CABLE, SINGLE FIBER, MULTIMODE, SPACE QUALITY, GENERAL SPECIFICATION FOR

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SPACE STATION DIVISION
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INTERNATIONAL SPACE STATION PROGRAM

SSQ 21654 Rev. B
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International Space Station Program
Johnson Space Center, Houston, Texas

LETTER CHANGE RECORD

REV LTR	DESCRIPTION OF CHANGE	AUTHOR AND DATE	APPROVAL SIGNATURE
	BID ISSUE RELEASE	MDSSC-SSD 1 March,1990	S.J. Stock
NEW	Completely revised and re drawn Incorporated PDR RID comments, Supplier comments and all applicable comments from all known sources.	MDSSC-SSD 9 October, 1991	Original signed by S.J.Stock
A	See **Revision "A" Release Engineering Order** for the complete details of the changes incorporated in Revision A.	MDSSC-SSD	S.J. Stock
B	Official PCB Release Version (include CR 21654-002, 21654-004 R1, CR 21654-005 R2 and CR 21654-006)		PRIME RELEASE 07-02-96

PREFACE

SSQ 21654 Space Station Program, Cable, Single Fiber, Multimode, Space Quality, General Specification detail the requirements and characteristics for a single fiber cable with a glass optical fiber and the appropriate processes, procedures and tools.

/s/ Patrick A. Swartzell 6/28/96

Program Manager (or delegated authority) Date
Space Station Program

SPACE STATION PROGRAM OFFICE
CABLE, SINGLE FIBER, MULTIMODE, SPACE QUALITY
GENERAL SPECIFICATION

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1.0 Scope

1.1 Purpose

The purpose of this specification is to detail the requirements and characteristics for a single fiber cable with a glass optical fiber and the appropriate processes, procedures and tools. This cable is suitable for service in a manned, zero gravity, low earth orbit Space Station with a minimum life expectancy of 10 years. The NFOC-2TFF-1GRP-1 cable is for interior usage and the NFOC-2XXX-1GRP-1 cable is for external usage. The NFOC-2TFF-1GRP-1 cable also requires preconditioning which is specified in sections 3 and 5.

1.2 Intent

This specification is intended as a ”stand alone” document. Documents listed in paragraph 2.0 are intended to be a ”soft reference” in that the applicable requirements have been paraphrased and are contained herein. For example, materials, thicknesses and type of process is specified. However, no attempt to provide details, e.g. cure time, process rate, specific equipment required, etc., for the specific process has been made. The approved supplier’s processing procedure applies and is identified by process number and revision letter in Appendix D.

The intent also is to reduce, and where possible eliminate, the dependency on outside documents and the need to gather thousands of reference pages and continually track ”change traffic” associated with those documents. Should a change in a referenced document be deemed applicable, this specification must be changed to incorpor ate that change. Users cannot rely on automatic incorporation of changes in referenced documents. Users of this specification are encouraged to help in this effort by requesting only those changes considered applicable, along with the appropriate technical rationale, via the Specification Custodian or NASA Space Station Program Office, Reston, Virginia. In this way true configuration management is possible and the user becomes an integral part of the process.

The cable is intended for use with the size 16 optical termini specified in SSQ 21635, SSQ 21636, and SSQ 21637 type connector inserts and in environments that includes a space vacuum, a normally pressurized habitat, and an airlock alternately providing a pressurized or vacuum environment allowing ingress and egress to and from the airlock and space.

1.3 Interconnect System

The fiber optic cable is part of an interconnect system that includes Fiber Optic Termini, Connectors, Accessories, Wire and Cable, Tools, Assembly Processes and Procedures and, as such, are commonality color coded to aid in their proper match in an effort to eliminate errors in ground based factory or On Orbit installation, assembly and repair.

The specific color assigments are usually found in the appendix which contains the drawings of contacts, or in a table listing color assignments by wire size or listed as a requirement with other detail characteristics (fiber optic cable). For example: the fiber optic cable defined in this SSQ is color coded violet and the fiber optic contact (termini) used with this cable will have a violet stripe on the barrel to indicate it is used with this cable. The contact will also have strips designating the contact size and connector type. Anyone familiar with the system can tell at a glance it is a correct combination.

1.3.1 Tools, Processes, And Procedures

Appendices are included within this specification providing Tools and Fiber/Cable Stripping Processes and Procedures. Users with certified Tools and Applicable Processes and Procedures in place need only demonstrate that those Tools, Processes and Procedures meet the requirements applicable to the subject at hand.

Users without adequate Tools and Applicable Processes and Procedures are provided with a list of Tools and Applicable Processes and Procedures which will assure compliance to the requirements specified herein.

1.4 Classification

Cable conforming to this specification and bearing the appropriate part number designation shall be considered as Class S - Space Qualified.

1.5 Document Generation

This specification, text and graphics, is computer generated. The text software is Microsoft ”Word”, Version 5.0 or Microsoft ”Word for Windows”, Version 1.1. This software contains conversion capability for many major word processor programs.

The mechanical drawings were produced with DesignCad, Version 4.2. This software contains conversion capability to and from DXF, IGES, and HPGL formats.

Users of, and suppliers to, this specification are strongly encouraged to utilize common computer interfaces. This specification is available on floppy disk as well as paper. The goal is to minimize paper as a means of communication in recognition of national conservation policies.

Contact the Specification Custodian or NASA Space Station Program Office, Johnson Space Center, Houston, Texas should questions arise.

1.6 Configuration Management

This NASA specification is under configuration management by the NASA Space Station Program Office, Parts Control Board, Johnson Space Center, Houston, Texas.

1.6.1 Specification Changes

Changes to this specification shall be reviewed and approved by the NASA Space Station Program Office, or their designee, prior to official release of the Revision containing those changes.

1.6.2 Specification Distribution

Released copies of this specification are available from the Specification Custodian and/or the NASA Space Station Program Office, Parts Control Board, Johnson Space Center, Houston, Texas.

1.6.3 Procuring Activity

The Procuring Activity is responsible for supplier negotiations dealing with their procurement effort. This includes any development associated with product not developed and tooled as part of the initial release of this specification.

The Procuring Activity is responsible for the coordination of all specification related issues with the Specification Custodian such that development status and any related changes may be incorporated.

A development status data base shall be maintained by the Specification Custodian and/or the NASA Space Station Program Office with the intent of incorporation in a program wide data base (EPIMS) when available.

1.7 Specification Custodian

The contractor(s) shown on the title page of this specification have been designated by the NASA Space Station Program Office, Reston, Virginia, as specification technical manager (Specification Custodian) and tasked to generate this specification and provide related custodial activities on behalf of NASA.

The Specification Custodian, in conjunction with the NASA Space Station Program Office, Johnson Space Center, Houston Texas, or their designee, is responsible for program coordination, supplier coordination, technical evaluation and incorporation of comments, and final preparation of revisions to this specification.

The Specification Custodian, with approval of the NASA Space Station Program Office or their designee, may assign any portion, or all, of these duties to any active participant in the Space Station program.

The Specification Custodian shall act in concert with the Joint Work Package Connector Board and the Procuring Activity, or as directed by the NASA Space Station Program Office or their designee, in all issues regarding this specification.

