The documentation and process conversion measures necessary to comply with this revision shall be completed by 17 June 2015.

METRIC
MIL-PRF-85045G
17 June 2014
SUPERSEDING
MIL-PRF-85045F
12 August 1999

PERFORMANCE SPECIFICATION

CABLES, FIBER OPTIC, 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 cables utilizing optical fibers for signal transmission.

1.2 Classification. Cables covered by this specification consist of one or more single fibers and optical transmission elements with properties as specified (see 3.1) and are of the following configuration types, classes, and applications:

1.2.1 Fiber optic cable configuration type. The fiber optic cable configuration type (see 3.4.2) is designated by a single number as indicated in table I.

TABLE I. Fiber optic cable configuration type.

Cable configuration type	Designation
Buffered fiber 1/	1
OFCC 2/	2
Cable bundle 3/	3
Ribbon cable 4/	4
Tube cable 5/	5

NOTES:
1/ The cable is constructed using buffered fibers (see 6.5.2) with no individual protective jackets or strength members.
2/ The cable is constructed using Optical Fiber Cable Components (OFCCs) (see 6.5.8) that are not grouped into bundles having bundle jackets or binders (see 6.5.4 and 6.5.1).
3/ The cable is constructed using buffered fibers or OFCCs that are grouped into cable bundles (see 6.5.3) with bundle jackets or binders.
4/ The cable is constructed using fiber ribbons (see 6.5.9).
5/ The cable is constructed using hollow tubes or ducts.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy mil, with the subject line "Document Comment". 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/.

1.2.2 Class. The class designation is defined by the mode volume of the optical fiber.

a. MM – Multimode
b. SM – Single-mode

1.2.3 Application. The application designation is defined by the intended application of the optical cable.

a. Airborne (A)
b. Shipboard (B)
c. Ground benign (G)
d. Space (S)
e. Ground tactical (T)

1.2.4 Part or identifying number (PIN). The PIN is constructed in accordance with the following:

M	**85045**	**/X**	**-**	**XXXX**	**-**	**XXXX**
Prefix for Military Specification	Specification Number	Spec Sheet No.		Two-, three-, or four-character alpha numeric		Two sets of two-character numeric (when specified, see 3.1)

Examples: M85045/02-001
M85045/24-03-1872

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 of 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 cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

TT-P-645 - Paint, Alkyd Type, Formula Number 84

FEDERAL STANDARDS

FED-STD-228 - Test Methods for Cables and Wire, Insulated

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for

MIL-S-24235 - Stuffing Tubes, Metal, and Packing Assemblies for Electric Cables, General Specification for

MIL-I-24728 - Interconnection Box, Fiber Optic, Metric, General Specification for

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

(See supplement 1 for list of specification sheets.)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1678-2 - Fiber Optic Cabling Systems Requirements and Measurements (Part 2: Optical Measurements) (Part 2 of 6 Parts)

MIL-STD-1678-3 - Fiber Optic Cabling Systems Requirements and Measurements, Physical, Mechanical, Environmental and Material Measurements (Part 3 of 6 Parts)

MIL-STD-2003-4 - Electric Plant Installation Standard Methods for Surface Ships and Submarines (Cableways)

MIL-STD-2042 - Fiber Optic Cable Topology Installation Standard Methods for Naval Ships

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-454 - General Guidelines for Electronic Equipment

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

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

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-STD-6001 - Flammability, Offgassing, and Compatibility Requirements and Test Procedures

(Copies of this document are available online at https://standards.nasa.gov.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9510-AB-ATM-010 - Nuclear Powered Submarine Atmosphere Control Manual

(Copies of this document are available online at https://nll.ahf.nmci navy mil, may be requested by phone at 215-697-2626, or may be requested by email at nllhelpdesk@navy mil. This publication can be located by searching the Navy Publications Index for the TMIN without the suffix.)

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.

ASTM INTERNATIONAL

ASTM D470 - Standard Test Methods for Crosslinked Insulations and Jackets for Wire and Cable

ASTM D512 - Standard Test Methods for Chloride Ion in Water

ASTM D1141 - Standard Practice for the Preparation of Substitute Ocean Water

ASTM D1179 - Standard Test Methods for Fluoride Ion in Water

ASTM D1246 - Standard Test Method for Bromide Ion in Water

ASTM D3761 - Standard Test Method for Total Fluorine in Coal by the Oxygen Bomb Combustion/Ion Selective Electrode Method

ASTM D3868 - Standard Test Method for Fluoride Ions in Brackish Water, Seawater, and Brines

ASTM D3869 - Standard Test Methods for Iodide and Bromide Ions in Brackish Water, Seawater, and Brines

ASTM D4327 - Standard Test Method for Anions in Water by Suppressed Ion Chromatography

ASTM E595 - Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment

ASTM E800 - Standard Guide for Measurement of Gases Present or Generated During Fires

(Copies of these documents are available online at www.astm.org.)

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60794-1-2 - Optical Fibre Cables – Part 1-2: Generic Specification – Cross Reference Table for Optical Cable Test Procedures

(Copies of this document are available online at www.iec.ch.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 17025 - General Requirements for the Competence of Testing and Calibration Laboratories

(Copies of this document are available online at www.iso.org.)

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

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

TIA-455-13 – Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies

TIA-455-25 - Impact Testing of Optical Fiber Cables

TIA-455-33 - Optical Fiber Cable Tensile Loading and Bending Test

TIA-455-37 - Low or High Temperature Bend Test for Fiber Optic Cable

TIA-455-39 - Optical Fiber Cable Water Wicking Test

TIA/EIA-455-41 - Compressive Loading Resistance of Fiber Optic Cables

TIA/EIA-455-81 - Compound Flow (Drip) Test for Filled Fiber Optic Cable

TIA-455-84 - Jacket Self-Adhesion (Blocking) Test for Fiber Optic Cable

TIA-455-87 - Fiber Optic Cable Knot Test

TIA/EIA-455-88 - Fiber Optic Cable Bend Test

TIA-455-91 - Fiber Optic Cable Twist-Bend Test

TIA-455-104 - Fiber Optic Cable Cyclic Flexing Test

TIA-598 - Optical Fiber Cable Color Coding

(Copies of these documents are available online at www.tiaonline.org.)

UK MINISTRY OF DEFENCE'S DIRECTORATE OF STANDARDISATION (DSTAN)

MODUK DEF STAN 02-711 - Determination of the Smoke Index of the Products of Combustion from Small Specimens of Materials

(Copies of this document are available online at www.dstan.mod.uk.)

UNDERWRITERS LABORATORIES, INC. (UL)

UL 1685 - Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

(Copies of this document are available online at www.comm-2000.com.)

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 (except for related 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 (see 6.2).

3.2 Qualification. Fiber optic cables 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 4.5 and 6.3).

3.3 Materials. The cable shall be constructed of material as specified (see 3.1). Materials selected for cable usage shall be of a type and quality to assure compliance with the requirements of this specification, and shall be physically and chemically compatible for their intended use and throughout their intended lifetime. All combinations of materials used shall be non-nutrient to fungus and of a virgin nature. When specified (see 3.1), materials and combinations of materials used in cable construction shall meet the requirements for toxic or explosive fumes produced by flame. Materials and combinations of materials used in cable construction shall have no adverse effect on the health of personnel or equipment when used for its intended purpose.

3.3.1 Recycled, recovered, environmentally preferable, or biobased materials. Recycled, recovered, environmentally preferable, or biobased 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.

3.3.2 Filler. The fillers shall be evenly distributed, easily removable, and shall provide compactness and cross-sectional circularity to the finished cable.

3.3.2.1 Water-blocking material. Water-blocking material used in cable interstices shall be compatible with all other cable materials. Unless otherwise specified (see 3.1), the material shall be clean, non-tacky, and non-irritating to the touch when not exposed to moisture. The material shall be free-stripping from the cables and components by hand and shall not require the use of chemicals or other mechanical means or removal. The material shall not interfere with any termination technique used with finished cable of components.

3.3.3 Strength members. Unless otherwise specified (see 3.1), strength members shall be all dielectric.

3.3.4 Jackets. Materials used for jackets (inner and outer) shall be as specified (see 3.1).

3.3.5 Cable nuclear vulnerability. When specified (see 3.1), materials shall meet the nuclear vulnerability requirements specified in appendices to the individual specification sheets.

3.3.6 Materials for space applications. When specified (see 3.1), materials used in space flight applications shall meet the following additional material requirements.

3.3.6.1 Thermal vacuum outgassing. When specified (see 3.1) and when tested in accordance with 4.8.5.1, all non-metallic materials shall not exhibit greater than 1.0 percent total mass loss and shall not produce greater than 0.1 percent collected volatile condensable materials.

3.3.6.2 Material flammability. When specified (see 3.1) and when tested in accordance with 4.8.5.2, non-metallic materials shall be considered non-flammable or self-extinguishing if less than 6 inches of the minimum use thickness sample is consumed and the time of burning does not exceed 10 minutes. There shall be no sparking, sputtering, or dripping of flaming particles from the test sample.

3.3.6.3 Material toxicity (off-gassing). When specified (see 3.1) and when tested in accordance with 4.8.5.3, all non-metallic materials shall not exceed a total hazard index of 0.5.

3.3.7 Ambient toxicity. When specified (see 3.1), material samples shall meet the requirements of 4.8.7.

3.4 Design and construction. The design, construction, and physical dimensions of the complete cable and cable elements shall be as specified (see 3.1). The cable shall consist of one or more optical transmission elements individually surrounded by protective layers to provide performance and dimensional characteristics as specified (see 3.1). Unless otherwise specified (see 3.1), the cable shall be of a circular cross-section and concentric geometry. The surface of the jacket shall be dry and free from any coating, film, or treatment, which would interfere with the bonding to the jacket of encapsulating or molding materials used in splicing and terminating. Unless otherwise specified (see 3.1), finished cable and OFCC short-term (dynamic) minimum bend diameter (see 6.5.10) shall be as listed in table II. The cable and the cable components shall be designed to comply with the specified properties while subject to specific operating and storage temperature ranges as specified (see 3.1). The long-term (static) minimum bend diameter (see 6.5.7) shall be specified (see 3.1).

TABLE II. Minimum short-term bend diameter.

Application	Bend diameter to cable diameter (or OFCC diameter)
Ground tactical (T)	5X
Shipboard (B)	8X
Ground benign (G)	24X

3.4.1 Optical fibers. Optical fibers shall be in accordance with MIL-PRF-49291 and the applicable specification sheets (see 3.1). The optical fiber shall be coated with a material to preserve the high, pristine tensile strength of the glass fiber. The fiber and coatings shall maintain their physical characteristics at temperatures not greater than 85 °C. Coating and buffer material shall be readily removable by mechanical means.

3.4.1.1 Number of fibers. The number of optical fibers in the cable shall be specified (see 3.1).

3.4.2 Cable configuration. The detailed cable configuration shall be as specified (see 3.1) and shall be either a buffered fiber, an OFCC, a cable bundle, a ribbon cable, or a tube cable (see 1.2.1).

3.4.2.1 Buffered fibers. Unless otherwise specified (see 3.1), the outer diameter of the buffered fiber shall be 900 micrometers. The buffer design shall be tight buffer, and the concentricity of the buffer shall be greater than or equal to 0.65 for 900-micrometer buffered fibers.

3.4.2.1.1 Buffered fiber color coding. Unless otherwise specified (see 3.1 and 6.2), individual fiber buffers shall be color-coded for identification in accordance with TIA-598. The fiber buffer within an OFCC shall be color-coded the same as the OFCC jacket color code.

3.4.2.2 Optical fiber cable component (OFCC). The OFCC dimensions and concentricity requirements shall be as specified (see 3.1).

3.4.2.2.1 OFCC jacket color coding. Unless otherwise specified (see 3.1 and 6.2), individual OFCC jackets shall be color-coded for identification in accordance with TIA-598. For cable designs with more than 12 OFCCs within a bundle, the OFCCs may be marked for identification in lieu of color coding.

3.4.2.2.2 OFCC kink. For Type 2 cables or cables containing OFCCs, OFCC kink shall be tested in accordance with 4.7.3.5. Visual inspection shall reveal no kinking, cracking, splitting, tearing, or collapsing of the OFCC jacket for free form loop diameters not less than the minimum short-term bend diameter of the OFCC.

3.4.2.3 Cable bundle jacket. The cable bundle jacket dimensions and concentricity requirements shall be as specified in the specification sheet (see 3.1).

3.4.2.3.1 Cable bundle jacket color coding. Unless otherwise specified (see 3.1), individual cable bundle jackets shall be color-coded for identification in accordance with TIA-598.

3.4.2.4 Optical fiber ribbon (type 4 only). The dimensional requirements and the number of fibers per ribbon for the optical fiber ribbons shall be as specified (see 3.1). A ribbon shall consist of a linear array of nominally contiguous fibers which are held between the adhesive faces of two pressure sensitive tapes or are bonded together with a matrix material. The ribbons shall have no crossovers, defective fibers, or splices.

3.4.2.4.1 Ribbon fiber color coding. Unless otherwise specified (see 3.1), each fiber in a ribbon shall be color-coded for identification in accordance with TIA-598.

3.4.2.4.2 Ribbon color coding. Ribbon color coding shall be as specified (see 3.1).

3.4.2.5 Binders. The dimensional requirements and the number of fibers, buffered fibers, or OFCCs for each binder shall be as specified (see 3.1).

3.4.2.5.1 Binder color coding. Unless otherwise specified (see 3.1), each binder shall be color-coded for identification in accordance with TIA-598.

3.4.2.6 Cable tubes. The dimensional requirements for cable tubes shall be as specified (see 3.1).

3.4.2.6.1 Cable tube color coding. Cable tube color coding shall be as specified (see 3.1).

3.4.3 Cable jacket. The cable jacket shall provide environmental and physical protection to the enclosed cable elements. The cable jacket shall be applied concentrically to the cable core (see 6.5.5) to maintain circularity in the completed cable. Jacket dimensions and dimensional tolerances shall be as specified (see 3.1). The concentricity of the jacket shall be equal to or greater than 0.65. This requirement applies to primary layers, coatings, or underlying jackets. The jackets shall be easily removable without damage to other cable component members as specified in 3.6.18. The jackets shall be dry and free from any coating, film, or treatment that would tend to interfere with the bonding of it to encapsulating or molding materials used in splicing and terminating. All jackets shall be free of pinholes, blowouts, and bumps (see 4.7.2).

3.4.3.1 Cable and cable core component (see 6.5.6) jacket colors. Unless otherwise specified (see 3.1 and 6.2), the color of the overall cable jacket shall be black or blue. The individual OFCC jackets and cable bundle jackets shall be separately color-coded as specified in 3.4.2.2.1 and 3.4.2.3.1, respectively. The ribbon fibers and ribbons shall be color-coded as specified in 3.4.2.4.1 and 3.4.2.4.2, respectively.

