample units shall be selected from a lot of the same PIN within 24 months after the date of notification of qualification and during every 24 month period thereafter, except, when the total production in a 24 month period is less than 500 units of product or a total of 60 months have elapsed since the inspection was performed, in which case only eight specimens shall be tested. At no time shall the group B inspections be extended beyond 60 months.

4.7.1.3.2 Failures. If one or more sample units fail to pass group B inspection, the lot from which the samples were selected shall be rejected.

4.7.1.3.3 Rejected lots. Requirements regarding the rework of rejected lots shall be as identified in the qualification instructions (see 6.4.1).

4.7.1.3.4 Disposition of sample units. Sample units that have passed all inspection tests of group B may be shipped or tested to group C. Sample units which have failed any of the group B inspection tests shall not be shipped, even though the lot submitted is accepted.

4.7.2 Periodic inspection (group C). Inspection of product for qualification verification shall consist of group C inspections, as specified in table IV. The inspections shall be run in the order shown on sample units which have passed group A and B inspections. Except where the results of the inspections show non compliance with the applicable requirements (see 4.7.2.1.4), delivery of inspection lots which have passed group B inspection shall not be delayed pending the results of group C inspection. Group C inspection shall be performed every 60 months following notification of qualification acceptance.

4.7.2.1 Group C inspection. Group C inspection shall consist of the tests specified in table IV in the order shown. Group C inspection shall be performed on sample units of each style and selected from the inspection lots which have passed group A and B inspections. Group C inspection sample shall be representative of production.

4.7.2.1.1 Sampling plan. Every 60 months, a minimum of sixteen sample units of the same PIN, which have passed group B inspection shall be selected. Sixteen specimens shall be subjected to the inspections of groups I and II. Specimens as required by the qualification connector specification (see 3.1) shall be subjected to the inspections of group III.

4.7.2.1.2 Failures One or more specimen or sample unit failures shall constitute group C inspection failure.

4.7.2.1.3 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be shipped.

TABLE IV. Group C inspection.

Inspection	Requirement	Test method
Group I		
Insertion loss	3.5.1	4.8.2
Return loss	3.5.3	4.8.4
Group II		
Terminus insertion and removal forces	3.6.9	4.9.11
Maintenance aging	3.6.13	4.9.15
Fiber pull out force	3.6.10	4.9.12
Cable pull out force	3.6.11	4.9.13
Mating durability	3.6.12	4.9.14
Group III		
Environmental/mechanical	3.6.8	4.9.10

4.7.2.1.4 Noncompliance. Requirements regarding failure of group C inspection shall be as identified in the qualification instructions (see 6.4.2).

4.8 Optical conformance test methods. Cladding power shall be removed. In those cases where the fiber coating does not adequately perform this function, cladding mode strippers shall be used between the source and the terminus and between the terminus and the detector. Multiple fibers may not be concatenated during the measurement of change in optical transmittance or optical discontinuity. The center wavelength of test shall be 1330 $\pm$ 20 nm. Launch conditions shall be as in table V.

TABLE V. Light launch conditions.

Fiber type	Launch conditions
Single-mode	30 mm diameter mandrel
Multimode	Uniform overfill (initial insertion loss only) and 70/70 restricted or equivalent

4.8.1 Equivalent test methods. The use of equivalent test methods is allowed provided the preparing activity and the qualifying activity have approved the use of that equivalent test method by that manufacturer (see 6.3.5).

4.8.2 Insertion loss. The initial insertion loss of multimode termini shall be measured in accordance with method A of TIA/EIA-455-34, using both 70/70 and overfill launch conditions. For subsequent insertion loss tests, 70/70 launch conditions or equivalent shall be used. The insertion loss of single-mode termini shall be measured in accordance with method B of TIA/EIA-455-34 (see 3.5.1).

4.8.3 Discontinuity. Termini shall be tested in accordance with TIA/EIA-455-32 using equipment having a time resolution sufficient to resolve discontinuities of duration not less than 50 microseconds (µs) (see 3.5.2).

4.8.4 Return loss. The return loss shall be measured in accordance with EIA/TIA-455-107 or equivalent (see 3.5.3).

4.8.5 Change in optical transmittance. The change in optical transmittance shall be measured in accordance with TIA/EIA-455-20, utilizing a monitor fiber to evaluate the change in transmittance due to exposure of the terminus to environmental/mechanical and other tests (see 3.5.4).

4.9 Methods of inspection.

4.9.1 Equivalent test methods. The use of equivalent test methods is allowed provided the preparing activity and the qualifying activity have approved the use of that equivalent test method by that manufacturer (see 6.3.5).

4.9.2 Visual and mechanical examination. Visual and mechanical examinations shall be performed in accordance with TIA/EIA-455-13 to verify that the design, construction, physical characteristics, dimensions, marking, and workmanship are in accordance with the applicable requirements (see 3.4, 3.6, 3.7, and 3.8).