1.8 Approved Sources

Approved suppliers shall allow user review of any and all listed materials, processes, procedures, drawings, or any other item of interest related to this specification, at the suppliers facility or mutually agreed to location. Should disagreement arise direction from the NASA Space Station Program Office via the Specification Custodian shall be requested. The decision of the NASA Space Station Program Office shall be final.

It is intended that data deemed ”proprietary” by the supplier shall be protected to the best of the users ability.

Approved Sources are documented in Paragraph 6.0.

2.0 Applicable Documents

2.1 Government Documents

The following documents, of the exact issue shown, or if no issue is specified, the issue in effect at the date of invitation to bid, form a part of this specification to the extent specified herein. In the event of conflict between documents referenced here and the contents of Sections 3, 4, 5, 10, and the associated Appendices, the requirements detailed by this specification are considered the superseding requirements. See paragraph 1.0 Scope.

2.1.1 Specifications

Federal

None

Military

MIL-C-12000	Cable, Cord, And Wire, Electric, Packaging of
MIL-B-81705	Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable

NASA

JSC-SN-C-0005	Contamination Control Requirements, Specification for
JSC-SPEC-SP-R-0022	General Specification Vacuum Stability Requirements of Polymeric Material for Spacecraft Applications
NHB 5300.4 (1C)	Inspection System Provisions for Suppliers of Space Materials, Parts, Components and Services
NHB 8060.1B	Flammability, Odor and Offgassing Requirement and Test Procedures for Materials in Environments that Support Combustion
SSP 30213 REV ”B”	Space Station Program Design Criteria and Practices
SSP 30233 REV ”A”	Space Station Requirements for Materials and Processes, General Specification for
JSC 30246 October 1987	Electrical and Electronic Material and Process REV Standard
MSFC-HDBK-527/ JSC 09604	Materials Selection For Space Hardware Systems

2.1.2 Standards

Federal.

FED-STD-228	Cable and Wire, Insulated; Methods of Testing.

Military.

MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-130	Identification Marking of U.S. Military Property
MIL-STD-810	Environmental Test Methods and Engineering Guidelines.
MIL-STD-45662	Calibration Systems Requirements.

(Copies of specifications and standards required by contractors in connection with a specific acquisition should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Other Publications

The following documents form a part of this specification to the extent specified herein:

ASTM-E-595	Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

EIA-455-13	Visual and Mechanical Inspections of Fibers, Cables, Connectors and Other Fiber Optic Devices.(DOD Adopted)
EIA-455-20	Measurement of Change in Optical Transmittance.
EIA-455-31	Fiber Tensile Proof Test Method.
EIA-455-41	Compressive Load Resistance of Fiber Optic
EIA-455-47	Output Far-Field Radiation Pattern Measurements. (DOD Adopted)
EIA-455-177	Numerical Aperture Measurement of Graded-Index Optical Fibers

2.3 Order of Precedence

Unless otherwise specified, Specifications, drawings, and other documents shall apply in the following order.

A. This Specification

B. Applicable Drawings, Specifications, and Standards specified herein in the following order.

1. NASA Prepared and/or Controlled.
2. Government Controlled.
3. Industry Controlled.

2.4 Interpretation

Should the requirements of this specification and/or any associated documents become subject to conflicting interpretation, clarification shall be formally requested.

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

2.5 Communications

All written communications shall be through the NASA Space Station Program Office, Johnson Space Center, Houston, Texas the Specification Custodian or the Procuring Activity. The Procuring Activity shall be responsible for assuring Program coordination. See Paragraph 1.7.

3.0 Requirements

3.1 Item Description

. The design, construction, and physical dimensions of the complete cable and cable elements shall be as specified herein and in Appendix A. The cable shall consist of one optical transmission element surrounded by protective layers to provide the dimensional centering, circularity, and concentricity as specified. The cable shall be of a circular cross-section and concentric geometry.

3.2 General Requirements

3.2.1 Data Required For Design Approval

Prospective suppliers shall submit one reproducible copy of the following for technical evaluation:

3.2.1.1 Cross-Sectional Drawings

The cross-sectional drawing shall show all internal and external dimensions and their tolerances; identification of all materials and coatings (by chemical composition or by original manufactures part number) used in the construction of the cable; all methods for processing the materials; the location and size of marking; the maximum guaranteed weight. The drawing may be exaggerated dimensionally.

3.2.1.2 Exceptions And Deviations

Prospective suppliers shall submit a list of exceptions to or deviations from the conditions or requirements of the specification detailing by paragraph number the specifics of exceptions or deviations and the rationale or reasons thereof. The schedule and/or cost impact of not allowing each exception or deviation shall be identified.

3.2.2 Data Required For Final Design Approval

3.2.2.1 Test Procedures

Detailed qualification and acceptance test procedures shall be submitted to and approved by the Specification Custodian prior to the start of testing.

3.2.2.1.1 Qualification Test Procedures

Detailed Qualification Test Procedures in accordance with paragraph 4.4.1.1 shall be submitted four weeks minimum prior to scheduled start of qualification testing. See Appendix C.1.

3.2.2.1.2 Acceptance Test Procedures

Detailed Acceptance Test Procedures in accordance with paragraph 4.9.4 shall be submitted six weeks minimum prior to scheduled start of acceptance testing. See Appendix C.2 .

3.2.2.1.3 Destructive Physical Analysis

3.2.2.2 Qualification Test Reports

A detailed Qualification Test Report shall be submitted to the Specification Custodian four weeks maximum following completion of testing to provide a record that the articles tested comply with the qualification test requirements of the specification. See paragraph 4.8.5 for report requirements. See Appendix C.1.

3.2.2.3 Top Assembly Drawings

The final top assembly drawing identified in the Baseline Control Document shall be submitted to the Specification Custodian four weeks maximum prior to the start of production.

3.2.2.4 Materials List

A complete list of materials, including material rating per MSFC-HDBK-527/JSC-09604, quantity and exposed surface area shall be submitted four weeks prior to start of production. See Appendix D.

3.2.3 Baseline Configuration Control

Configuration control will be accomplished by process baseline control established in accordance with Appendix D. The process baseline control shall be approved by the Specification Custodian prior to initiating manufacturing or testing of products to be furnished under this specification.

3.2.3.1 Baseline Control Document

The Baseline Control Document shall be submitted to the Specification Custodian four weeks maximum prior to the start of production.

3.2.3.2 Baseline Control Deviations

After final approval of the Baseline Control Document, there shall be no deviation without written approval of the Specification Custodian (See Paragraph 1.6 and 1.7). All requests for deviation from the requirements of this specification shall be submitted to the procuring activity procurement department in writing and accompanied by thorough technical rationale.

3.3 Materials

3.3.1 General

The cable shall be constructed of materials as specified in Appendix A. Materials selected for cable usage shall comply with SSP 30233 REV ”A” and SSP 30246 REV October 1987 and 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.

Material and combinations of materials used in the construction of the cable shall be selected to meet the requirements of SSP 30233 REV”A” (fungus, offgassing, outgassing, sublimation, emission of objectionable or irritating odors, toxicity, flammability) and shall be resistance to the effects of exposure to atomic oxygen. 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.