3.4.4 Fillers. Fillers may be used to provide firmness, roundness, and water-tightness of finished cables. Fillers shall be made of electrically non-conducting material meeting the applicable requirements of 3.5, 3.6, and 3.7. Filler material shall be of a consistency so as to not induce attenuation during the cabling process and shall have physical properties so as to prevent changes in optical parameters when the cable is subjected to the physical and environmental tests specified (see 3.1). The fillers shall be removable in accordance with 3.6.18.

3.4.5 Strength and central members. The strength members shall consist of peripheral layers of non-electrically conducting materials as specified (see 3.1). If a central member is specified (see 3.1), the central member shall be electrically non-conductive.

3.4.6 Cabling. Optical cables shall be cabled as specified (see 3.1). The length of lay shall be that required to meet the minimum specified bend radius, flexing, and twisting-bending requirements. Strength members, fillers, and central members may contain splices. Splices in the strength members, fillers, and central members shall be dimensionally indistinguishable within the manufacturer's tolerances from the unspliced components. The splice strength shall be not less than the strength of the unspliced material.

3.4.6.1 Cable physical dimensions. When tested in accordance with 4.7.3.1 and 4.7.3.2, the physical dimensions of the finished cable shall be as specified (see 3.1).

3.4.6.2 Concentricity. When tested in accordance with 4.7.3.3, the concentricity of the finished cable, OFCC, buffered fiber(s), and cable bundle(s) shall be as specified (see 3.1). The concentricity shall be greater than or equal to 0.65, and shall apply to jackets and underlying jackets.

3.4.6.3 Cable mass per unit length. When tested in accordance with 4.7.3.4, the mass per unit length of a fully assembled cable shall not exceed the value specified (see 3.1).

3.4.6.4 Cable continuous lengths. Lengths shall be as specified (see 6.2). Fully assembled cable shall be continuous and shall not be repaired or spliced.

3.5 Optical performance requirements.

3.5.1 Attenuation rate. The attenuation rate of the fiber prior to cabling or application of other stresses shall be tested in accordance with 4.7.4.1. Unless otherwise specified (see 3.1), the change in attenuation rate of the optical fiber in the finished cable shall not exceed the values shown in table III from the pre-cabled coated fiber value. The attenuation rate at the wavelengths of operation of the finished cable shall be as specified (see 3.1).

TABLE III. Maximum change in attenuation rate.

Application	Fiber type	Change in attenuation rate (dB/km)
Tactical (T)	Multimode	≤0.5
	Single-mode	≤0.3
Shipboard (B)	Multimode	≤1.0
	Single-mode	≤0.5

3.5.2 Change in optical transmittance. The change in optical transmittance of the cabled fibers due to exposure to mechanical (environmental and physical) tests shall not exceed the values specified in table IV when tested in accordance with 4.7.4.2. The end-resultant attenuation due to cumulative environmental and mechanical testing shall not exceed that specified (see 3.1).

TABLE IV. Maximum change in optical transmittance.

Fiber type	Change in optical transmittance	
	Mechanical (dB)	Environmental 1/
Multimode (MM)	0.5	0.5
Single-mode (SM)	0.2	0.3

NOTE:

1/ The change in optical transmittance requirement for freezing water immersion, gas flame, and shock are for the specified test length and shall not be normalized for 1 kilometer.

3.5.3 Crosstalk. When specified (see 3.1), the cable shall be tested in accordance with 4.7.4.3. The far end crosstalk between any two fibers shall be not greater than -60 decibels below the active fiber optical output level.

3.6 Mechanical performance requirements.

3.6.1 Tensile loading and elongation. After testing a specimen of finished cable or OFCC in accordance with 4.7.5.1, there shall be no evidence of cracking, splitting, or breaking of the cable components or elongation greater than 2 percent. Unless otherwise specified (see 3.1), the change in optical transmittance of each fiber shall not exceed 2.0 decibels during the test and the values specified in 3.5.2 after testing.

3.6.1.1 Operating tensile load. When specified (see 3.1), the cable shall be tested in accordance with 4.7.5.1.1. There shall be no evidence of cracking, splitting, or breaking of the cable components. The change in optical transmittance shall not exceed the values specified in 3.5.2 during or after the test.

3.6.2 Dynamic bend. When tested in accordance with 4.7.5.2, the finished cable or OFCC shall reveal no jacket softening, surface damage (cracking, splitting, or other defect to permit jacket penetration), or identification marking impairment. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after the test.

3.6.3 Low temperature flexibility (cold bend). When tested in accordance with 4.7.5.3, a post-test visual examination of the cable jacket shall reveal no cracking, splitting, or other defect to permit jacket penetration. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 after the test.

3.6.4 Cyclic flexing. When tested in accordance with 4.7.5.4, a post-test visual examination of the cable shall reveal no splitting, cracking, or crazing of the specimen jacket. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after the test.

3.6.5 Crush. When tested in accordance with 4.7.5.5, a post-test visual examination of the cable jacket shall reveal no cracking, splitting, or other defect to permit jacket penetration. Cable exterior deformation shall not be considered as damage or cable failure. The change in optical transmittance shall not exceed the values specified in 3.5.2 during and after the test, and the optical crosstalk shall meet the requirements of 3.5.3 during and after the test.

3.6.6 Cable twist-bending. When tested in accordance with 4.7.5.6, finished cable specimens shall exhibit no evidence of degradation of jacket materials. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after testing. A post-test visual examination shall reveal no jacket softening, surface damage (cracking, splitting, or other defect to permit jacket penetration), or any identification marking impairment which affects legibility.

3.6.7 Radial compression (for application B only). When specified (see 3.1) and when tested in accordance with 4.7.5.7, the finished cable shall reveal no cracking, splitting, or other defect to permit jacket penetration. The change in optical transmittance of each fiber shall not exceed 0.1 decibels during and after the test.

3.6.8 Impact. When tested in accordance with 4.7.5.8, the cable shall meet the following requirements: A visual examination of the cable jacket shall reveal no cracking, splitting, or other defect to permit jacket penetration. The jacket may crack or split on any low temperature impact after the second low temperature impact. The change in optical transmittance shall not exceed the values specified in 3.5.2 after the test.

3.6.9 Corner bend. Unless otherwise specified (see 3.1), cables shall be tested in accordance with 4.7.5.9. A post-test visual examination shall reveal no cracking, splitting, or tearing of the cable. The change in optical transmittance shall not exceed the values specified in 3.5.2 during and after the test.

3.6.10 Knot. When specified (see 3.1), the cable shall be tested in accordance with 4.7.5.10. A post-test visual inspection shall reveal no cracking, splitting, or tearing of the cable. The change in optical transmittance shall not exceed the values specified in 3.5.2 during and after the test.

3.6.11 Pressure cycling (for application B only). When specified (see 3.1), during the test specified in 4.7.5.11, the change in optical transmittance for each fiber shall not exceed the values specified in 3.5.2.

3.6.12 Hosing (for application B only). When specified (see 3.1) and when tested in accordance with 4.7.5.12, the requirements of 3.6.12.1 and 3.6.12.2 apply only to water-blocked cables.

3.6.12.1 Low pressure. When tested in accordance with 4.7.5.12.1, water leakage through the cable specimen shall be only axial and shall not exceed 35 milliliters.

3.6.12.2 Hydrostatic. When tested in accordance with 4.7.5.12.2, the cable specimen shall permit no more than 1000 milliliters times the squared cable outer diameter (in centimeters) flow of axial water, and no more than 20.0 millimeters slippage of cable internal parts (strength members, OFCCs, fillers, etc.). Splitting or cracking of the cable between the gland nuts (inside of the stuffing tube) is allowed.

3.6.13 Dripping. When specified (see 3.1), the cable shall be tested in accordance with 4.7.5.13. A post-test visual inspection of the lower vertical cable end shall reveal no evidence of globule formation nor shall any dripping be observed on the drip collector.

3.6.14 Cable jacket tear strength. When tested in accordance with 4.7.5.14, the cable jacket tear strength shall be not less than 60 Newtons per centimeter (N/cm) of jacket thickness.

3.6.15 Cable jacket material tensile strength and elongation. When tested in accordance with 4.7.5.15, the tensile strength of the cable and cable component jacket materials shall be not less than 900 Newtons per square centimeter (N/cm^2). The percent elongation shall be not less than 125 percent.

3.6.16 Cable abrasion resistance. When tested in accordance with 4.7.5.16, the cable shall withstand 250 cycles of scraping abrasion and 150 cycles of cable-to-cable abrasion. Unless otherwise specified (see 3.1), exposure of any layers below the cable jacket shall be considered failure.

3.6.17 Cable shrinkage. When tested in accordance with 4.7.5.17, the total shrinkage of the length of finished cable (and buffered fiber, OFCC, cable bundle jacket, and ribbon, as specified [see 3.1]) shall be not greater than 6.35 millimeters for thermo-set jacket cables and 20 millimeters for thermoplastic jacket cables.

3.6.18 Cable element removability. When tested in accordance with 4.7.5.18, finished cable jacket, OFCC jacket, cable bundle jacket, optical fiber buffer, and ribbon tape shall be easily and cleanly removable by mechanical means without damage to the cable or optical fibers or both. No surface scratches or defects to the optical fiber shall be visible under 10 times magnification after the fiber buffer material has been removed. The cable water-block or filler materials, if applicable, shall be flexible and easily removable from any part to which it is in contact through the use of fingers only. The presence of occasional particles or slivers of filler residue will be acceptable, provided that these can be removed by light brushing with the fingers or with a dry cloth. Filler material which leaves residue that is removable only by vigorous wiping or through the use of solvents shall not be acceptable.

3.6.19 Durability of identification marking. Identification marking, including stripping or banding when specified (see 3.1), when applied to the outer surface of the finished cable, shall be capable of withstanding the durability test specified in 4.7.5.19 for 500 cycles. This test shall not be required when the identification marking is under a clear jacket.

3.6.20 Ribbon delamination (type 4 only). When tested in accordance with 4.7.5.20, the ribbon shall not delaminate.

3.6.21 Stuffing tube compression. When specified (see 3.1) and when tested in accordance with 4.7.5.20, the change in optical transmittance shall not exceed the values specified in 3.5.2 during and after the test.

3.7 Environmental performance requirements. The finished cable shall perform according to all the requirements herein and as specified (see 3.1), during the specified operating environments, and after the specified storage environment. Unless otherwise specified (see 3.1), the operating temperature range and storage temperature range shall be as shown in table V and as specified (see 3.1).

TABLE V. Temperature ranges.

Application	Operating range (°C)	Storage range (°C)
Ground tactical (T)	-46 to +71	-54 to +85
Shipboard (B)	-28 to +65	-40 to +70 1/
Ground benign (G)	-40 to +75	-40 to +75
Airborne (A)	-46 to +125	-54 to +125
Space (S)	-60 to +85	-60 to +85

NOTE:
1/ The shipboard nonoperational temperature range is the same as the shipboard storage temperature range.

3.7.1 Temperature cycling. When tested in accordance with 4.7.6.1, a post-test visual examination shall reveal no jacket softening, surface damage, or identification marking impairment. Post-test cable outer diameter shall remain within ±10 percent of the pretest cable outer diameter. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 at the low and high temperatures during and after the test.

3.7.2 Thermal shock. When tested in accordance with 4.7.6.2, a post-test visual examination shall reveal no jacket softening, surface damage (cracking, splitting, or other defect to permit jacket penetration), or identification marking impairment. Post-test cable outer diameter shall remain within ±10 percent of the pretest cable outer diameter. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 after the test.

3.7.3 Temperature humidity cycling. When tested in accordance with 4.7.6.3, a post-test visual examination shall reveal no jacket softening, surface damage, or identification marking impairment. Post-test cable outer diameter shall remain within ±10 percent of the pretest cable outer diameter. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after the test.

3.7.4 Storage temperature. When specified (see 3.1), the cable shall withstand the test specified in 4.7.6.4. The exterior surface of the test specimens shall show no cracks or defects. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 after the test.

3.7.5 Altitude immersion (previously barometric pressure [reduced]). When specified (see 3.1), the cable shall withstand the test specified in 4.7.6.5. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after the test.

3.7.6 Temperature life (life aging). When tested in accordance with 4.7.6.6, a post-test visual examination shall reveal no jacket softening, surface damage, or identification marking impairment. Post-test cable outer diameter shall remain within ±10 percent of the pretest cable outer diameter. The jacket tensile strength and elongation shall be not less than 75 percent of the initial value. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 after the test.

3.7.7 Freezing water immersion (ice crush). When specified (see 3.1), the cable shall withstand the test specified in 4.7.6.7. The change in optical transmittance of each fiber shall not exceed the values specified in 3.5.2 during and after the test.

3.7.8 Weathering. When specified (see 3.1) and tested in accordance with 4.7.6.8, after the 1200 hours of exposure, the cable jacket shall show no evidence of softening, gumminess, or surface damage (cracking, splitting, or other defect to permit jacket penetration). The jacket tensile strength and elongation shall be not less than 75 percent of the initial value (see 4.7.5.15).

3.7.9 Fluid immersion. When tested in accordance with 4.7.6.9, the tensile strength and elongation retention properties of the cable jacket material shall be not less than 50 percent of the initial values. The finished cable shall reveal no cracks, splits, gumminess, or voids in the cable jacket. The outer diameter of the finished cable shall not deviate greater than 50 percent. The cable jacket shall not be preconditioned before this test other than normal jacket processing.

3.7.10 Wicking. When specified for water-tight cables (see 3.1) and when tested in accordance with 4.7.6.10, a post-test examination of the immersed end of the cable specimen shall reveal a water penetration of less than 5 millimeters from the cable end and a change in mass of less than 1 percent.

3.7.11 Jacket self-adhesion or blocking. When tested in accordance with 4.7.6.11, a post-test visual inspection shall reveal no areas of localized adhesion between contacting cable surfaces, the metal storage spool, or areas that are of a more severe nature than a "mild" condition.

3.7.12 Flammability. When tested in accordance with 4.7.6.12, the requirements of 3.7.12.1 and 3.7.12.2 apply only when specified (see 3.1).

3.7.12.1 Flammability (60-degree angle). When specified (see 3.1) and when tested in accordance with 4.7.6.12.1, cables shall self-extinguish within 30 seconds. The distance of flame travel shall not exceed 10 centimeters, and there shall be no ignition of the tissue paper.