4.9.3 Size. Each of the dimensions specified in the specification sheet (see 3.1) for the termini shall be measured using calibrated measuring devices with the range, precision and accuracy appropriate for the tolerances specified (see 3.1 and 3.6.1).

4.9.4 Weight. The terminus shall be weighed using calibrated scales having the range, precision and accuracy appropriate for the tolerances specified (see 3.1 and 3.6.2).

4.9.5 Identification marking. Identification markings on termini shall be visually examined and measured for conformance with the requirements of 3.6.3.

4.9.6 Terminus cleaning. The optical face of each terminus shall be cleaned according to the instructions supplied by the manufacturer. The terminus may be removed from its operational position, and the alignment sleeve may be removed to facilitate cleaning (see 3.6.4).

4.9.7 Circular runout. Termini shall be tested in accordance with TIA/EIA-455-135 (see 3.6.5).

4.9.8 Terminus retention. Termini shall be inserted into the appropriate qualification connector (see 3.1) and tested as follows: Termini shall be subjected to axial compressive loads applied to the front face of the terminus tending to push the terminus to the rear of the connector insert. (Care must be exercised in the design of the force application mechanism so that it does not physically touch the optical fiber endface.) A preload not greater than 3 lbs (13.4 N) may be used to seat the terminus for the initial position measurement. Axial loads shall be applied at a rate 4.4 N per second up to the maximum load specified (see 3.6.6). The terminus position shall be measured while under the maximum load specified. The maximum load specified shall be maintained for a minimum of five seconds.

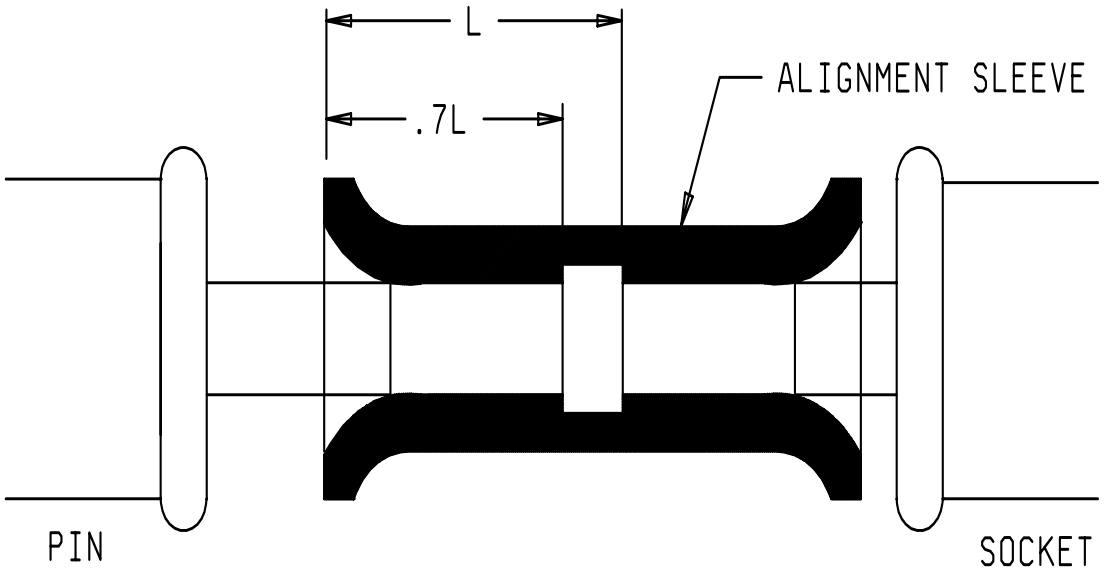
4.9.9 Terminus engagement and separation force. Sockets shall be mounted in a suitable fixture for applying gradually increasing loads for the engagement and separation of the specified test pins. The test pins shall be inserted a minimum of 0.7 L (see figure 2). A maximum diameter test pin shall be inserted and removed from each socket termini. The engagement force shall be measured during insertion. A minimum diameter test pin shall be inserted and removed from each socket termini and the separation force shall be measured during removal (see 3.6.7). The test pin shall be cleaned periodically to remove any surface buildup which may affect the measured engagement and separation force.

4.9.10 Environmental/mechanical. Termini shall be installed in the applicable qualification connector (see 3.1) and subjected to the environmental/mechanical tests specified in the associated specification sheet (see 3.1). Termini shall meet the requirements of 3.6.8. Change in optical transmittance (see 4.8.5) and optical discontinuity (see 4.8.3) shall be monitored as specified in the associated specification sheet (see 3.1).