3.3.2 Fungus

Materials shall be fungus inert as defined by MIL-STD-454, Requirement 4. (Ref SSP 30233 REV”A”, 3.2.9) (Ref 4.10.1 for test Method)

3.3.3 Offgassing/Toxicity, Odor, Flammability, And Outgassing

Materials capable of emitting objectionable or irritating odors, noxious, toxic, flammable and/or electrically active (i.e. reducing arc/corona onset, sustaining, and extinction voltages below those exhibited by air) effluents , when exposed to low pressures and/or high temperatures, shall not be used unless treated to the extent that any remaining effluent is rendered benign. The requirements of NHB 8060.1B are applicable to the finished cable.

3.3.3.1 Offgassing/Toxicity

The quantity of each offgassed product produced from the polymeric materials used in the cable shall not exceed the Maximum Allowable Concentration(MAC) levels defined by NHB 8060.1B. (Ref 4.10.2 for test method).

3.3.3.2 Odor

Materials shall be submitted for odor testing to determine the odor characteristics The nature and quantity of odor products of any undiluted odor sample material submitted to the odor evaluation test panel members shall have an average rating of 2.5 or lower to pass the odor test as defined by NHB 8060.1B. (Ref 4.10.3 for test method).

3.3.3.3 Flammability

The materials used in the cable shall be non combustible or self-extinguishing (Flammability Rating A as listed in MSFC-HDBK-527/JSC09604). Materials shall self-extinguish within 6 inches when tested in the minimum use thickness and the burning time does not exceed 10 minutes when exposed to an environment of 30% oxygen and 70% nitrogen at a pressure of 10 PSIA. There shall be no sparking, sputtering or dripping of flaming particles from the test sample. (Ref NHB 8060.1B, Group 1) (Ref 4.10.4 for test method).

3.3.3.4 Outgassing(Vacuum Stability)

When the cable has been subjected to all manufacturing and preshipment processing, the polymeric materials used in the cable shall not exceed a maximum total mass loss (TML) of 1.0 percent mass and a maximum volatile condensable material (VCM) content of 0.1 percent when exposed to the following conditions :

Pressure	10^{-6} torr or less
Temperature of specimen	124°C to 126°C
Temperature of condensable plates	24°C to 26°C
Vacuum exposure time	24 hours

The finished cable shall be Thermal Vacuum conditioned at 125°C at a pressure 10^{-6} torr for 48 hours during the manufacturing or preshipment processing. (Ref 4.10.5 for test method).

3.3.4 Atomic Oxygen Effects

All exposed materials (i.e. marking, sealants, grommets, shells, etc.) shall be selected for their resistance to the atomic oxygen environment encountered in low earth orbit (LEO). Atomic oxygen is a strong oxidizing agent. Chemical reactions of certain materials with the ram flow of atomic oxygen, which is present in significant quantities in LEO, may lead to mass loss (reduction in thickness of exposed material) and change of surface properties. This degradation may shorten the usable lifetime of the cable.

Materials are divided into three categories:

a. Non reactive materials are those for which no changes have been detected on Shuttle flights or in ground based simulations.

b. Somewhat reactive--materials which change in important properties on a time scale of years.

c. Highly reactive--materials which change in important properties in a very short time.

Non reactive materials shall be used where ever possible.

Somewhat reactive materials may be used and shall be suitably protected to prevent or inhibit direct or reflected exposure to atomic oxygen or used in such thickness that assures component performance to the requirements of this specification when, due to its thickness is reduced at its end-of-life by exposure to atomic oxygen.

Highly reactive materials shall not be used.

The Specification Custodian shall determine the suitability of all materials. (Ref SSP 30233 REV A, 3.2.8) (Ref 4.10.6 for test method).

3.4 Design and Construction

3.4.1 Optical Fiber

The fiber used in the cable shall be of glass composition with graded index profile and a numerical aperture, bandwidth, attenuation and proof strength as specified in Appendix A. The optical fiber and cable dimensions, ovality, concentricity's of the various fiber elements and unit weight shall be as specified herein and in Appendix A.

3.4.1.1 Optical Fiber Buffer

The optical fiber shall be coated with a material to preserve the high pristine tensile strength of the glass fiber as drawn. These coatings are called buffers. All buffer materials shall be processed in such a manner as to ensure the material meets all dimensional requirements and passes all tests specified in this specification and Appendix A. The softening point of the material shall not be lower than 85^{O} C. Buffer materials shall be readily removable by mechanical or a combination of thermal and mechanical (thermal strip) means without damaging the cladding or leaving residual coating material on the stripped fiber which cannot be easily removed with a cotton pad.

3.4.2 Cable

The fiber shall be enclosed in a cable structure consisting of strength members and outer jacket to provide physical protection for the fiber and isolate the fiber from tensile loads.

3.4.2.1 Strength Member

Strength members shall be as specified in Appendix A.

3.4.2.2 Cable Jacket

The cable jacket shall provide environmental and physical protection to the cable elements. The cable jacket shall be applied concentrically to the cable core to maintain circularity in the completed cable. The cable jacket dimensions, dimensional tolerances and concentricity of the jacket to the underlying elements shall be as specified herein and in Appendix A. The surface of the jacket shall be dry and free from any coating, film or treatment which would interfere with bonding to the jacket of encapsulating, bonding or molding materials used in termination.

3.4.2.3 Color

The color of the finished cable shall be as specified in Appendix A.

3.4.2.4 Lengths and Splices

Fully assembled cable shall be continuous in length as specified by purchase order and the fiber shall not be repaired or spliced.

3.4.2.5 Cable Weight

The weight per unit length of the cable shall as specified in Appendix A.

3.5 Performance

3.5.1 Fiber

The following performance requirements apply to the bare fiber

3.5.1.1 Numerical Aperture

The numerical aperture of the fiber shall be as specified in Appendix A. (Ref 4.10.9).

3.5.1.2 Optical Fiber Bandwidth

The bandwidth of the fiber shall be as specified in Appendix A. (Ref 4.10.10).

3.5.2 Cable

The following performance requirements apply to the finished cable.

3.5.2.1 Attenuation Rate

The maximum attenuation rate of the fiber in the finished cable shall be as specified in Appendix A. (Ref 4. 10.11).

3.5.2.2 Attenuation Measurements

The attentuation shall be measured when specified by the individual test. Two methods exist to measure the optical performance. They are listed along with their attributes.

3.5.2.2.1 Induced Loss

Induced loss measurement are used to determine the optical performance of the test sample during the exposure to the test environment. Induced loss measurement require that the test set be operational and connected for the duration of the test. Induced loss measurements are as accurate as the optical equipment (± 0.02 dB) and are preferred when testing small lengths of cable.

The maximum allowable increase in attenuation in the specimen during exposure to an environmental condition or mechanical stress shall be 0.3 dB unless specified differently in the individual test requirement. The cable attenuation shall return to within 0.1 dB of initial value when the environmental condition or mechanical stress is relieved. (See 4.10.12.3).

3.5.2.2.2 Substitution Loss

Substitution loss measurements are used to determine the permanent change in optical performance due to the exposure to the test environment. Substitution loss measurements allow the test equipment to be disconnected from the test sample during the test. Substitution loss measurement accuracy are limited to the connector remating repeatability (for ST connectors (the accuracy is about 0.07 dB).

Unless specified in the test requirement, the change in substitution loss measurements taken before and after the exposure to the test shall not exceed 0.20 dB. The procedure is in section 4.10.12.4.