3.7.12.2 Flame extinguishing and smoke generation. When specified (see 3.1) and when tested in accordance with 4.7.6.12.2, cables shall be self-extinguishing, shall not burn to the top of the tray, and shall meet smoke requirements. The total smoke released and the peak smoke release rate shall be not greater than 95 square meters and 0.25 square meters per second, respectively.

3.7.13 Shock. When specified (see 3.1) and when tested in accordance with 4.7.6.13, the finished cable shall reveal no physical damage. Unless otherwise specified (see 3.1), discontinuities shall not have a magnitude greater than the values specified in 3.5.2 for change in optical transmittance and a duration greater than 50 microseconds.

3.7.14 Water absorption. When tested in accordance with 4.7.6.14, the maximum water absorption of the finished cable or a sample of the external cable jacket material shall be not greater than 4.0 milligrams per square centimeter (mg/cm^2) of exposed cable surface area.

3.7.15 Paint susceptibility. When specified (see 3.1) and when tested in accordance with 4.7.6.15, the cable jacket shall show no signs of jacket weakening, cracking, or other damage.

3.7.16 Electromagnetic effects. When specified (see 3.1) and when tested in accordance with 4.7.6.16, the propagated radio frequency (RF) attenuation of the cable shall be not less than 100 decibels attenuation for frequencies not greater than 1 gigahertz and 60 decibels attenuation at 10 gigahertz.

3.8 Chemical properties.

3.8.1 Acid gas generation. When tested in accordance with 4.8.1, the acid gas generation, expressed as acid equivalent, shall be not greater than 2.0 percent of the weight of the sample.

3.8.2 Halogen content. When tested in accordance with 4.8.2, the total halogen content of the cable shall be as specified (see 3.1).

3.8.3 Toxicity index. When tested in accordance with 4.8.3, the toxicity index shall not exceed 5.0.

3.8.4 Fungus resistance. When tested in accordance with 4.8.4, polymeric cable 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.

3.8.5 Smoke index. When specified (see 3.1) and when tested in accordance with 4.8.6, the smoke index shall not exceed the maximum limit:

a. Jacket: 25 maximum

b. OFCC/BOF tube: 45 maximum

c. Filler (water swellable): 45 maximum

3.9 Identification marking. Except as otherwise specified in the procurement contract (see 6.2) or in the specification sheet (see 3.1), the finished cable shall be identified by a marking applied to the outer surface of the cable or visible through the outer surface. When cable is to be used in an end item for the Government, omission of the identification marking of product shall be permissible only when so stated in the specification sheet for the cable or the Government contract for the end item. The identification marking shall consist of the following, at intervals of 0.25 to 1.5 meters, as measured from the beginning of one complete marking to the beginning of the succeeding complete marking:

a. PIN (see 1.2.4).

b. Manufacturer's code designation.

c. The words "Fiber Optic Cable".

d. Date code (4 digit – week, year).

e. When specified (see 6.2), meter markings shall be included.

The identification marking shall be permanent and legible. Identification marking shall be applied with the vertical axis of the printed characters lengthwise of the cable when the nominal diameter of the finished cable is 1.25 millimeters or smaller. The vertical axis of the printed characters may be either crosswise or lengthwise of the cable when the nominal diameter of the cable exceeds 1.25 millimeters.

3.9.1 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 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. 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, the manufacturer shall remove completely the military part number and the "JAN" or the "J" from the sample tested and also from all items 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 2,577,735 for the certification mark "J".

3.10 Workmanship. All details of workmanship shall be in accordance with high grade fiber optic cable manufacturing practice. Cables shall be dimensionally uniform. The minimal level of visual examination to be performed shall be as specified in 3.10.a through 3.10.e and is not intended to restrict other pertinent workmanship examinations deemed necessary by the manufacturer (see 4.7.2).

a. Outer jacket shall be free of cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots, and discontinuities.

b. Inner layers shall be free of cuts, holes, bulges, thin spots, and discontinuities.

c. Strength members shall be uniformly laid with no discontinuities.

d. Fillers and water sealant shall be uniformly distributed throughout the cable body.

e. OFCCs shall not kink at diameters above the minimum short-term bend diameter.

4. VERIFICATION

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

a. Qualification inspection (see 4.5).

b. Conformance inspection (see 4.6).

4.2 Verification program. Requirements for the verification program shall be as required by the qualifying activity (see 6.3.2).

4.3 Test equipment and inspection facilities. Requirements for test equipment and inspection facilities shall be as required by the qualifying activity (see 6.3.3).

4.3.1 Fire testing provisions. All fire tests specified in this document shall be conducted by a laboratory that is accredited to ISO/IEC 17025. Accreditation shall be obtained from a recognized accreditation body such as American Association for Laboratory Accreditation (A2LA) or International Code Council's International Accreditation Service (IAS). The scope of accreditation shall include specific flammability and fire tests required for qualification. All other fire test provisions shall be as specified (see 6.2 and 6.3.8.1).

4.4 Inspection conditions. Unless otherwise specified (see 3.1), all inspections shall be performed in accordance with the standard test conditions specified in TIA/EIA-455 or as specified herein. When a cable construction utilizes spliced fibers, test samples shall be selected to include the fiber splices.

4.5 Qualification inspection. Qualification inspection shall be performed on the cable and shall be as specified in table VI, in the order listed. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 3.2 and 6.3) on sample units produced with equipment and procedures normally used in production. Group qualification (extent of qualification) shall be as specified in 4.5.2.

4.5.1 Sample units. Unless otherwise specified (see 3.1), the sample units shall be as specified in table VI. The qualification sample shall consist of two sample units, one a minimum of 1 kilometer in length and one a minimum of 0.5 kilometer in length. The 1 kilometer sample unit shall be cut to form two sample units, each a minimum of 0.5 kilometer in length.

4.5.2 Extent of qualification. In instances where two or more specification sheets cover cables identical in materials and construction, except for attenuation, or in instances where cable constructions include varying numbers of fibers, the cable configuration incorporating the lowest attenuation range and the largest number of fibers shall be in accordance with the sample selected for qualification testing in accordance with 4.5.1 and shall meet all the requirements of this specification and the specification sheet (see 3.1). When acceptable to the qualifying activity, qualification may be extended to include those cables with higher attenuation and fewer number of fibers provided the samples meet all the requirements of the specification sheet.

4.5.3 Inspection routine. The samples shall be subjected to the qualification inspection specified in table VI in the order shown. In cases where certain requirements and tests are applicable only when specified (see 3.1), these tests shall be conducted in the order shown when specified in the applicable specification sheet (see 3.1). Tests which are specified as not applicable to a specific cable construction shall not be conducted. All sample units shall be subjected to the applicable inspections of Groups I and II. Specimens shall be cut from each sample unit in lengths at least as long as specified in table VI. Test specimens from each sample unit shall be subjected to the applicable tests of Group III through Group V, inclusive of table VI; however, each test specimen shall be subjected to only one group of tests in addition to Groups I and II. Test specimens for Group VI shall be cut from undamaged test specimens from Groups III, IV, or V. Optical tests shall be performed on the sample when required in section 3 as specified by the individual test in section 4.

4.5.3.1 Qualification of modified designs. Qualification inspection of items which contain design changes from previously qualified items may be limited to a subset of the qualification inspections identified in 4.5.3 (see Appendix A).

4.5.3.2 Qualification by similarity. Qualification inspection by similarity of items to previously qualified items may be limited to a subset of the qualification inspections identified in 4.5.3 (see Appendix A).

4.5.3.3 Qualification of cable produced at a new manufacturing location. Qualification inspection of items which are produced at a new manufacturing location from previously qualified items may be limited to a subset of the qualification inspections identified in 4.5.3 (see Appendix A).

4.5.4 Failure. Failure of any sample or specimen to meet the requirements specified herein shall be cause for disapproval of or removal of product qualification.

TABLE VI. Qualification inspection.

Inspection	Requirement paragraph	Test paragraph	Cable length 1/ 2/ 20/
Group I			
Visual and mechanical inspection	3.4, 3.9, 3.10	4.7.2	3 samples, 0.5 km each 3/
Attenuation rate	3.5.1	4.7.4.1	3 samples, 0.5 km each 4/
Group II			
Crosstalk	3.5.3	4.7.4.3	3 samples, 0.5 km each 4/
Electromagnetic effects	3.7.16	4.7.6.16	1 specimen, 6 m 5/
Group III			
Temperature cycling	3.7.1	4.7.6.1	2 samples, 0.5 km each 4/ (1 on reel, 1 off reel)
Temperature humidity cycling	3.7.3	4.7.6.3	2 samples, 0.5 km each 6/
Storage temperature	3.7.4	4.7.6.4	2 samples, 0.5 km each 6/
Low temperature flexibility (cold bend)	3.6.3	4.7.5.3	2 specimens, 8 m each 7/
Cyclic flexing	3.6.4	4.7.5.4	6 specimens, 5 m each 8/ (2 specimens for each temperature)
Crush	3.6.5	4.7.5.5	2 specimens, 5 m each 7/
Cable twist-bending	3.6.6	4.7.5.6	6 specimens, 5 m each 8/ (2 specimens for each temperature)
Impact	3.6.8	4.7.5.8	2 specimens, 5 m each 7/
Altitude immersion	3.7.5	4.7.6.5	1 unit, 0.46 km 9/
Temperature life (life aging)	3.7.6	4.7.6.6	2 specimens, 300 m each 7/
Tensile loading and elongation	3.6.1	4.7.5.1	2 specimens, 150 m each 10/
Operating tensile load	3.6.1.1	4.7.5.1.1	2 specimens, 150 m each 11/
Freezing water immersion (ice crush)	3.7.7	4.7.6.7	2 specimens, 30 m each 7/
Fungus resistance	3.8.4	4.8.4	2 specimens, 0.5 m each 7/
Knot	3.6.10	4.7.5.10	6 specimens, 5 m each 8/
Cable element removability	3.6.18	4.7.5.18	2 specimens, 0.5 m each 7/
Flammability (60-degree angle)	3.7.12.1	4.7.6.12.1	2 specimens, 6 m each 7/
Group IV			
Thermal shock	3.7.2	4.7.6.2	1 specimen, 0.49 km 4/ (on reel)
Weathering	3.7.8	4.7.6.8	1 specimen, 2 m 12/ and 3 material samples 13/
Fluid immersion	3.7.9	4.7.6.9	1 specimen, 2 m 12/ and 3 material samples 13/ for each specified fluid
Paint susceptibility	3.7.15	4.7.6.15	2 specimens, 2 m 14/
Jacket self-adhesion or blocking	3.7.11	4.7.6.11	1 specimen, 30 m 12/
Shock	3.7.13	4.7.6.13	1 specimen, 30 m 12/

TABLE VI. Qualification inspection – Continued.

Inspection	Requirement paragraph	Test paragraph	Cable length 1/ 2/ 20/
Dynamic bend	3.6.2	4.7.5.2	1 specimen, 150 m 15/
Hosing:			
Low pressure	3.6.12.1	4.7.5.12.1	1 specimen, 1.5 m 12/
Hydrostatic	3.6.12.2	4.7.5.12.2	1 specimen, 2 m 12/
Radial compression (for application B only)	3.6.7	4.7.5.7	1 specimen, 10 m 12/
Pressure cycling (for application B only)	3.6.11	4.7.5.11	1 specimen, 30 m 12/
Corner bend	3.6.9	4.7.5.9	2 specimens, 5 m 14/
OFCC kink	3.4.2.2.2	4.7.3.5	2 specimens, 1 m 12/
Group V			
Dripping	3.6.13	4.7.5.13	1 specimen, 30 cm 12/
Cable jacket tear strength	3.6.14	4.7.5.14	3 specimens, 1 m each 14/
Cable jacket material tensile strength and elongation	3.6.15	4.7.5.15	5 specimens 16/
Cable abrasion resistance	3.6.16	4.7.5.16	4 specimens, 2 m each 17/
Cable shrinkage	3.6.17	4.7.5.17	3 specimens, 0.5 m each 14/
Durability of identification marking	3.6.19	4.7.5.19	3 specimens, 2 m each 14/
Ribbon delamination (type 4 only)	3.6.20	4.7.5.20	3 specimens, 2 m each 14/
Stuffing tube compression	3.6.21	4.7.5.21	1 specimen, 3m 14/
Flame extinguishing and smoke generation	3.7.12.2	4.7.6.12.2	1 specimen, 50 m 12/
Wicking	3.7.10	4.7.6.10	2 specimens, 2 m 14/
Water absorption	3.7.14	4.7.6.14	2 specimens 18/
Group VI			
Acid gas generation	3.8.1	4.8.1	1 specimen, 1 m 19/
Halogen content	3.8.2	4.8.2	1 specimen, 1 m 19/
Toxicity index	3.8.3	4.8.3	1 specimen, 1 m 19/
Thermal vacuum outgassing	3.3.6.1	4.8.5.1	1 specimen, 1 m 19/
Material flammability	3.3.6.2	4.8.5.2	1 specimen, 1 m 19/
Material toxicity (off-gassing)	3.3.6.3	4.8.5.3	1 specimen, 1 m 19/
Smoke index	3.8.5	4.8.6	1 specimen, 1 m 19/

TABLE VI. Qualification inspection – Continued.

NOTES:

1/ Tolerance on 0.5 kilometer length is ±10 percent provided results are normalized to 1 kilometer.
2/ Tolerance on shorter lengths is ±10 percent.
3/ The visual and mechanical inspection shall only be conducted on a 2-meter section of each sample.
4/ The same samples as used in the visual and mechanical inspection shall be used.
5/ A specimen cut from one of the visual and mechanical inspection test samples shall be used.
6/ The same samples as used in the temperature cycling test shall be used. 1 on reel, 1 off reel.
7/ A specimen cut from each sample used in the temperature cycling test shall be used.
8/ Three specimens cut from each sample used in the temperature cycling test shall be used.
9/ One of the samples used in the temperature cycling test shall be used.
10/ A specimen cut from each sample used in the life test shall be used.
11/ The same sample as used in the tensile loading and elongation test shall be used.
12/ A specimen cut from the specimen used in the thermal shock test shall be used.
13/ Three jacket material samples as specified in 4.7.5.15 shall be used in this test.
14/ Specimens cut from the specimen used in the thermal shock test shall be used.
15/ A specimen cut from the specimen used in the thermal shock test or one of the specimen used in the tensile loading and elongation test shall be used.
16/ Jacket material samples as specified in 4.7.5.15 shall be used in this test.
17/ Specimens cut from the specimen used in the thermal shock test shall be used. Two specimens shall be used for scraping abrasion testing and two specimens shall be used in the cable-to-cable abrasion testing.
18/ Jacket material samples as specified in 4.7.5.15 shall be used.
19/ A specimen cut from one of the samples used in the temperature cycling or thermal shock tests shall be used.
20/ Mixed fiber cables, consisting of alternating single-mode and multimode fibers, can be used for qualification purposes. If a failure occurs for any fiber in a mixed fiber cable, then all of the fibers in the cable are considered to have failed (both single-mode and multimode).