4.9.11 Terminus insertion and removal forces. Pin and socket termini shall be inserted into a qualification connector using a terminus insertion tool, and the force required to insert the terminus shall be measured (see 3.6.9). A terminus removal tool shall then be engaged to unlock the terminus. The terminus shall be removed, and the force required to remove the terminus shall be measured.

4.9.12 Fiber pull out force. Pin and socket termini shall be installed and mated in a qualification connector. The fiber pull out force shall be tested by applying the axial tensile load specified between the fiber and the terminus for a duration of one minute (see 3.6.10). The change in optical transmittance shall be monitored during and after the test in accordance with 4.8.5. After the test the terminus shall be removed from the qualification connector and visually examined in accordance with 4.9.2.

4.9.13 Cable pull out force. Cable pull out force shall be tested in accordance with EIA/TIA-455-6. Pin and socket termini shall be installed and mated in a qualification connector (see 3.1). The axial tensile load shall be applied between the cable and the terminus up to the load specified and shall be maintained for a minimum of 1 minute (see 3.6.11). The change in optical transmittance shall be measured during and after the test in accordance with 4.8.5. At the completion of the test, the terminus shall be removed from the qualification connector and visually examined in accordance with 4.9.2.



L = Distance from socket end face to
the end of the alignment sleeve.

FIGURE 2. Minimum depth of engagement for termini engagement and separation force tests.

4.9.14 Mating durability. Termini shall be installed in a qualification connector and mated and unmated in accordance with EIA/TIA-455-6 (see 3.6.12). The change in optical transmittance (see 4.8.5) shall be measured every 100 mating cycles during the test and after the test. The terminus engagement and separation force shall be measured after the test. Cleaning of the termini is permitted during and after completion of the test in order to meet the requirements of 3.5.4.

4.9.15 Maintenance aging. Pin and socket termini shall be inserted into a qualification connector using a terminus insertion tool (see 3.6.13). The force required to insert the terminus shall be measured on the first and last cycle. A terminus removal tool shall be engaged to unlock the terminus and the terminus removed. The force required to remove the terminus shall be measured on the first and last cycle.

4.9.16 Fungus resistance. Termini composed of materials not listed as fungus inert in guideline 4 of MIL-HDBK-454 shall be tested in accordance with TIA/EIA-455-56 (see 3.3.5).

4.10 Interoperability. Unless otherwise specified (see 3.1), test samples and qualified termini shall be inserted into qualification connectors (see 3.1) as specified in table VI (see 3.4.6). Insertion loss shall be measured in accordance with 4.8.2. The terminus insertion and removal forces shall be measured in accordance with 4.9.11. The terminus retention force shall be measured in accordance with 4.9.8.

TABLE VI. Interoperability test configurations.

Configuration #	Receptacle sockets	Plug pins
1	Qualified	Candidate
2	Candidate	Qualified
3	Candidate	Candidate

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The fiber optic termini covered by this specification are intended for use in military applications where their performance characteristics are required. The termini covered by this specification are unique due to the fact that these devices must be able to operate satisfactorily in systems under the following demanding conditions: 10 g's vibration and over 1000 g's of shock. In addition, these requirements are verified under a qualification system. Commercial termini are not designed to withstand these environmental conditions.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1).
c. Specification sheet number, title and date.
d. Packaging requirements (see 5.1).
e PIN (see 6.6).
f. Quantity of termini required.
g. Exception, if any, to the optional provisions of this specification including:
(1) Special preparation for delivery requirements, if applicable (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL-29504, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Commander, Naval Sea Systems Command, (SEA 05QV), 2531 Jefferson Davis Highway, Arlington, VA 22242-5160; however, information pertaining to qualification of products may be obtained from the agent for the qualifying activity: Defense Supply Center Columbus, (ATTN: DSCC-VQ), P.O. Box 3990, Columbus, OH 43216-5000 (see 3.2 and 4.6).

6.3.1 Conformity to qualification sample. It is understood that termini supplied under the contract should be identical in every respect to the qualification sample tested and found satisfactory, except for changes previously approved by the Government. Any unapproved changes from the qualification sample will constitute cause for rejection.

6.3.2 Provisions governing qualification SD-6. Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Standardization Documents Order Desk, 700 Robbins Ave, Bldg 4D, Philadelphia, PA 19111-5094.

6.3.3 Verification program. A verification program must be established and maintained in accordance with MIL-STD-790 or equivalent standard. Evidence of such compliance will be verified by the qualifying activity of this specification as a prerequisite for qualification and continued qualification. Results of audits to MIL-STD-790 equivalent quality assurance standards by third parties must be available to the government for review. The verification system procedures, planning and all other documentation and data that comprise the verification system must be available to the Government for review. The Government may perform any necessary inspections, verifications and evaluations to ascertain conformance to the requirements and adequacy of the implementing procedures (see 4.1).