3.5.3 Radiation Resistance

For a 130 meter length of cable, attenuation shall not increase by more than 6 dB (operate through condition) when exposed to radiation at 300 rads/min dose rate to a total dose level of 4 kilorads (Si) (test level only). Following exposure to the radiation, the cable specimen's attenuation shall return to within 1.0 dB or less of the original value (annealed), within 3.0 hours (back at room temperature). Radiation tests and measurements shall be performed at -40°C , +20°C and +70°C at a wavelength of 1300nm $\pm$ 10nm. (See 4.10.13).

3.5.4 Thermal Shock

There shall be no cracking or melting of the coating materials and the induced attenuation of a test specimen shall meet paragraph 3.5.2.2.1 when exposed to 10 cycles of thermal shock from -95° C / +135° C (See 4.10.14).

3.5.5 Survival Temperature

The cable shall withstand 72 hour exposure at temperature extremes of -132°C and +150° C. The outer jacket shall show no cracking or other defects and the induced attenuation change, if any, shall meet the requirements of paragraph 3.5.2.2.1. (See 4.10.15).

3.5.6 Crush

Cable shall withstand a minimum 50 pound compressive load with no more than 0.2 dB change while load is applied and cable shall return to initial attenuation value when load is removed. (See 4.10.16).

3.5.7 Cable Bend

The cable shall withstand a minimum bend radius of 0.5 ” (inches) with no attenuation change. Normal installation bend radius of the cable will be 2.0” (inches). (See 4.10.17).

3.5.8 Jacket Shrinkage

The jacket shall not shrink more than 0.4 percent in length after exposure to 10 cycles of thermal shock -95°C to +135°C. (4.10.18).

3.5.9 Vacuum

A three meter length of cable shall be subjected to the following thermal/vacuum profile:

a. One inch maximum pressure at room temperature for six hours
b. One inch maximum pressure at 135°C for six hours
c. Ambient conditions for 12 hours

The cable shall not show any signs of damage during or after the exposure to the reduced pressure and high temperature and the induced optical attenuation when measured per the requirements in 3.5.2.2.1 except the allowable loss during the test shall not exceed 0.70 dB and the loss shall return to within 0.30 dB after the exposure to thermal vacuum. The loss deviation from paragraph 3.5.2.2.1 accounts for the induced loss of the 2 connector pairs in the test setup that are exposed to the thermal vacuum environment.

3.6 Identification Marking

The finished cable shall be identified by a printed marking applied to the outer surface of the cable.

The printed identification shall be printed at intervals of 12 inches, as measured from the beginning of succeeding complete marking, and consist of the following:

Specification sheet part number
Manufacturer's code designation in accordance with publications H4-1 and H4-2.
Date Code

The printing shall be a contrasting color in accordance with Mil-Std-130, Class 1. Identification printing shall be applied with vertical axes of the printed characters lengthwise of the cable when the nominal diameter of the cable exceeds 0,050 inch. All printed characters shall be complete and legible.

3.6.1 Durability of Identification

Identification printing, when applied to the outer surface of the finished cable shall be capable of withstanding a minimum of 250 cycles (500 strokes) and a 500 mg force nominal to the surface of the cable. Pass/fail criteria: Markings shall be visible and legible after completion of the required number of cycles.

3.7 Workmanship

All details of workmanship shall be in accordance with high grade optical fiber and cable manufacturing practice. Fiber coatings and cables shall be dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces and inclusions. The minimum level of visual examination to be performed, unless other wise specified, shall be as specified in "a." through "c".

This requirement is not intended to restrict other pertinent workmanship examinations deemed necessary by the supplier.

a. Outer jacket: Free of cuts, burnt areas, abrasions, holes, roughened areas, bulges, thin spots and discontinuities.

b. Inner layers: Free of cuts, holes, bulges, thin spots, and discontinuities.

c. Strength members: Uniform, laid with no discontinuities.

4.0 Quality Assurance Provisions

4.1 General

This section establishes the requirements for verifying cable performance, operability, and physical characteristics by test, analysis, demonstration or examination. The test program shall assure that the cable and its documentation meet the requirements established in sections 3, 5, 10 and applicable appendices.

The quality assurance provisions shall consist of the following classifications of inspections as follows:

A. Qualification
B. Product Acceptance
C. Destructive Physical Analysis
D. Receiving Inspections

4.2 Responsibility for Inspection

4.2.1 Contractor Responsibilities

Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein and in Appendix A. Except as otherwise specified, the supplier may use his own or any commercial laboratory acceptable to the Specification Custodian. The Specification Custodian reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

All items must meet all requirements of sections 3.0 and 5.0 and Appendix A. The inspections set forth in this specification shall become part of the suppliers overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract.

4.2.2 Test Equipment And Inspection Facilities

Provision for test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspections shall be the responsibility of the contractor.

Unless otherwise specified, all examinations and tests shall be performed within the following ranges of ambient temperature, humidity and pressure.

a. Temperature: Room ambient (20° to 30°C)
b. Relative humidity: Room ambient (10-80 percent)
c. Barometric pressure: 24 to 31 inches of mercury

4.2.3 Test Equipment Error

Equipment used to measure parameters shall not introduce errors greater than 10 percent of the tolerance on the parameter, or in the case of a single limit tolerance, the test equipment error shall be applied to the specified parameter in a manner to assure the parameter is being met. Accuracy of less than one-tenth of the tolerance shall require approval of the Specification Custodian. Test equipment calibration shall comply with MIL-STD-45662 or as an alternative, the test equipment calibration shall be current and certified as defined in the domestics contracts paragraph of MIL-STD-45662.

4.3 Product Assurance Program

4.3.1 Quality And Reliability Assurance Plan

The manufacturer shall prepare a quality and reliability assurance plan. The plan shall meet the intent, if not the letter, of the requirements of NHB5300.4 (1C). The manufacturer shall address the following paragraphs; 1C102, 1C103, 1C201, 1C202, 1C203, 1C204, and 1C300 through 1C310. The plan shall be submitted for review and approval.

4.3.2. Critical Hardware Notation

The manufacturer shall establish procedures by which their Purchase Orders (PO's), Purchase Requests (PR's), Request for Proposals (RFP's), contracts, and subcontracts, and those of their subcontractors and suppliers down to the lowest tier, shall include the following information. Additionally, each sheet of each drawing and the first sheet of each control document (i.e.; process, specification, procedure, etc.) shall also provide this information. The information shall be printed or stamped in bold face type. (Reference SSP 30213, Requirement G11.)

CRITICAL SPACE STATION HARDWARE

**FOR USE IN MANNED SPACE FLIGHT.
MATERIALS, MANUFACTURING, AND WORKMANSHIP
OF THE HIGHEST QUALITY STANDARD
ARE ESSENTIAL TO ASTRONAUT SAFETY.**

4.3.3 Flowchart

The manufacturer shall prepare and submit a manufacturing flowchart for production operations identifying the sequence of materials and processes used. The chart shall specify each inspection/test point or location. The chart shall also identify the individual documents that support the program plan sequence and shall detail the acceptance criteria for all inspections and tests.

4.3.4 Failure Mode Effects Analysis

The manufacturer shall prepare, and submit for approval, a complete failure mode effects analysis. The analysis shall be updated as required and form the basis of a computerized database. See paragraph 4.3.8.2.

4.3.5 Discrepancy/Failure Analysis

The manufacturer shall perform a complete failure analysis of all failures submitted for that purpose. The analysis shall consist of an analysis plan, a narrative of the analysis activity and full documentation of any anomalies found, and recommend action.