4.5.5 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.

4.5.5.1 Retention of qualification for group A inspections. At intervals of not more than 12 months after initial qualification, Group A inspections for retention of qualification shall be performed on cables, and shall include the examinations and tests of table VII. Sampling for Group A inspection shall be as specified in 4.6.2. Manufacturers shall certify that there have been no material changes since initial qualification.

4.5.5.2 Retention of qualification for group B inspections. At intervals of not more than 24 months after initial qualification and every 24-month period thereafter, Group B inspections for retention of qualification shall be performed on cables, and shall include the examinations and test of table VIII. Sampling for Group B inspection shall be as specified in 4.6.3, except when the total production in a 24-month period is less than 2 units of product (2 kilometers) or a total of 60 months have elapsed since the inspection was performed, in which case, only one specimen shall be tested.

4.5.5.3 Retention of qualification for group C inspections. At intervals of not more than 60 months after initial qualification and every 60-month period thereafter, Group C inspections for retention of qualification shall be performed on cables, and shall include the examinations and tests of table IX. Two 500-meter specimens shall be selected from those sample units covered by a single specification sheet, except when the total production in a 60-month period is less than two units of product (2 kilometers) inspection need not be made until production is at least 2 units of product. Periodic inspection shall consist of Group C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.4.4), delivery of products which have passed Group A and Group B inspections shall not be delayed pending the results of periodic inspection.

4.6 Conformance inspection. Conformance inspection shall consist of the inspections and tests specified for Group A inspection (table VII), Group B inspection (table VIII), and Group C inspection (table IX). Requirements for alternate forms of conformance inspection are identified in the qualification instructions (see 6.3.4).

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of Group A inspections.

4.6.1.1 Unit of product. A unit of product shall be 1 kilometer of cable of the same part number. If a production run is less than a unit of product, then the quantity produced shall be one unit of product.

4.6.1.2 Production unit. The production unit shall consist of the number of units of product produced on the same production line or lines, and offered for inspection at one time. All of the units of product in the production unit submitted shall have been produced during the same production period with the same materials and processes.

4.6.1.3 Sample unit. A sample unit shall be a unit of product selected at random from the production unit without regard to quality.

4.6.1.4 Specimen. A specimen shall be an individual length of cable cut from the sample unit.

4.6.2 Group A inspection. Group A inspection shall consist of the inspections and tests specified in table VII. In cases where certain requirements and tests are applicable only when specified (see 3.1), these tests shall be conducted in the order shown. Tests which are specified in the basic specification or specific specification sheet as not applicable to a specific cable construction shall not be conducted.

TABLE VII. Group A inspection.

Inspection	Requirement paragraph	Test paragraph
Visual and mechanical	3.4, 3.9, 3.10	4.7.2
Attenuation rate	3.5.1	4.7.4.1

4.6.2.1 Sampling plan. Group A inspection shall be performed on 100 percent of delivered product.

4.6.2.2 Failures. One or more failures shall constitute Group A inspection failure of the sample unit.

4.6.2.3 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.

4.6.3 Group B inspection. Group B inspection shall consist of the inspections specified in table VIII. In cases where certain requirements and tests are applicable only when specified (see 3.1), these tests shall be conducted in the order shown when specified (see 3.1). Tests which are specified in the basic specification or specific specification sheet as not applicable to a specific cable construction shall not be conducted. Group B inspection shall be made on sample units that have passed the Group A inspection.

TABLE VIII. Group B inspection.

Inspection	Requirement paragraph	Test paragraph
Low temperature flexibility (cold bend)	3.6.3	4.7.5.3
Dynamic bend	3.6.2	4.7.5.2

4.6.3.1 Sampling plan. Group B inspection shall be performed on two 170-meter specimens selected from those sample units covered by a single specification sheet.

4.6.3.2 Failures. If one or more specimens fail to pass Group B inspection, the production unit from which the specimens were selected shall be rejected.

4.6.3.3 Rejected production units. Requirements regarding the rework of rejected production units shall be as identified in the qualification instructions (see 6.3.10).

4.6.3.4 Disposition of sample units. Sample units from which a specimen has failed any of the Group B inspection tests shall not be shipped, even though the production unit submitted is accepted.

4.6.4 Group C inspection. Group C inspection shall consist of inspections specified in table IX. In cases where certain requirements and tests are applicable only when specified (see 3.1), these tests shall be conducted in the order shown. Tests which are specified in the basic specification or specific specification sheet as not applicable to a specific cable construction shall not be conducted. Group C inspection shall be made on sample units selected from production units which have passed the Group A and Group B inspections.

4.6.4.1 Sampling plan. Group C inspection shall be performed on two 500-meter specimens selected from those sample units covered by a single specification sheet.

4.6.4.2 Failures. One or more specimen or sample unit failures shall constitute Group C inspection failure.

4.6.4.3 Disposition of sample units. Specimens that have been tested to Group C inspection shall not be shipped.

4.6.4.4 Noncompliance. Requirements regarding failure of Group C inspection are identified in the qualification instructions (see 6.3.11).

TABLE IX. Group C inspection.

Inspection	Requirement paragraph	Test paragraph
Group I		
Temperature cycling	3.7.1	4.7.6.1
Temperature humidity cycling	3.7.3	4.7.6.3
Cable twist-bending	3.6.6	4.7.5.6
Impact	3.6.8	4.7.5.8
Temperature life (life aging)	3.7.6	4.7.6.6
Tensile loading and elongation	3.6.1	4.7.5.1
Operating tensile load	3.6.1.1	4.7.5.1.1
Group II		
Knot	3.6.10	4.7.5.10
Cable element removability	3.6.18	4.7.5.18
Flammability (60-degree angle)	3.7.12.1	4.7.6.12.1
Fluid immersion	3.7.9	4.7.6.9

TABLE IX. Group C inspection – Continued.

Inspection	Requirement paragraph	Test paragraph
Hosing:		
Low pressure	3.6.12.1	4.7.5.12.1
Hydrostatic	3.6.12.2	4.7.5.12.2
Pressure cycling	3.6.11	4.7.5.11
Cable jacket tear strength	3.6.14	4.7.5.14
Cable abrasion resistance	3.6.16	4.7.5.16
Cable shrinkage	3.6.17	4.7.5.17
Ribbon delamination	3.6.20	4.7.5.20
Flame extinguishing and smoke generation	3.7.12.2	4.7.6.12.2
Wicking	3.7.10	4.7.6.10
Group III		
Acid gas generation	3.8.1	4.8.1
Toxicity index	3.8.3	4.8.3
Thermal vacuum outgassing	3.3.6.1	4.8.5.1
Material flammability	3.3.6.2	4.8.5.2
Material toxicity (off-gassing)	3.3.6.3	4.8.5.3
Smoke index	3.8.5	4.8.6

4.7 Methods of inspection.

4.7.1 Equivalent test methods. The use of equivalent test methods is allowed provided that the preparing activity and the qualifying activity have approved the use of that equivalent test method by that manufacturer (see 6.2 and 6.3.4).

4.7.2 Visual and mechanical examination (see 3.4, 3.6, 3.7, 3.8, 3.9, and 3.10). Visual and mechanical examinations shall be performed in accordance with TIA-455-13 and in compliance with the data recording and evaluation criteria in Measurements 3101-3105 of MIL-STD-1678-3 to verify that the design, construction, physical characteristics, dimensions, marking, and workmanship are in accordance with the applicable requirements. Visual examination shall be accomplished utilizing ten-power (10X) magnification. Visual inspection for the color of the cable and the color of the fiber may be accomplished without magnification. Visual inspection of the cable may be limited to the cable ends and the exposed surface of the cable. Unspooling of the cable to inspect the unexposed portions is not required.

4.7.3 Fiber and cable construction inspections.

4.7.3.1 Cable and cable core component dimensions (see 3.4.6.1). Buffered fiber, OFCC, cable bundle, ribbon, and finished cable dimensions shall be measured in accordance with FED-STD-228, Method 1018.

4.7.3.2 Finished cable diameter (see 3.4.6.1). The diameter of the finished cable shall be computed from the circumference measurement determined in accordance with FED-STD-228, Method 1441.

4.7.3.3 Concentricity (see 3.4.6.2). The concentricity of the buffer, OFCC jacket, cable bundle jacket, and finished cable jacket shall be determined by locating and recording the minimum and maximum wall thickness of the same cross-section. The ratio of the minimum wall thickness to the maximum wall thickness is defined as concentricity.

4.7.3.4 Cable mass per unit length (see 3.4.6.3). The mass of 1 kilometer of fiber optic cable shall be determined in accordance with FED-STD-228, Method 8311.

4.7.3.5 OFCC kink (see 3.4.2.2.2). The OFCC shall be tested in a free form loop using IEC 60794-1-21, Method E10. Three specimens shall be tested from each fiber on each end of the cable. The free standing loop diameter shall be measured in a direction parallel to that in which the forces are applied. The test on each specimen shall be terminated when either a kink is formed or when one half the minimum bend diameter is reached. The free form loop diameter in which the first noticeable detrimental effect occurs is to be recorded along with the effect.

4.7.4 Optical properties inspections. Unless otherwise specified (see 3.1), the optical requirements specified herein shall be met at the center wavelength of 1.300±0.020 micrometers tolerance.

4.7.4.1 Attenuation rate (see 3.5.1). The attenuation rate of each individual fiber in the cable shall be measured in accordance with Measurement 2106 of MIL-STD-1678-2.

4.7.4.1.1 Attenuation rate (for type I fiber only). Light launch conditions utilizing beam optics are preferred.

4.7.4.1.2 Attenuation rate (for type II fiber only). Light launch conditions shall utilize a higher order mode filter as cited in Measurement 2106 of MIL-STD-1678-2.

4.7.4.2 Change in optical transmittance (see 3.5.2). This test shall evaluate the change of optical power (transmittance) level of the fibers in the cable due to exposure to one or more inspection (mechanical and environmental) tests. The wavelength tested shall be as specified in the applicable specification sheet (see 3.1). The periodicity of the measurement shall be appropriate for the test method (see applicable measurement in MIL-STD-1678-3).

4.7.4.2.1 Method. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with Measurement 2102 of MIL-STD-1678-2 for transmitted power, adhering strictly to the setup and test procedure specified.

4.7.4.3 Crosstalk (see 3.5.3). Fully assembled cable specimens shall be tested for crosstalk in accordance with Measurement 2106 of MIL-STD-1678-2. When applicable, the crosstalk shall be determined between a minimum of three randomly selected fibers in a multi-fiber cable, using each selected fiber sequentially as the actively transmitting element, and measuring the far-end power output of all other fibers in the cable specimen. The center wavelength shall be 1.300+0.020 micrometers, and the light launch conditions shall be as specified (see 4.7.4.1).

4.7.5 Mechanical properties inspections (see 3.6). Unless otherwise specified (see 3.1), for mechanical tests, the specimen length shall be as given in individual inspections. The change in optical transmittance shall be measured in accordance with 4.7.4.2. The change in optical transmittance shall be measured for all fibers in the cable, or a total of 12 fibers, whichever is less. In large-count fiber cables, at least one fiber per ribbon, cable bundle, or binder shall be monitored. Visual examination, where required, shall be conducted in accordance with 4.7.2.

4.7.5.1 Tensile loading and elongation (see 3.6.1). The tensile loading on both the OFCC and the finished cable shall be measured in accordance with TIA-455-33. The OFCC may be tested using the same mandrel size as is used to test the finished cable. A minimum preload of 45 Newtons shall be placed on the cable. The load shall be increased to 2500 Newtons times the cable outer diameter in centimeters in four equal increments. Attenuation measurements on all fibers shall be determined in unstressed and stressed conditions. At the completion of this test, the cable jacket shall be visually examined in accordance with 4.7.2.

4.7.5.1.1 Operating tensile load (see 3.6.1.1). The operating tensile load of the finished cable shall be tested in accordance with TIA-455-33. A minimum preload of 45 Newtons shall be placed on the cable. The load shall be increased to 500 Newtons times the cable outer diameter in centimeters and held for 72 hours. Attenuation measurements on all fibers shall be determined in unstressed and stressed conditions. At the completion of this test, the cable jacket shall be visually examined in accordance with 4.7.2.

4.7.5.2 Dynamic bend (see 3.6.2). The finished cable and OFCC shall be pulled 90 degrees over a sheave whose outside diameter is equal to the minimum bend diameter of the cable, rounded to the next higher centimeter. A 90-degree bend shall be placed in the cable by the sheave. The cable shall be pulled at a rate of 9 meters per minute, with a minimum tensile load of 875 Newtons for each centimeter of cable outer diameter. The cable core components shall be pulled and loaded as specified (see 3.1). Specimen length shall be 150 meters. Apparatus shall be used to permit pulling the entire specimen length over the sheave. Tensile load shall not be applied by friction devices in direct contact with the cable. Friction applied to the supply reel or spool is an acceptable technique. The change in optical transmittance shall be measured during and after the test. At the completion of the test, the cable jacket shall be visually examined in accordance with 4.7.2.

4.7.5.3 Low temperature flexibility (cold bend) (see 3.6.3). The low temperature flexibility characteristic shall be tested in accordance with Procedure II of TIA-455-37. The following special test conditions shall apply:

a. The mandrel diameter shall be equal to the minimum bend diameter of the cable rounded up to the nearest centimeter.

b. The conditioning temperature shall be the low operating temperature ±2 °C.

c. Tensioning masses as specified in TIA-455-37 shall be used.

d. Test level 6 shall apply (3 mandrel turns).

e. The specimen shall be visually examined under ten-power (10X) magnification.

f. Optical loss measurements at the low conditioning temperature prior to and after bending are not required. Post-test loss or transmittance measurements are required after the sample has been returned to room temperature and the bends removed. The post-test loss or transmittance values shall be compared to the loss or transmittance values obtained prior to the low temperature conditioning.

4.7.5.4 Cyclic flexing (see 3.6.4). A length of finished cable shall be tested at 30 cycles per minute over a sheave whose outer diameter is equal to the cable minimum bend diameter rounded up to the nearest centimeter. The cyclic flexing test shall be performed in accordance with TIA-455-104. The test sample shall be conditioned at the test temperature before conducting each test for a duration not less than 2 hours. The change in optical transmittance shall be measured during and after the test. After completion of the test, the specimen shall be visually examined in accordance with 4.7.2. The test shall be conducted at the temperatures and for the number of cycles shown in table X for the application specified.

TABLE X. Cyclic flexing test limits.