6.3.4 Test equipment and inspection facilities. Provision for test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections must be the responsibility of the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment must be in accordance with NCSL Z540-1, ISO 10012, or equivalent standard (see 4.2).

6.3.5 Alternative forms of conformance inspection and equivalent test methods. Requests for alternate forms of conformance inspection (see 4.7) must be submitted to the qualifying activity and to the preparing activity. Alternate forms of conformance inspection may be used upon written approval by the qualifying activity and by the preparing activity. The use of equivalent test methods is allowed (see 4.9.1). The manufacturer must have conducted both test methods and have submitted complete test data to the preparing activity and to the qualifying activity verifying the equivalency of each equivalent test method proposed.

6.3.6 Forwarding of qualification samples. Samples and the manufacturer's certified test reports must be forwarded to the testing laboratory designated in the letter of authorization from the activity responsible for qualification (see 6.3). Samples will be plainly identified by securely attached, durable tags marked with the following information:

a. Sample for qualification test.
b. "MIL-PRF-29504B".
c. Specification sheet part number.
d. Manufacturer's name and CAGE code number.
e. Manufacturer's part number.
f. Comprehensive description and prime manufacturer's name and formulation number of the base materials from which the product is made. (This information will not be divulged by the Government.)
g. Place and date of manufacture of sample.
h. Submitted by (name) (date) for qualification tests in accordance with the requirements of MIL-PRF-29504 under authorization (reference authorizing letter).

6.3.7 Optical transmittance instrumentation stability. Optical transmittance instrumentation should be subjected to the following stability tests before qualification testing is performed. The first test should consist of measuring the transmitted power through each channel once every minute for a four hour period. The second test should consist of measuring the transmitted power through each channel once every 30 minutes for a 96 hour period. The data for each channel should be analyzed to determine average transmittance, minimum and maximum transmittance, the standard deviation of the transmittance, and the minimum and maximum percent deviation of the transmittance.

6.3.8 Government witnessing of qualification tests. The qualification activity may require that a government witness be present during the following tests: size, insertion loss (including assembly fabrication), terminus insertion and removal forces, cable retention, mating durability, temperature cycling, mechanical shock, and thermal shock.

6.4 Conformance inspection.

6.4.1 Rejected lots. If an inspection lot is rejected, the contractor may rework it to correct defects, screen out the defective units and resubmit it for reinspection. Resubmitted lots should be inspected using tightened inspection.

6.4.2 Noncompliance. If a sample fails to pass group C inspection, the manufacturer should notify the qualifying activity of the failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials and processes, and so forth, and which are considered subject to the same failure. Acceptance of the product should be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, group C inspection should be repeated on additional sample units (all inspections tests or the inspection test which the original sample failed, at the option of the Government). Groups A and B inspections may be reinstituted; however, final acceptance should be withheld until the group C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken should be furnished to the cognizant inspection activity and to the qualifying activity.

6.5 TICC code bands. Color bands are intended for identification of termini before they are installed in the connector and prior to termini crimping (see 3.7 2).

6.6 Part or Identifying Number (PIN). Each terminus should be identified by four distinct color bands indicating the TICC as specified herein (see 3.7). The PIN should contain only the following:

M29504	/XX	-XXXX	X
Basic specification	specification sheet	TICC Code	1 character alpha numeric

6.7 Personnel safety. Care should be taken when handling the very fine (small diameter) optical fibers to prevent skin puncture or contact of fiber with the eye area. Also, direct viewing of the optical terminal face of a terminated cable, while it is propagating optical energy, is not recommended unless the radiation is in the visible portion of the optical spectrum, of sufficiently low power, and needed to perform test examinations not obtainable by other methods.

6.8 Subject term (key word listing).

Discontinuity
Engagement force
Insert
Insertion loss
Optical performance requirements
Retention
Return loss
Separation force

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

Custodians:
Army - CR
Navy - SH
Air Force - 11
DLA - CC
NASA - NA

Review activities:
Navy - AS
Air Force - 03, 13, 19, 33, 93, 99
DIA - DI

Preparing activity:
Navy - SH

Agent:
DLA - CC

(Project 6060-0132)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-29504B	**2. DOCUMENT DATE (YYMMDD)**

3. DOCUMENT TITLE
TERMINI, FIBER OPTIC CONNECTOR, REMOVABLE, GENERAL SPECIFICATION FOR

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME Gair Brown	b. TELEPHONE (Include Area Code) (1) Commercial (540) 653-1579 (2) AUTOVON 249-1579
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command ATTN: SEA 05Q 1333 Isaac Hull Avenue SE, Stop 5160 Washington Navy Yard, DC 20376-5160	**IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:** Defense Standardization Program Office (DLSC-LM) 8725 John J. Kingman Road, Suite 2533 Fort Belvoir, Virginia 22060-6221 Telephone (703) 767-6888 DSN 427-6888