Discrepancies/failures reported from any source shall be brought to the attention of the Specification Custodian, or NASA designated technical representative, within 5 working days of receipt by the manufacturer. The manufacturer shall analyze each report and shall transmit their recommended disposition or corrective action to the Specification Custodian within 10 working days of receipt of the report. Review of the proposed recommendations or corrective actions and notification of acceptance status shall be provided to the manufacturer within 5 working days of receipt of the report.

Implementation of the recommended disposition or corrective action shall be at the sole discretion of the Specification Custodian.

4.3.6 Disposition and Corrective Action

The manufacturer shall recommend the disposition or corrective action for all analyzed discrepancies. This action may range from ”use as is” to changes in design, materials, processes, manufacturing and or process controls, test methods, or any other action deemed necessary to satisfactorily resolve the reported discrepancy and increase reliability. The disposition or corrective action shall be accompanied by an engineering evaluation of possible undesirable secondary effects that may result from incorporation of the recommendation, and by an evaluation of the recommendation’s affects on immediate and long term reliability, useability, and impact on performance to the requirements of this specification.

4.3.7 On Orbit Discrepancy/Failure Report Activity

The manufacturer shall stand ready to provide immediate and total support of all ”On Orbit” discrepancy and failure reports. The manufacturer shall have at his disposal the tools and personnel necessary to simulate and analyze the reported discrepancy/failure and implement the appropriate action including the fabrication of necessary hardware to facilitate ”On Orbit Repair” launch schedules. To this end the manufacturer shall provide and maintain a roster including phone numbers of ”Key Personnel” such that immediate ”emergency” contact may be established.

4.3.8 Product History and Database

4.3.8.1 History

The manufacturer shall maintain a file of test reports, commendations, complaints, anomalies, discrepancy/failure reports, alerts and any other documents or information applicable to the product furnished to this specification.

4.3.8.2 Database

The manufacturer shall recommend and implement a computerized database, utilizing the collected data, to support analysis response to questions, discrepancies, or failures encountered in the field or ”On Orbit”.

The recommended database shall be compatible with the Microsoft ”Windows 3.0” environment.

4.4 Inspection and Test

4.4.1 Qualification Inspection

Qualification inspection shall be performed on cable taken from the supplier’s first production lot to qualify the design and producability of the cable. It shall consist of the verification of the applicable requirements of sections 3, 5 and 10 by the methods specified in section 4 as applicable. In the event of design change(s) in the cable, the qualifying activity reserves the right to require additional inspection of the first unit which reflects the design change.

The test required for Qualification and Product Acceptance are listed in Table II.

4.5 Inspection Conditions

All inspections shall be performed in accordance with the test conditions specified in the individual test procedure.

4.6 Preparation Of Optical Test Samples

The use of optical test methods to measure the effect of exposures to test environments on the performance of optical fiber cable requires mode stripping at the fiber ends of terminated cable. All cable specimen fibers requiring testing of optical parameters shall be coupled to an optical source which fully fills the test fibers. The fiber end terminations shall incorporate cladding mode stripping at the source (input) end of the test fiber. This shall be accomplished by removing the protective layer (buffers) down to the cladding for a length of 50 mm back from the fiber end and generously applying flat black paint completely around the fiber over this distance. An alternate method of cladding mode stripping uses a liquid of a higher index of refraction applied to the fiber. With either method to assure that the cladding modes have been removed, the optical power output from the test fiber must be monitored while the material is being applied. When no further reduction in power is gained by extending the fiber length being coated, cladding modes have been stripped.

4.7 Materials Inspection

Materials inspection shall consist of certification, supported by verifying data, that materials used in fabricating the delivered cable are in accordance with the requirements of 3.3 and Appendix A.

4.8 Qualification Inspection

Qualification inspection consists of verification of requirements of section 3.3, 3.4, 3.5 and 3.7 and shall be performed on sample units produced with equipment and procedures normally used in production at a laboratory acceptable to the Government .

4.8.1 Qualification

Qualification shall be as specified in 4.8.1.1 through 4.8.7.

4.8.1.1 Sample Unit Length

Unless otherwise specified, the minimum sample unit length shall be 225 meters, and the sample size shall consist of one sample unit.

200 meters shall be retained by the manufacturer for qualification tests and 25 meters shall supplied to Specification Custodian to be forwarded to NASA for materials testing.

4.8.1.2 Inspection Routine

The sample shall be subjected to the qualification inspection specified in Table III in the order shown. Optical tests shall be performed on the sample when specified by the individual test method in section 4.10. Fiber dimensional measurements may be performed prior to cabling and sample lengths shall be as required for the individual measurement.

4.8.2 Qualification Test Procedure

Detailed Qualification Test Procedures to establish product compliance with the requirements of this specification shall be prepared per the requirements of Appendix C.1 and submitted to the Specification Custodian for approval. Qualification tests shall not be started before the Specification Custodian has approved the procedures.

4.8.3 Qualification Test Discrepancy

Any discrepancy that occurs during testing shall be reported to the Specification Custodian within 24 hours. Testing shall continue unless otherwise advised by the Specification Custodian. The supplier shall prepare a description of the discrepancy, an analysis of the cause, corrective action proposed, and the extent of retest if applicable.

Table I. Classification of Tests

TEST	REQUIREMENT	PRODUCT QUALIFICATION	PRODUCT ACCEPTANCE
Material	3.3	X	
Fungus	3.3.2	X	
Offgassing/Toxicity	3.3.3.1	X	
Odor	3.3.3.2	X	
Flammability	3.3.3.3	X	
Outgassing	3.3.3.4	X	
Atomic Oxygen	3.3.4	X	
Design and Construction			
Visual and Mechanical	3.4	X	X
Fiber Proof Test Fiber	3.6 & 3.7	X	X
Dimensions Fiber	3.4.1	X	X
Strippability Cable	3.4.2	X	X
Dimensions Strength	3.4.2.1	X	X
Member Cable Jacket	3.4.2.2	X	X
Color	3.4.2.3	X	X
Length and Splices	3.4.2.4	X	X
Cable Weight	3.4.2.5	X	X
Performance	3.5	X	X
Numerical Aperture	3.5.1.1.	X	X
Optical Fiber Bandwidth	3.5.1.2	X	X
Attenuation Rate	3.5.2.1	X	X
Induced Attenuation	3.5.2.2	X	
Radiation Resistance	3.5.3	X	
Thermal Shock	3.5.4	X	
Storage Temperature	3.5.5	X	
Cycling Flexing	3.5.6	X	
Crush	3.5.7	X	
Cable Bend	3.5.8	X	

4.8.4 Qualification Test Failure

If a failure occurs during Qualification Tests, testing shall cease, the supplier shall notify the Specification Custodian at once verbally and shall follow-up with a written notification describing the cause of failure and the proposed corrective action. Written Specification Custodian approval of such action must be given prior to resumption of testing.