Application	Number of cycles	Temperature
Ground tactical (T)	2000	Minimum operating temperature
	2000	25±2 °C
	2000	Maximum operating temperature
Shipboard (B)	500	25±2 °C
	100	Minimum operating temperature

4.7.5.5 Crush (see 3.6.5). Compressive load testing shall be accomplished in accordance with TIA/EIA-455-41 for the finished cable. Unless otherwise specified (see 3.1), the following special test conditions shall apply:

a. The compressive load exposure shall be not less than 2000 Newtons per centimeter of cable outer diameter (inches per centimeter), held for 3 minutes, and released.

b. The compressive loading rate shall be not less than 2000 Newtons per minute.

c. The change in optical transmittance shall be measured while the specimen is under load and after load removal. Visual inspection of the specimen shall be made under ten-power (10X) magnification after load removal.

d. A break in any fiber caused by this test shall be a failure of the cable.

e. Optical crosstalk shall be monitored in accordance with 4.7.4.3.

4.7.5.6 Cable twist-bending (see 3.6.6). A length of cable shall be tested over a sheave whose outside diameter is equal to the minimum bend diameter of the cable, rounded to the next higher centimeter for the number of cycles and at the temperatures listed in table XI for the specified application. Twist-bending shall be accomplished in accordance with TIA-455-91. Unless otherwise specified (see 3.1), the test load shall be 100 Newtons. The test sample shall be conditioned at the test temperatures before conducting each test for a duration not less than 2 hours. The change in optical transmittance shall be measured during and after the test. After the tests, the specimen shall be visually examined in accordance with 4.7.2.

TABLE XI. Cable twist-bending test limits.

Application	Number of cycles	Temperature
Ground tactical (T)	2000	Minimum operating temperature
	2000	25±2 °C
	2000	Maximum operating temperature
Shipboard (B)	500	25±2 °C
	100	Minimum operating temperature

4.7.5.7 Radial compression (for application B only) (see 3.6.7). The intent of this test is to determine the response of the finished cable to the radial compressive forces that are applied to the cable when it is installed in Multi Cable Penetrators (MCPs). A cable specimen shall be fitted into three MCPs of appropriate size. A radial force shall be applied to the cable within the MCPs by installing the cable in accordance with the approved assembly drawing for the appropriate MCP. The insert block inner diameter shall be not greater than 1 millimeter larger than the cable outside diameter. MCPs that are an integral part of an interconnection box (see MIL-I-24728) may be used for this test. The minimum torque applied to the nuts on the MCP wedgepack shall be 5.6 Newton meters. Cable exterior deformation shall not be considered as a danger or cable failure. The change in optical transmittance shall be measured during and after the test.

4.7.5.8 Impact (see 3.6.8). A length of cable specimen shall be tested in accordance with TIA-455-25. The specimen shall be conditioned at the test temperature for a duration not less than 2 hours before conducting each test. The change in optical transmittance shall be monitored after testing. During the low temperature test, after the second cycle, the test shall be temporarily halted and the cable jacket shall be visually examined in accordance with 4.7.2. At the completion of each test, the cable jacket shall be visually examined in accordance with 4.7.2. The test shall be conducted at the conditions listed in table XII for the application specified.

TABLE XII. Application test conditions.

Application	Number of cycles	Temperature
Ground tactical (T)	50	Minimum operating temperature
	100	25±2 °C
	50	Maximum operating temperature
Shipboard (B)	50	25±2 °C
	20	Minimum operating temperature

4.7.5.9 Corner bend (see 3.6.9). A length of finished cable shall be tested in accordance with TIA/EIA-455-88, except that the radius of the corner shall be 5 times the cable outer radius, rounded to the next highest centimeter (for cable only) and 1.3 centimeters for cable core components. A test force of 1000 Newtons per centimeter of cable outer diameter or 500 Newtons, whichever is less, shall be applied for one minute. The change in optical transmittance shall be measured after 1 minute of loading (while loaded) and after unloading.

4.7.5.10 Knot (see 3.6.10). A length of finished cable shall be tested in accordance with TIA-455-87, Method A, except the test force shall be 1000 Newtons per centimeter of cable outer diameter or 500 Newtons, whichever is less.

4.7.5.11 Pressure cycling (for application B only) (see 3.6.11). The specimen shall be installed in a water pressure chamber with both ends brought out approximately 1 meter through bulkhead stuffing tubes (MIL-S-24235 stuffing tubes are recommended). The protruding ends of the specimen shall be prepared for attenuation testing. The specimen within the chamber shall be subjected to 24 pressure cycles. During each cycle, the gauge pressure of the chamber shall be raised to 7.0 megapascals (MPa) (1000 pounds force per square inch) and reduced to zero. For each cycle, the high pressure shall be held for 30 minutes and the zero pressure shall be held for 30 minutes. The change in optical transmittance shall be measured continuously throughout the test on a minimum of three randomly selected fibers per specimen, when applicable.

4.7.5.12 Hosing (for application B only) (see 3.6.12). Hosing shall be as specified in 4.7.5.12.1 and 4.7.5.12.2.

4.7.5.12.1 Low pressure (see 3.6.12.1). A fully assembled cable specimen shall be tested in accordance with the procedure specified herein. One end of the specimen shall be placed in a terminal fitting which will allow water pressure to be applied directly to the exposed cross-sectional area of the end of the cable. Exposure of the sides of the cable to the water shall be kept to a minimum, and the fitting shall not exert radial compression against the cable. Unless otherwise approved by the qualifying activity, the sealer used for the packing and in the terminal fitting shall be a metal alloy having a maximum melting point of 88 °C. The specimen shall be subjected to a seawater pressure of 172 kilopascals (kPa) (25 pounds force per square inch [lbf/in^2]) for a period of 6 hours at 23 °C. A 3-percent solution of salt (NaCl) water or seawater in accordance with ASTM D1141 shall be used. Water leakage through the specimen shall be measured and shall not exceed the maximum leakage specified in 3.6.12.1.

4.7.5.12.2 Hydrostatic (see 3.6.12.2). A fully assembled cable specimen shall be tested in accordance with the procedure specified herein. One end of the specimen shall be fitted into the appropriate size of stuffing tube (refer to MIL-STD-2042 for guidance in choosing the appropriate size stuffing tube). The specimen end shall protrude from the stuffing tube a minimum of 0.5 meter and a maximum of 0.75 meter. The stuffing tube shall be torqued to 41 Newton meters and preconditioned at ambient temperature for 24 hours. The stuffing tube shall then be re-torqued to 41 Newton meters and the cable internal components trimmed flush with the cable jacket end. Water pressure shall be applied to the stuffing tube end of the specimen. A 3-percent solution of salt (NaCl) water or seawater in accordance with ASTM D1141 shall be used. The water pressure shall be gradually applied up to the specified value (see 3.1) over a 3- to 10-minute time period and then held for 6 hours. Water leakage through the specimen and slippage of the cable internal parts shall not exceed the values specified in 3.6.12.2.

4.7.5.13 Dripping (see 3.6.13). A fully assembled cable specimen shall be tested in accordance with TIA/EIA-455-81. The specimen shall be suspended vertically in an oven for a period of 6 hours at an oven temperature of 150±3 °C. The extent of fluid flow or dripping from the open cable end shall be recorded. Visual inspection of the specimen shall be made using ten-power (10X) magnification.

4.7.5.14 Cable jacket tear strength (see 3.6.14). The tear strength of the finished cable shall be determined in accordance with FED-STD-228, Method 3111.

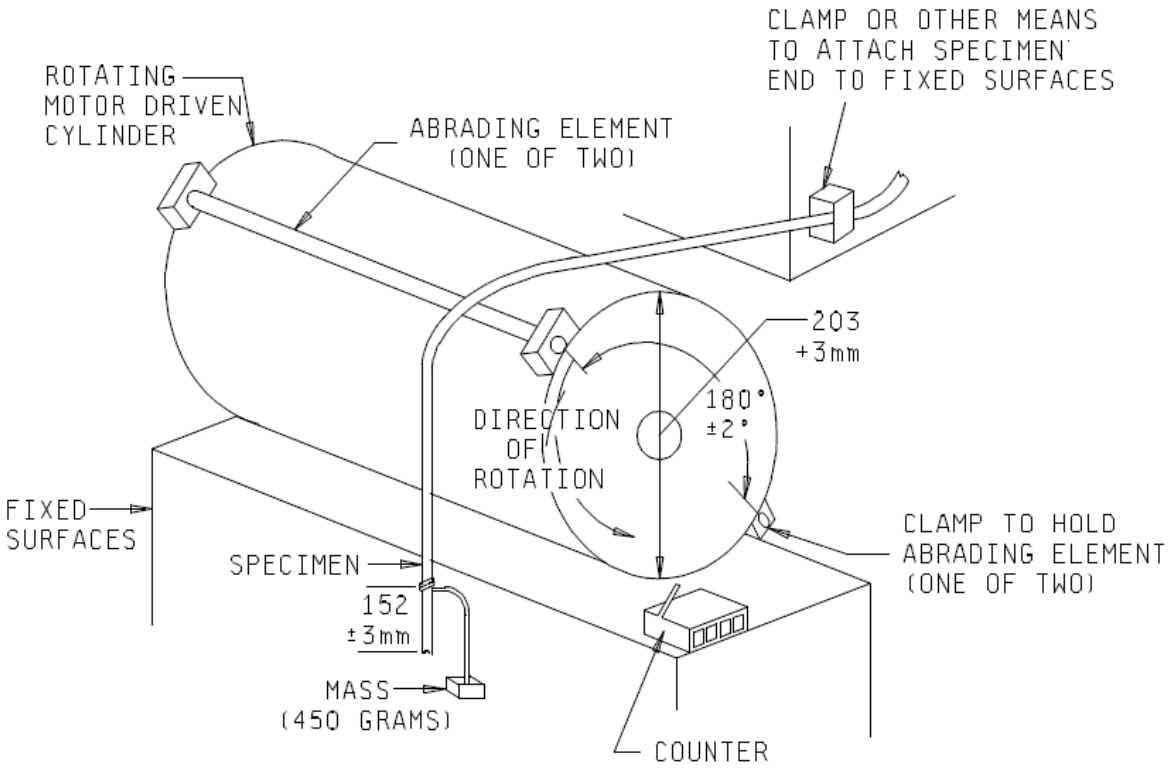
4.7.5.15 Cable jacket material tensile strength and elongation (see 3.6.15). Unless otherwise specified (see 3.1), extruded flat specimens of the jacket material shall be tested in accordance with FED-STD-228, Method 3021 and 3031, and with adherence to the restrictions on setup and test procedure and compliance with data recording in Measurement 3410 of MIL-STD-1678-3, using 2.5-centimeter bench marks, 6.35-centimeter (2.5-inch) jaw separation, and a rate of travel of 25 centimeters per minute. The thickness of the specimen shall be measured using a micrometer.

4.7.5.16 Cable abrasion resistance (see 3.6.16).

4.7.5.16.1 Cable scraping resistance. The cable scraping resistance test shall be performed in accordance with Measurement 3203 of MIL-STD-1678-3. A drum with an abrading edge, or equivalent, as shown in figure 1 and Measurement 3203 of MIL-STD-1678-3, shall be used.

4.7.5.16.2 Cable-to-cable abrasion.

4.7.5.16.2.1 Test apparatus. Cable-to-cable abrasion test apparatus and specimen relationship are shown on figures 2 and 3, respectively. The test apparatus shall consist of an electromagnetic transducer (driver) rigidly mounted on a heavy steel frame with the axial motion of the driver in a horizontal plane. The transducer shall drive a rocker arm via a spring steel bar. Mounted on this arm shall be a curved specimen holder upon which is mounted one of the cables (lower). The curvature of the upper surface of the specimen holder shall be an arc whose center is located at the pivot point of the rocker arm. The second (upper) specimen shall be mounted on the underside of a beam which is fastened to the frame through a thin, flexible nickel titanium alloy strip which shall serve as a hinge and allow the beam to be displaced only in a vertical direction. The beam and the driven specimen holder shall be positioned such that two cable specimens form an included angle of 60 degrees. The lower specimen holder shall be driven, by the transducer, at a rate of 1 Hertz and a peak-to-peak amplitude of 0.4 centimeter, along the bisector of the included angle. This symmetrical driving arrangement shall produce wear patterns of equal area on both specimens.



NOTES:

1. The length from the top center of the rotating cylinder to the end of the cable specimen to which the weight is attached shall be a minimum of 762 millimeters (30 inches).
2. The bottom edge of the clamped specimen shall be level with the top surface of the rotating cylinder.

FIGURE 1. Scraping abrasion test apparatus.

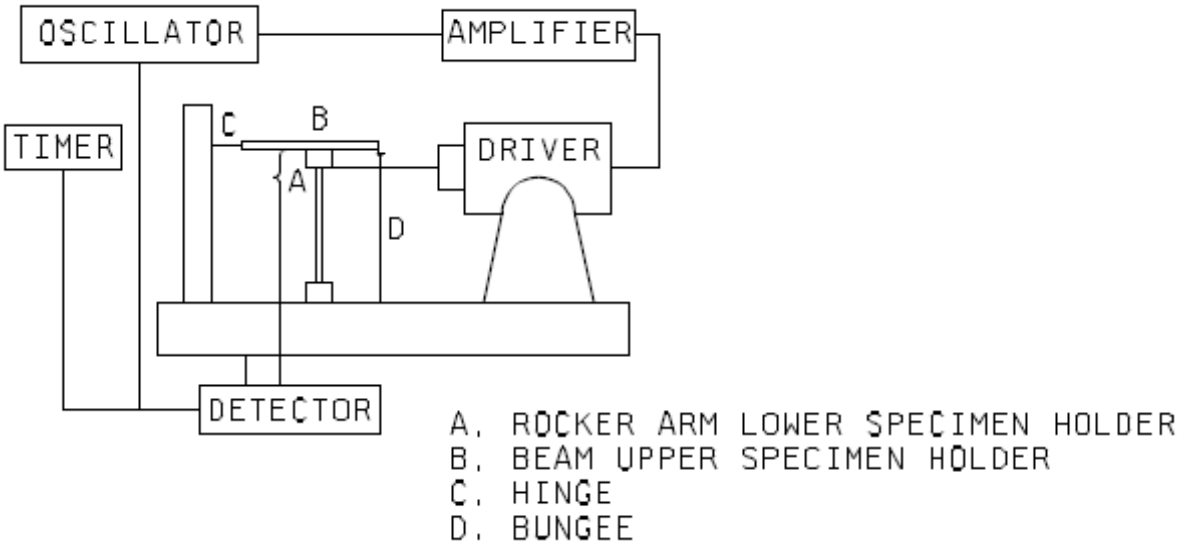


FIGURE 2. Abrasion resistance test apparatus.