4.8.5 Qualification Test Report

Following successful completion of qualification testing, the supplier shall submit in accordance with 3.2.2.2 one reproducible copy of the Qualification Test Report, certified by an authorized representative of the company, which shall contain the following information for which approval is requested:

a. Certification of the fact that the test samples were in conformance with and tested to the latest approved revision of the specification with respect to design, construction, materials, workmanship, marking, manufacturing processes and controls, test procedures, etc.

b. Dated and signed examination and test result data verifying that the samples complied with all the qualification test requirements of this drawing. The data shall include:

    1. Measured or observed test conditions at the time of test or examination as required.
    2. All pertinent qualitative observations and quantitative values obtained by measurement, including oscillographs, recordings, charts, photographs, etc.
    3. Calculated values and sample calculations.
    4. References to applicable drawings or documents (design drawing, test procedure, Q.C. procedure, etc.) cross-correlated to the specific requirements and test method paragraph of this specification for each of the examination and test parameters itemized in table III.

4.8.6 Disposition Of Test Samples

All test samples, or the remains thereof, shall be clearly identified as qualification test samples, along with their appropriate part number. The test samples shall then be protectively packaged and, unless otherwise specified in the purchase contract, shipped to the Specification Custodian in a container marked ”Qualification Samples - Do Not Use. ”The cable samples shall be conspicuously marked with at least two red ”X’s” in a manner which does not obscure other markings.

4.8.7 Qualification By Similarity

If a cable, which is similar in materials and construction to what is specified herein, has previously been subjected to, and successfully passed, tests which are the equivalent of those required herein, it may be possible to utilize the previous tests in lieu of part or all of the testing required by this specification. In such a case, the supplier may submit a statement which identifies the similarities and differences between the previously tested cable and the cable specified herein. The statement should cover design features, construction and materials of the cable to permit a competent evaluation of the similarity of the cables and the validity of the comparison. The statement, together with certified copies of the earlier tests reports, shall be submitted for the Specification Custodian approval in advance of the start of qualification testing. If approved, they shall also be included as part of the Qualification Test Report.

4.8.8 Qualification by Analysis

Should any of the requirements be qualifiable by analytical processes the supplier shall submit that analysis to the Specification Custodian for approval in advance of the start of qualification testing. If approved the analyses shall be included as part of the Qualification Test Report.

4.9 Product Acceptance Test

4.9.1 Acceptance Of Product For Delivery

Product Acceptance Tests shall consist of those inspections and tests listed on Table II.

4.9.2 Unit Of Manufacture

The unit of manufacture shall be defined by the purchase order.

4.9.3 Sample Unit

Sample length shall be one (1) meter for dimensional and mechanical inspection. As required for Numerical Aperture (NA), Attenuation and Bandwidth tests.

4.9.4 Product Acceptance Test Procedures

Product Acceptance Test Procedures and the Product Acceptance Test Data Sheets shall be prepared per the requirements of Appendix C.2 to establish product compliance with the requirements of this specification and submitted to the document custodian for approval. Product Acceptance Tests shall not be started before The Specification Custodian has approved the procedures.

Table II Qualification Inspection

INSPECTION	REQUIREMENT PARAGRAPH	TEST PARAGRAPH	SPECIMEN GROUP
Material	3.3		
Fungus	3.3.2	4.10.1	
Offgassing/Toxicity	3.3.3.1	4.10.2	
Odor	3.3.3.2	4.10.3	
Flammability	3.3.3.3	4.10.4	
Outgassing	3.3.3.4	4.10.5	
Atomic Oxygen	3.3.4	4.10.6	
Design and Construction	3.4		
Visual and Mechanical	3.6 & 3.7	4.10.7	
Fiber Dimensions	3.4.1	4.10.7	
Fiber Strippability	3.4.1.1	4.10.7	
Cable Dimensions	3.4.2	4.10.7	
Strength Member	3.4.2.1	4.10.7	
Cable Jacket	3.4.2.2	4.10.7	
Color	3.4.2.3	4.10.7	
Length and Splices	3.4.2.4	4.10.7	
Cable Weight	3.4.2.5	4.10.7	
Fiber Proof Test	3.4.1	4.10.8	
Identification Marking	3.6	4.10.7	
Performance	3.5		
Numerical Aperture	3.5.1.1.	4.10.9	
Optical Fiber Bandwidth	3.5.1.2	4.10.10	
Attenuation Rate	3.5.2.1	4.10.11	
Induced Attenuation	3.5.2.2	4.10.12	I& II
Radiation Resistance	3.5.3	4.10.13	II
Thermal Shock	3.5.4	4.10.14	I
Storage Temperature	3.5.5	4.10.15	I
Cycling Flexing	3.5.6	4.10.16	I
Crush	3.5.7	4.10.17	I
Cable Bend	3.5.8	4.10.18	I

4.9.5 Destructive Physical Analysis (DPA)

Destructive Failure analysis consists of those destructive inspections performed by the designated test agency to verify compliance with those attributes available only by device dissection. DPA procedures are documented in Appendix C.4.

4.9.6 Receiving Inspection

Receiving Inspections consists of the tests and examinations performed by the designated test agency to verify that the cable meets the requirements of this specification at the time of receipt by the procuring activity. Receiving Inspection criteria is documented in Appendix C.3.

4.10 Methods Of Inspection

4.10.1 Fungus

The non-metallic materials used in the connectors shall be tested to assess the extent to which they will support fungal growth using the test methods and criteria defined by MIL-STD-810, Method 508. They shall meet the requirements of 3.3.2.

4.10.2 Offgassed Products Test

The offgassing rating and toxicological summation of the total offgassed products for each material that has been previously tested are documented in MSFC-HDBK-527/JSC09604 or the Material And Process Technical Information System (MAPTIS) electronic data base located at George C. Marshall Space Flight Center, Huntsville, Al. If a material is not included in this data base, samples and requests for testing per NHB 8060.1B shall be submitted to NASA or the Specification Custodian. The offgassing rating shall meet the requirements of 3.3.3.1.

4.10.3 Odor Test

The odor ratings for materials that have been previously tested are documented in MSFC-HDBK-527/JSC09604 or the Material And Process Technical Information System (MAPTIS) electronic data base located at George C. Marshall Space Flight Center, Huntsville, Al. If a material is not included in this data base, samples and requests for testing per NHB 8060.1B shall be submitted to NASA or the Specification Custodian. The odor rating shall meet the requirements of 3.3.32.

4.10.4 Flammability (Upward Propagation Test)

The flammability ratings for materials that have been previously tested are documented in MSFC-HDBK-527/JSC09604 or the Material And Process Technical Information System (MAPTIS) electronic data base located at George C. Marshall Space Flight Center, Huntsville, Al. If a material is not included in this data base, samples and requests for testing per NHB 8060.1B shall be submitted to NASA or the Specification Custodian. The flammability rating shall meet the requirements of 3.3.3.3.

4.10.5 Outgassed Products Test

The data for maximum total loss (TML) and maximum volatile condensable material (VCM) content of materials that have been previously tested is documented in MSFC-HDBK-527/JSC09604 or the Materials And Process Technical Information System (MAPTIS) electronic data base located at George C. Marshall Space Flight Center, Huntsville, Al. If a material is not included in this data base, samples and requests for testing per SP-R-0022 shall be submitted to NASA or the Specification Custodian. The TML and VCM levels shall meet the requirements of 3.3.3.4.

4.10.6 Atomic Oxygen Effects Test

Universally accepted test methods for measuring material resistance to Atomic Oxygen (AO) have not been established. Resistance of materials to AO is calculated from the recession rate of small coupons exposed to AO either on racks in the shuttle cargo bay, or in selected ground tests. The Specification Custodian shall determine the suitability of all materials through analysis of expected end-of life recession and other material degradation.

4.10.7 Visual And Mechanical Examinations

4.10.7.1 General

Visual and mechanical examinations shall be performed to verify that the design, construction, physical characteristics, dimensions, marking, and workmanship are in accordance with the requirements in paragraphs(see 3.3, 3.4, 3.6 and 3.7). Visual examinations shall be accomplished utilizing 10x magnification unless otherwise indicated. Visual inspection for the color of the cable may be accomplished without magnification. The visual examination is to examine the cable for Macro-type defects rather than Micro-type defects. Dimensions of the fiber and cable shall be in accordance with 3.4 and Appendix A-1. (Reference EIA 455-13).

4.10.7.2. Test Equipment

Optical Magnifier, 10X power (maximum) for examination of the product for damage and defects such as cracks, splits in outer jacket, etc.

Dimensional and other measurement equipment (Vernier calipers, rules, comparitors, scales, etc.) shall be of sufficient accuracy to verify dimensional and weight parameters specified in 3.0 and Appendix A..

4.10.7.3. Test Specimen

The test specimen shall be a sample from the reel of the product lot being submitted for inspection. The length of the specimen for acceptance and receiving inspection shall be sufficient to perform all visual and mechanical examinations.

Dimensional measurements shall be made on at least two (2) samples [minimum one (1) meter in length], one from the outside end of the product and one from the inside end of the reel of product.

4.10.7.4. Test Procedure

4.10.7.4.1 Visual Examination

The product shall be visually examined using the specified magnifier (when required) to assure that it meets the specified requirements as to:

a. Materials used (Material certifications to establish conformance to material type requirements) and verification of data submitted relative to lot number, etc.

b. General design and construction
c. Workmanship
d. Finish
e. Identification of product (marking)
f. Damage

4.10.7.4.2 Mechanical Examination

The product shall be measured to determine conformance to the dimensions specified in Appendix A. The cable specimens shall be prepared for dimensional inspection by stripping off outer jacket, trimming strength member and stripping off buffer as required by the measurement method used. The following dimensions are to be verified:

a. Core diameter
b. Core ovality
c. Cladding diameter
d. Cladding ovality
e. Core/Cladding offset
f. Primary buffer diameter
g. Primary buffer ovality
h. Secondary buffer diameters (ID & OD)
i. Outer Jacket OD

Data sheets shall be furnished, to the procuring quality organization,

documenting the actual measurements of the dimensions specified on Figure 1 of Appendix A for each sample used for dimensional inspection for qualification and quality conformance (acceptance) inspections.

4.10.7.5 Cable Weight

The weight of a unit length shall be measured (see 3.4.2.5) and the value recorded on the test data. Following the basic method defined in FEDERAL STANDARD 228, Method 8311, cut a cable specimen (two feet minimum) and measure to the nearest 1/64 inch with a precision steel scale and record the value as L_c. Weigh the cable specimen to within 0.20 gram and record as W_c. Calculate the weight in pounds per 1000 feet using the following formula:

$$\text{lbs./1000 ft.} = \frac{W_c}{L_c} \times 26{,}455$$

where W_c = weight of the specimen in grams
L_c = length of the specimen in inches

Record the results on the data sheet.

4.10.7.6 Durability Of Color Markings

The durability of product identification or color markings applied to the cable for coding shall be evaluated at 20° to 25 °C (68° to 77°F) as follows:

4.10.7.6.1 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. The instrument shall be capable of rubbing a small cylindrical steel mandrel (usually a needle), 0.025 inch 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 cylindrical surfaces in contact. A weight affixed to a jig above the mandrel shall control the thrust exerted normal to the surface of the insulation. 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 3/8 inch and the frequency shall be 120 strokes (60 stroking cycles) per minute.

4.10.7.6.2 Durability Testing Procedure

In performing the test, a specimen of cable shall be mounted in the specimen clamp and the weight specimen in the applicable specification sheet shall be applied through the abrading mandrel to the marked surface. The counter shall be set at zero and the drive motor started. The specimen shall be observed throughout the test and as soon as the mandrel has developed a continuous line of erasure or obliteration through all applicable markings contacted in its strokes, the number of abrading cycles shall be recorded. Three specimens from each sample unit shall be tested and the results averaged.

4.10.7.7 Strippability

Fibers shall be stripped of their coatings with the use of commercially available mechanical fiber stripper or thermal strip tool with provision to prevent fiber damage from the jaws. After stripping, any coating residue shall be removable with Kim wipes or equivalent material. Inspect the fiber under 10X magnification for compliance with 3.4.1.2. A record shall be made of the results and included in the data package.

4.10.8 Fiber Proof Test

The fiber tensile strength shall be measured to determine the actual minimum tensile load which a continuous length of the optical fiber specified in this specification can be certified to have survived.

The minimum proof test load shall be as specified in 3.4.1.1. The proof load shall be applied uniformly over a known fixed length of sample and for a known time at a rate of speed through the proof-test zone that is essentially constant. The tensile load shall be monitored continuously by direct measurement or the equivalent. The speed and the length of fiber under proof-test shall be chosen so as to ensure that the proof stress is applied for approximately 1 sec. Any untested portion of the fiber lot shall be discarded from the sample. A record shall be made of the proof-test and included in the data package.

Fiber identification, fiber diameter, gauge length, proof-test load, humidity, temperature and velocity shall be reported using metric units. (Reference EIA-455-31).

4.10.9 Numerical Aperture

The numerical aperture of the fiber shall be measured on fully assembled cable specimens. The numerical aperture measurement shall be made utilizing angular radiant intensity (far-field) distribution measurement data. (Reference EIA-455-47 and EIA-455-177).

4.10.10 Optical Fiber Bandwidth

The cable shall be measured for information transmission capacity. The bandwidth shall be normalized to a unit length: MHz-km. The method shall measure the information transmission capacity of a glass core optical fiber in the frequency domain. (Reference EIA-455-30).

Report the operator and date, test sample identification, test sample length, source wavelength and results.

4.10.11 Attenuation Rate

The fiber shall be tested to measure the spectral attenuation (dB) between two cross sections separated by a known distance and at a specific wavelength. The attenuation rate of the fiber in the cable shall then be calculated and recorded on the data sheet. In addition to demonstrating specification compliance, these initial attenuation values are the baseline values which are used to gage the change in attenuation during and after exposure to the various mechanical and environmental test conditions in subsequent tests.

The test report shall include the title of test, date and name of operator, measurement data, identification and length of fiber measured, temperature, spectral attenuation and spectral attenuation rate.

4.10.12 Attenuation Measurements

The following are the procedures required to make optical loss measurements for the International Space Station Program. There are three procedures outlined below. Although the EIA/TIA Specifications are referenced, the following procedures take precedence in the case of conflict.

4.10.12.1 Test Equipment

The test equipment used to perform optical measurements shall be capable of meeting the performance requirements of this section. The RIFOCS CP-1107 Power Meter is the standard equipment for the Space Station Program and is complient to all Space Station Program requirements. Any equipment other the RIFOCS shall be approved by the specification custodian.

4.10.12.1.1 Light Source

The optical source shall be a optically and modally stabilized LED having a center wave length between 1270 nanometers and 1330 nanometers. The far field 1/2 sine ∠ output of the source shall conform to Table IV. The source bandwidth shall be within 60 nanometers. The LED shall not be modulated.