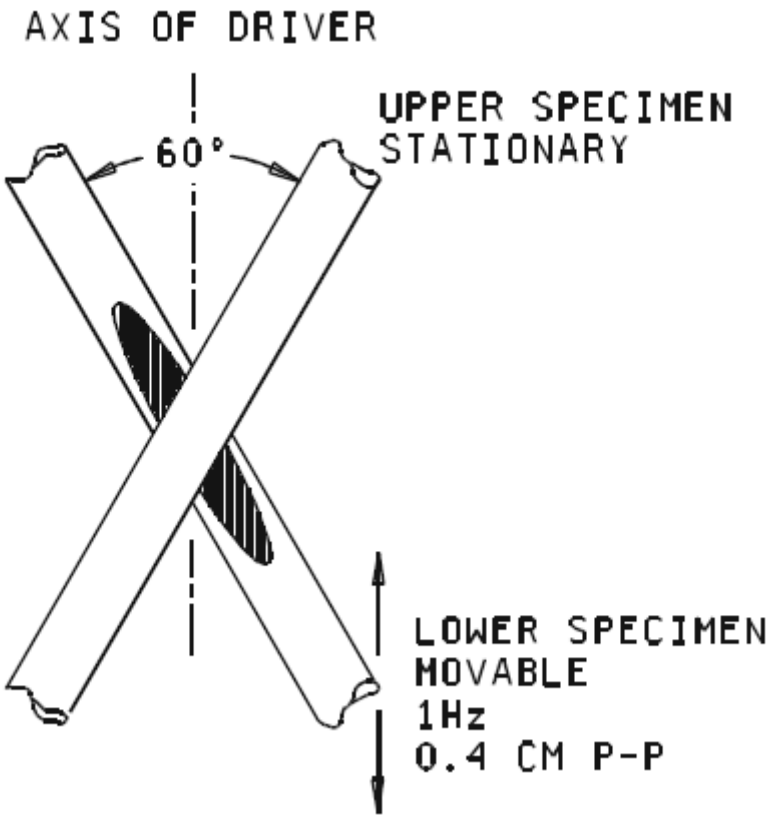


FIGURE 3. Abrasion resistance specimen relationships.

4.7.5.16.2.2 Test procedure. Test specimens shall be mounted as described above. The applied force between the two cable specimens shall be produced by one or more rubber bungees between the beam and the frame. The actual force shall be measured with a force gauge directly in line with the intersection of the two specimens. The force measurement shall be taken when a force just sufficient to separate the two specimens is achieved. The force shall be measured before and after the test, and the results shall be averaged. The average force determined in this manner shall be 10.0±1.0 Newtons. The end point of the test shall be when the specified number of cycles is attained for the specimen under test.

4.7.5.17 Cable shrinkage (see 3.6.17). A 30-centimeter specimen of cable shall be cut so that all components are flush at both ends. The specimen shall be aged at 150±3 °C for 6 hours in an air-circulating oven. At the end of this period, the specimen shall be removed from the oven and allowed to return to room temperature. The length of the specimen shall again be measured and the shrinkage shall be calculated as the difference between the two measurements.

4.7.5.18 Cable element removability (see 3.6.18). This test is applicable to the materials used to fill the voids within or between cable bundles, between the cable core components, or between and around fiber ribbons. It is also applicable to filler material used to fill the voids between the cable core components inner and outer jackets.

4.7.5.18.1 Specimens. A specimen shall consist of a length of completed cable approximately 1.0 meter long.

4.7.5.18.2 Procedure. All cable parts external to the cable core, such as cable jacket and strength member, shall be removed from one end of the specimen so as to expose the cable fibers and filler material for a distance of approximately 0.9 meter. Using fingers only (no hand tool), the filler shall be separated from the buffered fibers, cable core components, cable bundles, or fiber ribbon(s) for their fully exposed length. For cable bundles, approximately 40 centimeters of jacket shall be removed, exposing the buffered fibers and cable core components, or both. The residual filler material on the buffered fiber or cable core component outer jackets, or both, shall be removed using fingers only. For core component, approximately 20 centimeters of the outer jacket shall be removed exposing the core component's core. The core component strength member shall be pushed back and removed exposing the inner jacket. The residual filler material on the core component inner jacket shall be removed using fingers only. For ribbons, approximately 20 centimeters of the tapes or matrix materials shall be removed from the ribbons and fibers shall be separated. Any residual material left on the fibers from the tapes shall be removed with a dry cotton cloth.

4.7.5.19 Durability of identification marking (see 3.6.19). The durability of product identification or markings applied to the cable for coding shall be evaluated at 20 to 25 °C.

4.7.5.19.1 Durability testing apparatus. The marking durability tester shall be designed to hold a short specimen of finished cable firmly clamped in a horizontal position with the upper longitudinal surface of the specimen fully exposed. This instrument shall be capable of rubbing a small cylindrical steel mandrel, 0.60±0.05 millimeter in diameter, repeatedly over the upper surface of the cable, in such position that the longitudinal axes of the mandrel and the specimen are at right angles to each other with their cylindrical surfaces in contact. A mass affixed to a jig above the mandrel shall control the force exerted normal to the outer surface of the jacket. A motor-driven, reciprocating cam mechanism and counter shall be used to deliver an accurate number of abrading strokes in a direction parallel to the axis of the specimen. The length of the stroke shall be 10 millimeters and the frequency shall be 120 strokes (60 stroking cycles) per minute.

4.7.5.19.2 Durability testing procedure. In performing the test, a specimen of cable shall be mounted in the specimen clamp and the mass of 150 grams shall be applied through the abrading mandrel to the marked surface. The counter is then set at zero and the drive motor started. The test shall continue for 500 cycles. The specimen shall be removed and visually examined in accordance with 4.7.2. Failure is defined as an erasure or obliteration to the point of illegibility of any marking contacted during the test exposure.

4.7.5.20 Ribbon delamination (type 4 only) (see 3.6.20). A 30-centimeter sample of fiber ribbon shall be exposed to a temperature of 88±2 °C and relative humidity of 95 percent for 72 hours in a forced air oven.

4.7.5.21 Stuffing tube compression (see 3.6.21). A fully assembled cable specimen shall be tested as follows: One end of the specimen shall be fitted into the appropriate size of bulkhead stuffing tube (refer to MIL-STD-2042 for guidance in choosing the appropriate size bulkhead stuffing tube). The stuffing tube shall be torqued to 115 Newton meters (the maximum distance between the gland nut and the stuffing tube body shall be 3.2 millimeter) and conditioned at ambient temperature for 24 hours. The stuffing tube shall be torqued a second time to 115 Newton meters, conditioned for a second 24 hours, torqued a third time, and conditioned for a final 24 hours. Change in optical transmittance measurements shall be made approximately 5 minutes before and after the stuffing tube is torqued and once every three hours during the conditioning periods. The change in optical transmittance shall be measured during and after the test.

4.7.6 Environmental tests (see 3.7). For environmental tests, the specimen lengths are given in the individual inspections. Change in optical transmittance measurements shall be made in accordance with 4.7.4.2. Measurements of the change in optical transmittance for environmental properties shall be made for all fibers in the cable, or a total of 12 fibers, whichever is less. In large-count fiber cables, at least two fibers per ribbon, cable bundle, or binder shall be tested. Visual examination of the specimen after exposure, where required, shall be conducted in accordance with 4.7.2.

4.7.6.1 Temperature cycling (see 3.7.1). The cable shall be tested in accordance with Measurement 3301 of MIL-STD-1678-3 using the test condition schedule and soak times in accordance with table XIII. Change in optical transmittance shall be measured during and after the test.

TABLE XIII. Temperature cycling steps.

Step	Temperature (°C)	Duration (hours)
1. Maintain	Room ambient	8 (minimum)
2. Ramp to	Low operating temp +0, -3	2
3. Maintain	Low operating temp +0, -3	8 (minimum)
4. Ramp to	25±2	2
5. Maintain	25±2	6 (minimum)
6. Ramp to	High operating temp +0, -3	1
7. Maintain	High operating temp +0, -3	6 (minimum)
8. Ramp to	25±2	1
9. Maintain	25±2	6 (minimum)
10. Repeat steps 2 through 9 four additional times for a total of five cycles		

4.7.6.2 Thermal shock (see 3.7.2). Cables shall be tested in accordance with Measurement 3304 of MIL-STD-1678-3 using test condition A-0. The temperature extremes shall be the specified storage temperature extremes (see 3.1). Soak times less than those specified in Measurement 3304 of MIL-STD-1678-3 may be used if approved by the qualifying activity. The change in optical transmittance shall be measured after the test. Pre-test and post-test measurements of the cable outer diameter shall be made and recorded. Visual inspection of the test specimens shall be accomplished using ten-power (10X) magnification.

4.7.6.3 Temperature humidity cycling (see 3.7.3). Cables shall be tested in accordance with Measurement 3302 of MIL-STD-1678-3. The sub-cycle shall be included in the test. The change in optical transmittance shall be measured during and after the test. Pre-test and post-test measurements of the cable outer diameter shall be made and recorded. Visual inspection of the test specimens shall be accomplished using ten-power (10X) magnification.

4.7.6.4 Storage temperature (see 3.7.4). The specimen shall be subjected to 240 hours minimum of exposure to the low storage temperature extreme ±2 °C. Following the low temperature exposure, the specimen shall be exposed to room ambient temperature for a period of 24 hours, ±1 hour. The specimen shall then be exposed for 240 hours minimum to the high storage temperature extreme ±2 °C. Following the high temperature test, the specimen shall be exposed to room ambient temperature for a period of 24 hours, ±1 hour. The change in optical transmittance shall be measured after the test. After the test, the specimen shall be visually examined using the ten-power (10X) magnification.

4.7.6.5 Altitude immersion (previously barometric pressure [reduced]) (see 3.7.5). Cable shall be tested in accordance with Measurement 3305 of MIL-STD-1678-3. The complete sample shall be located within the chamber, with the entire sample submerged in a distilled water tank within the chamber. Instrument end connections shall not be submerged and shall be either routed outside the chamber or to an optical interface port. The change in optical transmittance shall be measured during and after the test. During each test cycle, optical transmittance measurements shall be made at each ramp and during the plateau.

4.7.6.6 Temperature life (life aging) (see 3.7.6). Flat extruded jacket material shall be tested in accordance with Measurement 3410 of MIL-STD-1678-3 at the temperature and duration listed in table XIV for that particular material. Fully assembled cable samples shall be tested in accordance with Measurement 3303 of MIL-STD-1678-3 for 240 hours at 110 °C or for 450 hours at 100 °C. The change in optical transmittance shall be measured after the test. The special test conditions specified in a through c shall apply.

a. Pre-test and post-test measurements of the cable outer diameter shall be made and recorded.

b. Visual inspection of the jacket shall be made using ten-power (10X) magnification.

c. The tensile strength and elongation of the aged extruded flat jacket material shall be determined in accordance with 4.7.5.15 after the test.

TABLE XIV. Cable life test conditions.

Jacket material	Aging conditions
Thermoplastic	240 hours at 110 °C
Thermoset	4 hours at 175 °C

4.7.6.7 Freezing water immersion (ice crush) (see 3.7.7). The specimen shall be tested in accordance with Measurement 3307 of MIL-STD-1678-3. The change in optical transmittance shall be monitored during and after the test.

4.7.6.8 Weathering (see 3.7.8). Flat extruded jacket material and the finished cable shall be tested in accordance with table XV and Measurement 3306 of MIL-STD-1678-3. After completion of the test exposure, the finished cable shall be visually examined and the flat extruded jacket material shall be tested for jacket material tensile strength and elongation in accordance with 4.7.5.15.

TABLE XV. Conditions for weathering tests.

Conditions	
Xenon arc lamp	6000 watts
Borosilicate glass filters irradiance	0.35 watts per square meter at 340 nanometers
Procedure	
Exposure – arc lamp on	18 hours Black panel temperature 63±2 °C Relative humidity 50±2 °C (Water is sprayed onto the specimen for 18 minutes every 2 hours)
Exposure – arc lamp off	6 hours Temperature 25±2 °C Relative humidity 90 to 95%
Total exposure	1200 hours

4.7.6.9 Fluid immersion (see 3.7.9).

4.7.6.9.1 Cable jacket material. Specimens of flat extruded cable outer jacket material shall be tested in accordance with Measurement 3409 of MIL-STD-1678-3 using temperature range 1. The size of each specimen shall be in accordance with 4.7.5.15. After each 24-hour immersion, the specimen shall be removed, blotted to remove excess fluid, and suspended in the air at room temperature for not less than 3 hours, 30 minutes and not more than 4 hours, 30 minutes. The tensile strength and elongation of each specimen shall then be determined in accordance with 4.7.5.15.

4.7.6.9.2 Finished cable. One specimen of finished cable shall be tested in accordance with Measurement 3409 of MIL-STD-1678-3 using temperature range 1. The 2-meter specimen may be cut into five pieces, and each piece immersed such that its two ends are exposed to the atmosphere. After each 24-hour immersion, the specimen shall be removed, blotted to remove excess fluid, and suspended in air at room temperature for not less than 3 hours, 30 minutes and not more than 4 hours, 30 minutes. After the test, the cable shall be tested for diameter change. The cable diameter shall be determined by measuring the cable circumference and dividing the resultant value by 3.14.

4.7.6.10 Wicking (see 3.7.10). Wicking characteristics shall be tested in accordance with TIA-455-39. The visual examination shall be made using ten-power (10X) magnification.

4.7.6.11 Jacket self-adhesion or blocking (see 3.7.11). Blocking characteristics shall be tested in accordance with TIA-455-84 to qualify the cable jacket self-adhesion property. The cable specimen shall be conditioned at the high storage temperature ±2 °C for a period of 48 hours prior to testing for blocking. After the test exposure, the specimen shall be visually examined using ten-power (10X) magnification.

4.7.6.12 Flammability (see 3.7.12). Cables shall be tested in accordance with 4.7.6.12.1 and 4.7.6.12.2 as specified (see 3.1).

4.7.6.12.1 Flammability (60-degree angle) (see 3.7.12.1). Cables shall be tested as follows. The specimen shall be placed at an angle of 60 degrees with the horizontal and marked 200 millimeters from the lower end. The specimen shall be held taut in this position throughout the test using cable clamps or other suitable holding fixtures. A tissue shall be suspended horizontally 250 millimeters below the test specimen with the tissue center directly below the test mark on the specimen. A Bunsen burner shall be adjusted to produce a 75-millimeter flame with the inner cone approximately 25 millimeters in height. The temperature of the hottest portion of the flame, as measured with a pyrometer, shall be not less than 950 °C. The Bunsen burner shall be positioned beneath the specimen (the burner shall be perpendicular to the specimen) so that the hottest portion of the flame is applied to the specimen at the test mark and the flame applied for 30 seconds. The time required for the specimen to self-extinguish, the maximum distance of flame travel from the mark, and any ignition of the tissue paper shall be recorded.

4.7.6.12.2 Flame extinguishing and smoke generation (see 3.7.12.2). Cables shall be subjected to the UL Flame Exposure test of UL 1685 in accordance with Measurement 3406 of MIL-STD-1678-3. Specimen length and quantity shall be as specified in UL 1685. The information specified in a through d shall be recorded:

a. Flame temperature.

b. Period of time between burner shut-off and cessation of flame on the specimen.

c. Overall distance of specimen jacket damage above the burner.

d. Total smoke released (square meters) and peak smoke release rate (square meters per second).

4.7.6.13 Shock (see 3.7.13). A 30-meter minimum length of cable shall be used for this test. The specimen shall be subjected to Grade A, Type A, Class I shocks as specified by MIL-S-901 using the fixtures, setup, and test procedure constraints specified in Measurement 3302 of MIL-STD-1678-3. Not less than 1 meter of the test specimen shall be mounted to simulate shipboard installation in a cable tray (refer to MIL-STD-2003-4 for guidance). After completion of the test, the cable shall be visually examined in accordance with 4.7.2. Signal discontinuity shall be monitored during the test, in accordance with Measurement 2104 of MIL-STD-1678-2, with equipment having a time resolution sufficient to resolve discontinuities of duration not less than 50 microseconds.

4.7.6.14 Water absorption (see 3.7.14). Water absorption shall be determined using the gravimetric method of ASTM D470 with a water temperature of 71±1 °C for a continuous 3-day period. The exposed surface area of the finished cable or cable jacket specimen shall be not less than 5 square centimeters and not greater than 10 square centimeters.

4.7.6.15 Paint susceptibility (see 3.7.15). A 2-meter sample of finished cable shall be wrapped around a mandrel having an outer diameter equal to the minimum bend diameter of the cable. This cable mandrel assembly shall be painted using paint in accordance with TT-P-645 and allowed to dry for 120 hours. After drying, the cable sample shall be removed from the mandrel and visually examined.

4.7.6.16 Electromagnetic effects (see 3.7.16). Test shall be performed using the setup and procedures in Measurement 3308 of MIL-STD-1678-3. The cable shall be tested to determine the propagation characteristics (toward attenuation or conduction) of the cable through the waveguide. Measurements required (such as the enclosure shielding effectiveness for the enclosure to be used in the test, the dynamic range of the test setup, and the measured level of RF propagation through the cable and waveguide installed in the shielded enclosure) shall be verified at the discrete frequencies specified in MIL-STD-1678-3, Measurement 3308, table 3308-BI.

4.8. Chemical tests.

4.8.1 Acid gas generation (see 3.8.1). The total emission of any soluble acids (pH less than 3) shall be determined as follows. The required apparatus is shown on figure 4. A weighted sample of the finished cable, approximately 2.5 centimeters long, shall be placed in a silica boat which is put into the center of a silica tube, 26 to 60 centimeters long with 3.7 to 15.3 centimeters of internal diameter. The silica tube shall be placed in the tube furnace. An air supply, derived from a blower or compressed air cylinder, at the rate of 1 liter per minute, ±5 percent, shall be passed through the silica tube and then through four absorber flasks, each containing 150 milliliters of de-ionized water. The furnace heating shall be commenced and the temperature of the tube and sample shall be raised to 800±10 °C over a period of approximately 40 minutes and then held at temperature for an additional 40 minutes. During the heating period, acid gases produced will be carried into the absorber flasks by the air flow. On completion of heating cycle, the fluids in the absorber flasks shall be titrated against 0.1 normal sodium hydroxide solution using Congo Red as an indicator. The total titer indicates the total soluble acids; 1.0 milliliter of 0.1 normal sodium hydroxide solution is equivalent to 3.65 milligrams of acid expressed as acid equivalent relative to hydrochloric acid.

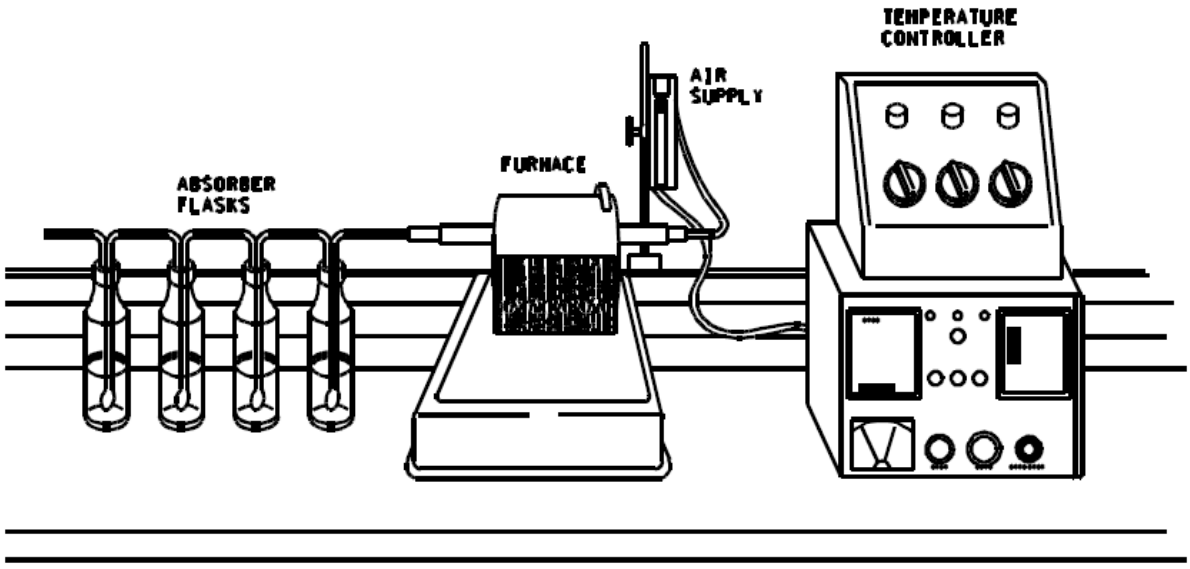


FIGURE 4. Acid gas generation test apparatus.

4.8.2 Halogen content (see 3.8.2). Cable specimens shall be tested to determine the fluorine, chlorine, bromine, and iodine content using any of the methods identified in 4.8.2.1 through 4.8.2.3.

4.8.2.1 X-ray fluorescence. An X-ray fluorescence instrument shall be used to determine the amount of all four halogens in an approximately 1-gram sample. The sample shall not be combusted prior to making the measurement. The X-ray fluorescence instrument used shall have sufficient measurement detection limits for each of the four halogens.

4.8.2.2 Ion chromatograph. Approximately 1 gram of finished cable shall be analyzed to determine the amount of all four halogens. Sample pretreatment shall be performed in accordance with ASTM E800. Halogen content shall be determined in accordance with ASTM D4327.

4.8.2.3 Ion selective electrode. Approximately 1 gram samples shall be used in these tests. Sample pretreatment shall be performed in accordance with ASTM E800. Fluoride content shall be determined in accordance with ASTM D1179, ASTM D3868, or ASTM D3761. Chloride content shall be determined in accordance with ASTM D512. Bromide content shall be determined in accordance with ASTM D1246. Iodide content shall be determined in accordance with Method C of ASTM D3869.

4.8.3 Toxicity index (see 3.8.3). The toxicity index of the finished cable shall be tested in accordance with Measurement 3407 of MIL-STD-1678-3. The cable sample shall be positioned above the flame source at a 45-degree angle and apply the flame so that it is centered on the cable sample. The combustion gases shall be chemically analyzed using calorimetric gas reaction tubes.

4.8.4 Fungus resistance (see 3.8.4). Cables composed of materials not listed as fungus inert in Guideline 4 of MIL-HDBK-454 shall be tested in accordance with Measurement 3401 of MIL-STD-1678-3.

4.8.5 Materials test for space applications.

4.8.5.1 Thermal vacuum outgassing (see 3.3.6.1). Non-metallic materials shall be tested in accordance with ASTM E595.

4.8.5.2 Material flammability (see 3.3.6.2). Material samples shall be tested in accordance with NASA-STD-6001, Test 1.

4.8.5.3 Material toxicity (off-gassing) (see 3.3.6.3). Material samples shall be tested in accordance with NASA-STD-6001, Test 7.

4.8.6 Smoke index (see 3.8.5). The smoke index shall be measured as specified in MODUK DEF STAN 02-711 with exceptions and modifications as listed in 4.8.6.1 and 4.8.6.2.

4.8.6.1 Specimen:

a. Jacket. Each specimen shall consist of a sufficient number of 75-millimeter long strips cut from the cable jacket to completely cover the face area of the sample holder. To prevent excessive buckling and distortion of the specimen during test, a wire mesh, manufactured from either a 1.0-millimeter diameter stainless steel wire with a spacing of 12.5 millimeters and a square mesh configuration or a 40-mil stainless steel wire 2-mesh screen (2 openings per inch), shall be placed inside and across the face of the sample holder. The specimen shall be fabricated by placing the specimen holder (with wire mesh) test face down onto a flat surface and positioning each 75-millimeter length in the holder in a parallel arrangement, so that when the holder is in the test position, the strips will be vertical. An insulating block 10 millimeters thick, completely wrapped in aluminum foil, shall be placed on top of the strips followed by a tension spring and locking pin.

b. Insulation. The test specimen shall be a 1-meter length of OFCC or as specified (see 3.1).

c. Fillers and sealants:

(1) Non fibrous. The test specimen shall be 3 by 3 inches of 0.070±0.010-inch thick block of the same material used in the cable.

(2) Fibrous. The test specimen shall consist of as many 75-millimeter lengths of 0.070±0.010-inch diameter strands necessary to fill the 3- by 3-inch test specimen holder one layer deep and as closely spaced as possible. The test specimens shall be prepared as described in 4.8.6.1.a.

4.8.6.2 Special procedures. Special procedures shall include the following:

a. Only the use of propane gas shall be allowed.

b. The Radiometer shall be used to calibrate the heat flux at the initial start of each test period.

c. The test chamber shall be calibrated using a NIST or equivalent CELLULOSE standard, intended for checking the operation and performance of smoke-density chambers under non-flaming exposure conditions, at the initial start of each test period.

d. The chamber shall be inspected to assure air tightness. Seals and gaskets shall be replaced as needed.

e. The test shall be run using a minimum of three specimens. If test values are below the limits specified (see 3.1), test is complete. If one test value deviates from the median value by more than 20 percent, two additional tests shall be performed. The high- and low-test values shall be discarded and the remaining three averaged.

4.8.6.3 Observation. Specimen failure shall be construed if any smoke index is greater than that specified (see 3.1).

4.8.7 Ambient toxicity (see 3.3.7). Material samples shall be tested in accordance with S9510-AB-ATM-010, Chapter “Material Control Program”.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point’s packaging activities within the Military Service or Defense Agency, or within the military service’s system commands. 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 that may be helpful, but is not mandatory.)

6.1 Intended use. The fiber optic cables covered by this specification are intended for use in military applications where their performance characteristics are required. These cables are military-unique due to the fact that these cables must operate satisfactorily in demanding system environments as listed below. For example, shipboard application conditions include numerous unique requirements for cables, such as fluid, shock, stringent toxicity, and flammability requirements.

a. Fixed plant. Used in systems in fixed locations, including indoor, outdoor aerial, direct burial, duct, and undersea applications.

b. Tactical. Concerned with use in non-vehicular and mobile militarized systems.

c. Space. Which involves use in vehicles and/or systems deployed in outer space.

d. Airborne. Involving use in aircraft or missile systems.

e. Shipboard. Involving use in systems deployed in a mobile marine environment (on board or in tow).

f. Ground vehicle. Involving use in land vehicular systems.

g. Other specialized military applications.

6.1.1 Temperature rating. Temperature ratings, as specified in specification sheets pertaining to this specification, represent the maximum permissible operating temperature range of the cable.

6.1.2 Materials compatibility. The jacketing systems of the fiber optic cables covered by this specification may be degraded by certain fluids or compounds. If such degradation occurs, the fluids or compounds and the conditions necessary for failure should be added to the specification sheet as a precautionary note.

6.1.2.1 Compatibility note. The insulation systems of polyvinylidene fluoride jacketed cables of this specification may be degraded by contact with hydraulic fluids of the phosphated ester type at high temperature. Cables of this specification with polyvinylidene fluoride jackets are not recommended for applications where they will be in contact with hydraulic fluids of phosphate ester types at temperatures above 50 °C.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Title, number, and date of the applicable specification sheet.

c. Complete cable part number (PIN).

d. Minimum acceptable continuous cable length (see 3.1 and 3.4.6.4).

e. Meter marking requirements (see 3.1 and 3.9.e).

f. Jacket and fiber color required (see 3.4.2.1.1, 3.4.2.2.1, and 3.4.3.1).

g. Special marking requirements (see 3.9).

h. Additional fire testing provisions (see 4.3.1 and 6.3.8.1).

i. Equivalent test methods, if other than as specified (see 4.7.1).

j. Packaging requirements (see 5.1).

k. Total quantity of cable required.

l. Length of cable per reel.

m. Data required.

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 No. 85045 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 orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil; however, information pertaining to qualification of products may be obtained from the agent for the qualifying activity: DLA Land and Maritime, ATTN: VQP, P.O. Box 3990, Columbus, OH 43218-3990. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.3.1 Provisions governing qualification (SD-6). Copies of SD-6, Provisions Governing Qualification, may be obtained online at http://quicksearch.dla.mil.

6.3.2 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. 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 the adequacy of the implementing procedures (see 4.2).

6.3.3 Test equipment and inspection facilities. Provisions for testing 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 ISO/IEC 17025 or equivalent standard (see 4.3).

6.3.4 Alternate forms of conformance inspection and equivalent test methods. Requests for alternate forms of conformance inspection (see 4.6) 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 4.7.1). 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 alternate test method proposed.

6.3.5 Conformity to qualified sample. It is understood that cable supplied under contract must 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.

6.3.5.1 Proposed change to qualified sample. Any proposed changes to the qualified cable must be submitted to the qualifying activity for review and determination if requalification testing will be required. This includes material changes, new manufacturing process or change in the process, new supplier, plant move, etc.

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-85045G".

c. Specification sheet part number.

d. Manufacturer's name and Commercial and Government Entity (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-85045 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 4-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 qualifying activity may require that a Government witness be present during some or all of the testing.

6.3.8.1 Additional fire testing provisions. NAVSEA reserves the right to witness the tests, and perform any of the tests set forth herein where such testing is deemed necessary to assure compliance to prescribed requirements of the qualification tests (see 6.2).

6.3.9 Electromagnetic effects test documentation. Electromagnetic effects test documentation should include a detailed test plan and test report. The test plan should detail the specific test setups and procedures, the test facility, and the test profiles that will be used. The test report should detail the exact procedures followed, the equipment used for each test phase, calibration dates of all test equipment, test results in graphical and tabular format, photographs/sketches of the test setups, the test data sheets, and an indication of pass/fail. The test data sheets should include test sample identification, ambient temperature and humidity values, dates and times of the test initiation and completion, names and initials of the test personnel, and data tables. The data tables should include the frequency at which each measurement was conducted, the field propagation/orientation, enclosure shielding effectiveness, reference level of the transmitter, dynamic range of the measurement, measured level for the test, the propagated RF attenuation, the required RF attenuation, and an indication of pass/fail. The reference level should include the source output, receiver sensitivity, and antenna gain.

6.3.10 Rejected production units. If a production unit is rejected, the supplier may screen out the defective units of product (if possible), and resubmit for re-inspection.

6.3.11 Noncompliance. If a specimen fails to pass Group C inspection, the manufacturer should notify the qualifying activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted. Acceptance and shipment of the product should be discontinued until corrective action, acceptable to the qualifying activity, has been taken. After the corrective action has been taken, Group C inspection should be repeated on additional sample units (all tests and examinations, or the test which the original sample failed, at the option of the qualifying activity). Group A and Group B inspections may be reinstituted; however, final acceptance and shipment should be withheld until the Group C inspection has shown that the corrective action was successful. In the event of failure after re-inspection, information concerning the failure should be furnished to the cognizant inspection activity and the qualifying activity.

6.4 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.

6.5 Definitions. The following definitions of terms in this document are generally accepted by the optical fiber cable manufacturing industries. TIA-440 may be used as an additional reference for definitions of terms related to fiber optics.

6.5.1 Binder. A binder is a string or tape which ties together a number of fibers, buffered fibers, or OFCCs.

6.5.2 Buffered fiber. A buffered fiber is a coated optical fiber augmented with an additional coating or buffer jacket to protect the fiber and render it more visible and manageable.

6.5.3 Cable bundle. A cable bundle is a number of fibers, buffered fibers, ribbons, or OFCCs, grouped together in the cable core within a common protective layer.

6.5.4 Cable bundle jacket. A cable bundle jacket is the material which forms a protective layer around a bundle of fibers, buffered fibers, ribbons, or OFCCs.

6.5.5 Cable core. A cable core is the part of the cable interior to the outermost jacket.

6.5.6 Cable core component. A cable core component is a part of the cable core, such as a buffered fiber, OFCC, cable bundle, ribbon, and perhaps other parts.

6.5.7 Long-term minimum bend diameter. Long-term minimum bend diameter is the minimum diameter at which a cable may be bent for extended periods of time with no degradation in optical performance.

6.5.8 OFCC. An OFCC is a buffered fiber augmented with a concentric layer of strength members and an overall jacket.

6.5.9 Ribbon. A ribbon is optical fibers arrayed side by side and maintained in this lateral position by various means.

6.5.10 Short-term minimum bend diameter. Short-term minimum bend diameter is the minimum diameter at which the cable may be bent for short periods of time (such as during cable installation) with no permanent degradation in optical performance.

6.6 Subject term (key word) listing.

Aperture, numerical
Armor sheathing
Attenuation
Bandwidth
Binder
Bundle
Core
Crosstalk
Diameter, cable
Dielectric construction
Flammability
Jacket
OFCC
Ribbon

6.7 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.

QUALIFICATION OF MODIFIED DESIGN, QUALIFICATION BY SIMILARITY FOR MM TO SM, AND QUALIFICATION DUE TO PLANT RELOCATION

A.1 SCOPE

A.1.1 Scope. This Appendix covers qualification of modified design, qualification by similarity for MM to SM, and qualification due to plan relocation. For scenarios not addressed in this Appendix, qualification inspection reductions will be determined by the qualifying activity and the preparing activity based on the extensiveness of the design changes and the anticipated effects of those changes on the item performance. This is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 MODIFIED DESIGNS

A.2.1 Qualification of modified designs. Qualification by modified design scenarios are identified in table A-I. For scenarios not addressed in table A-I, qualification inspection reductions will be determined by the qualifying activity and the preparing activity based on the extensiveness of the design changes and the anticipated effects of those changes on the item performance.

TABLE A-I. Configuration 2, qualification by similarity due to changes in material/process.

Test	Initial	Qualification by similarity: due to changes in material/process [1/]				
	Qualification [2/]	OFCC process/ material [3/]	Outer jacket material	Water blocking material	OFCC and outer jacket material	Modified cable jacket color
Group I						
Visual and mechanical	X	X	X	X	X	X
Attenuation rate	X	X	X	X	X	X
Group II						
Crosstalk	[4/]					
Electromagnetic effects	[4/]		X		X	X
Group III						
Temperature cycling	X	X		X [5/]	X	
Temperature humidity cycling	X	X		X [5/]	X	
Storage temperature	[4/]					
Low temperature flexibility (cold bend)	X	X	X	X [5/]	X	X
Cyclic flexing	X	X	X		X	X
Crush	X	X			X	
Cable twist-bending	X					
Impact	X	X	X		X	X
Altitude immersion	[4/]					
Temperature life (life aging)	X	X	X	X [5/]	X	X
Tensile loading and elongation	X	X		X [5/]	X	
Operating tensile load	[4/]	X			X	

TABLE A-I. Configuration 2, qualification by similarity due to changes in material/process – Continued.

Test	Initial	Qualification by similarity: due to changes in material/process [1/]				
	Qualification [2/]	OFCC process/ material [3/]	Outer jacket material	Water blocking material	OFCC and outer jacket material	Modified cable jacket color
Freezing water immersion	[4/]					
Fungus resistance	X	X	X	X [5/]	X	X
Knot	[4/]					
Cable element removability	X	X		X	X	
Flammability (60-degree angle)	[4/]					
Group IV						
Thermal shock	[4/]	X			X	
Weathering	[4/]		X		X	X
Fluid immersion	X		X		X	
Paint susceptibility	[4/]		X		X	
Jacket self-adhesion or blocking	X		X		X	
Shock	[4/]					
Dynamic bend	X	X		X [5/]	X	
Hosing: low pressure (B only)	[4/]	X	X	X	X	
Hosing: high pressure (B only)	[4/]	X	X	X [5/]	X	
Radial compression (B only)	[4/]					
Pressure cycling	[4/]					
Corner bend	X	X			X	
OFCC kinking	X	X			X	
Group V						
Dripping	[4/]	X	X		X	
Cable jacket tear strength	X		X		X	X
Cable jacket material tensile strength and elongation	X		X		X	X
Cable abrasion resistance, cable scraping resistance	X		X		X	
Cable abrasion resistance, cable-to-cable abrasion	X		X		X	
Cable shrinkage	X		X		X	
Durability of identification	X		X		X	X
Ribbon delamination (type 4 only)						
Stuffing tube compression	[6/]					
Flaming smoke generation	[6/]					

TABLE A-I. Configuration 2, qualification by similarity due to changes in material/process – Continued.

Test	Initial	Qualification by similarity: due to changes in material/process [1/]				
	Qualification [2/]	OFCC process/ material [3/]	Outer jacket material	Water blocking material	OFCC and outer jacket material	Modified cable jacket color
Flame extinguishing and smoke generation	X	X	X	X [5/]	X	X
Wicking	[4/]					
Water absorption	X		X		X	
Group VI						
Acid gas generation	X	X	X	X [5/]	X	X
Halogen content	X	X	X	X [5/]	X	X [7/]
Toxicity index	X	X	X	X [5/]	X	X
Smoke index	X	X	X		X	X
Crosslink verification	[6/]		X		X	X
Pressure withstand	[6/]					
Change in optical transmittance	X					
Bandwidth	X					

NOTES:

X Test invoked/modified in specification sheet as applicable.

[1/] For details on specimen size and sequence, see 4.5.3.

[2/] The initial qualification shown is for the 4- and 8-fiber cable. Where the initial qualification was a different cable or additional testing was required, all additional applicable tests in the specification sheet are also required in each of the qualification by similarity.

[3/] Includes a change in qualified fiber source. The qualification by similarity is only applicable if the new fiber source is of the same PIN as the already qualified fiber. The qualification by similarity is not applicable if there is a change in core/cladding size.

[4/] When specified.

[5/] Test is not applicable if the new water-blocking material is of the same material and construction with a similar weight to the water blocking material in the already qualified cable. For the test to be not applicable, the following conditions must also be met: the new water blocking material will be processed on the same cabling machinery using the same methods and will be applied to the cable structure in the same manner (tape length vs. cable length, twist rate, etc.) as the water blocking material used in the already qualified cable. The qualifying activity shall make final determination on test applicability.

[6/] Test found only in specification sheet.

[7/] A certificate of conformance to halogen content requirement may be achieved by providing formulation of colorants.

A.3 NEW MANUFACTURING LOCATION

A.3.1 Qualification of cable produced at a new manufacturing location. Qualification due to plant relocation scenarios are identified in table A-II. For scenarios not addressed in table A-II, qualification inspection reductions will be determined by the qualifying activity and the preparing activity based on the extensiveness of the changes and the anticipated effects of those changes on the item performance.

TABLE A-II. Application B, configuration 2, conformance/qualification due to plant relocation.

Test	Initial	Plant relocation [1/, 2/]		
	Qualification [3/]	New people and new equipment or same equipment	Same people and same equipment	Same people and all or some new equipment
Group I				
Visual and mechanical	X	X	X	X
Attenuation rate	X	X	X	X
Group II				
Crosstalk	[4/]			
Electromagnetic effects	[4/]			
Group III				
Temperature cycling	X	X	X	X
Temperature humidity cycling	X	X		
Storage temperature	[4/]	X		
Low temperature flexibility (cold bend)	X	X	X	X
Cyclic flexing	X	X		
Crush	X			
Cable twist-bending	X			
Impact	X	X		
Altitude Immersion	[4/]			
Temperature life (life aging)	X			
Tensile loading and elongation	X	X		X
Operating tensile load	[4/]	X		X
Freezing water immersion	[4/]			
Fungus resistance	X			
Knot	[4/]			
Cable element removability	X	X		
Flammability (60-degree angle)	[4/]			
Group IV				
Thermal shock	[4/]	X		
Weathering	[4/]			
Fluid immersion	X	X		
Paint susceptibility	[4/]			
Jacket self-adhesion or blocking	X	X	X	X
Shock	[4/]			

TABLE A-II. Application B, configuration 2, conformance/qualification due to plant relocation – Continued.

Test	Initial	Plant relocation [1/, 2/]		
	Qualification [3/]	New people and new equipment or same equipment	Same people and same equipment	Same people and all or some new equipment
Dynamic bend	X	X	X	X
Hosing: low pressure (B only)	[4/]	X	X	X
Hosing: high pressure (B only)	[4/]	X	X	X
Radial compression (B only)	[4/]			
Pressure cycling	[4/]			
Corner bend	X	X	X	X
OFCC kinking	X	X	X	X
Group V				
Dripping	[4/]			
Cable jacket tear strength	X			
Cable jacket material tensile strength and elongation	X			
Cable abrasion resistance, cable scraping resistance	X			
Cable abrasion resistance, cable-to-cable abrasion	X			
Cable shrinkage	X			
Durability of identification	X			
Ribbon delamination (type 4 only)				
Stuffing tube compression	[5/]			
Flaming smoke generation [5/]	X [5/]			
Flame extinguishing and smoke generation	X [4/]	X [6/]	X [6/]	X [6/]
Wicking	X			
Water absorption	X			
Group VI				
Acid gas generation	X			
Halogen content	X			
Toxicity index	[5/]			
Smoke index	X	X [6/]	X [6/]	X [6/]
Crosslink verification	[5/]	X		
Pressure withstand	X			
Change in optical transmittance	X			

TABLE A-II. Application B, configuration 2, conformance/qualification due to plant relocation – Continued.

Test	Initial	Plant relocation [1/, 2/]		
	Qualification [3/]	New people and new equipment or same equipment	Same people and same equipment	Same people and all or some new equipment
Bandwidth	X			

NOTES:
X Test invoked/modified in specification sheet as applicable.
1/ Where multiple cables require requalification due to plant relocation, the required cable configurations for testing shall be as determined by the qualifying activity.
2/ For details on specimen size and sequence, see 4.5.3.
3/ The initial qualification shown is for the 4- and 8-fiber cable. Where the initial qualification was a different cable or additional testing was required, all additional applicable tests in the specification sheet are also required for the plant relocation qualification by similarity.
4/ When specified.
5/ Test found only in specification sheet.
6/ Applicable unless otherwise specified (see 3.1).

A.4 QUALIFICATION BY SIMILARITY

A.4.1 Qualification by similarity. Qualification by similarity scenarios are identified in table A-III. For scenarios not addressed in Appendix A, qualification inspection reductions will be determined by the qualifying activity and the preparing activity based on the extensiveness of the design changes and the anticipated effects of those changes on the item performance.

A.4.2 Application B, configuration 2, qualification by similarity, fiber. Manufacturers who are qualified under a specification sheet for multimode fiber cable and whose single-mode fiber cable passes the tests and inspections specified in table A-III are qualified under the specification sheet for single-mode fiber cable. This qualification by similarity is applicable if the only difference between the previously qualified cable and the cable under test is that the optical fiber had been changed from a multimode fiber (M49291/6) to a single-mode fiber (M49291/7). Testing may be performed on either one or two lengths of cable, each with a minimum length of 0.5 kilometer. Test order must be observed up to and including the storage temperature test. If only one cable length is used, the thermal shock test shall be performed after the storage temperature test.

TABLE A-III. Qualification by similarity (fiber). [1/]

Group I
Visual and mechanical
Attenuation rate
Group III
Temperature cycling
Temperature humidity cycling
Storage temperature
Cyclic flexing
Crush
Cable twist-bending
Impact (low temperature only)

TABLE A-III. Qualification by similarity (fiber) – Continued. [1/]

Tensile loading and elongation
Operating tensile loading
Group IV
Thermal shock
Dynamic bend

NOTE:
[1/] For details on specimen size and sequence, see 4.5.3.

Custodians:
Army – CR
Navy – SH
Air Force – 85
NASA – NA

Review activities:
Army – AR, AV, MI
Navy – EC, OS
Air Force – 02, 13, 19, 99
DLA – CC

Preparing activity:
Navy – SH
(Project 6015-2010-002)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.