Table IV - Far Field Output

NA	Power (%)
0.093 to 0.118	80%
0.139 to 0.167	60%
0.182 to 0.208	40%
0.224 to 0.250	20%
0.267 to 0.290	5%

4.10.12.1.2 Source Monitoring Equipment (SME)

The source output power shall be monitored and recorded without disconnecting the test specimen. The launch conditions into the calibration cable set must meet the requires of 4.10.12.1.2. These measurements are used to allow corrections to compensate for source output variations.

Equipment that does not have continuois source monitoring capalblility, shall inclued a Certificate of Compliance that the optical source remains optically stable to ± 0.04 dB and and modally stable within 1 % of the measured optical power at each specified 1/2 sine ∠ for the duration of the testing sequence. The validation of the source shall be obtained before and after the testing and shall be submitted with the test data.

4.10.12.1.3 Detection Equipment

The detector and associated electronics shall be capable of measuring all energy exiting from the fiber and have a linear active area at least 10 times larger than the fibers core. They shall be linear at the wavelengths used, and over the expected range of power. The resolution of the detection equipment shall be as follows:

Interconnection Device Loss	Resolution
>.5 dB	.1 dB
<.5 dB	.05 dB

The detector shall be linear within 3% over the duration of the test and over a 23±5 ^{o}C temperature range.

4.10.12.1.4 Reference Cable Set

The Reference Cable 6 ± 0.6 meters of NFOC-2FFF-1GRP-1 fiber optic cable and terminated with ST connectors polished to attain a Physical Contact interface. The substitution loss of the Reference Cable shall not exceed 0.40 dB and the fiber core shall be free from surface defects when veiwed at 100 power magnification.

Connect the Reference Cable to the optical source and detector. Clean and mate each end connector until three consecutive OPT measurements agree to 0.03 dB. Do not disconnect the Reference Cable from the source until the SRD cable build is completed. Cut the cable 2.0 ± 0.2 meters from the source side of the Reference Cable. Terminate each cut end of the Reference Cable with a ST connector polished to achieve physical contact interface. Each termination shall measure no more than 0.40 dB. After this pair of termini have been installed, cut the cable 2.0 ± 0.2 meters from the detector end of the Reference Cable and install a pair of ST connectors as before. Label the segment toward the source as “S”, the center as “R” and the detector side as “D”. This cable set is called the Reference Cable Set, and is comprised of the S, R, and D cables.

4.10.12.1.5 MTC Cable

An MTC cable shall 6.0 ± 0.6 meters of SSQ 21654 fiber optic cable. It shall be terminated with ST connectors and polished to achieve a Physical Contact interface. The substitution loss shall not exceed 0.4 dB and the cable shall be free from surface defects when veiwed at 100 power magnification. This cable shall be protected and stored in a safe and environmentally stable area when not used.

When using a RIFOCS test set, the MTC cable can be RIFOCS’ P/N 333-110-03.

4.10.12.2 Optical Test Set Calibration

The test set calibration consists of two processes; one for the source and detector and one for the S and D cables. The measurement is very rigorous and is required to attain 0.07 dB measurement accuracy.

4.10.12.2.1 Meter and Source Calibration using the MTC Cable

Clean each termini optical surface on the appropriate MTC Cable using a clean lint free wipe wetted with N-Propyl alcohol followed by a clean lint free wipe (dry). Using clean, dry compressed air, blow the connector receptacle on the source and detector. Install the MTC Cable into the source and the detector. Disconnect the Source side of the MTC Cable from the source and reclean the source receptacle and the mating optical terminus. Repeat the cleaning remating steps until three consecutive OPT measurements agree to within 0.03 dB. Repeat this process on the detector side of the MTC Cable interfaces. Record the final OPT into the equipment log as $P_{MTC(date)}$. The OPT shall not exceed 0.1 dB change from the other logged readings.

4.10.12.2.2 SRD Cable Set Calibration

Clean each connector optical surface on the appropriate S Cable and D Cable using a clean lint free wipe wetted with N-Propyl alcohol followed by a clean lint free wipe (dry). Using clean, dry compressed air, blow the connector receptacle on the source and detector. Install the S and D into the source and the detector and mate the S and D cables. Disconnect the S from the source and reclean the source receptacle and the mating optical terminus. Repeat the cleaning remating steps until three consecutive OPT agree to within 0.03 dB. Repeat this process on the D to detector receptacle and then on the S to D interfaces. Record the final OPT as P_{SD} and the meter monitor power as P_{MSD}.

Disconnect the S to D interface and connect the R cable to the S and D cables. Clean and measure each connector until three consecutive OPT measurements agree to 0.03 dB. Record the final OPT measurement as $P_{S\text{-}R\text{-}D}$. Subtract the P_{SRD} from the P_{SD} OPT measurements and record it in the equipment log. Compare the R substitution loss to the previous records. If the R substitution loss has greater than 0.1 dB change, replace the SRD cable sets.

4.10.12.3 Induced Loss

(Reference EIA/TIA 455 FOTP -20 - Measurement of Change in Optical Transmittance) The induced attenuation (changes due to exposure to mechanical and environmental tests) shall be measured and recorded when specified in the specific mechanical or environmental test method in accordance with the following procedure. The optical loss measurements shall meet the requirements specified in paragraph 3.5.2.2.

4.10.12.3.1 Optical Measurements

The following Optical Power Throughput measurements shall be recorded:

P_{MSDD} = Meter Optical Power Throughput (OPT), SD - Cable, Induced Loss
P_{MDB} = Meter OPT, Before, Induced Loss
P_{MDX} = Meter OPT, After or Subsequent, Induced Loss
P_{SSD} = OPT, SD - Cable, Induced Loss
P_{DB} = OPT, Before, Induced Loss

P_{DX} = OPT, After or Subsequent, Induced Loss

4.10.12.3.2 Test Set Up

The test equipment shall be per 4.10.12.1 and calibrated per 4.10.12.2. The test set shall remain connected to the test sample during the environmental exposure.

4.10.12.3.3 Test Procedure

The test setup shall not be separated from source once testing has begun. Induced attenuation measurements shall be made immediately before, during and/or after tests as specified in the applicable mechanical or environmental test method. Replace the R Cable with the test sample. Clean the test sample to S Cable interconnection and record the OPT. Reclean the interconnection until three consecutive OPT measurement agree to within 0.03 dB. Record the final OPT measurement as P_{DB} and the meter monitor power as P_{MDX}. Run the environmental test. Measure and record the test sample OPT at the specified intervals as P_{DX} where x indicates the interval. After the environmental test is complete, measure the final OPT and record it as P_{DF} and the meter monitor power as P_{MDF}.

4.10.12.3.4 Induced Loss Calculations

Induced loss shall be calculated as follows when the power is measured in watts

$$\Delta L_D \text{ (dB)} = 10 \log\left(\frac{P_{DB}}{P_{DX}} \bullet \frac{P_{MDX}}{P_{MDB}}\right)$$

or when the power is measured in dB

$$\Delta L_D \text{ (dB)} = (P_{DB}-P_{DX}) - (P_{MDB} - P_{MDX})$$

4.10.12.4 Substitution Loss

(Reference EIA/TIA 455 FOTP-171 however these requirements superceed FOTP-171 if conflicting.

4.10.12.4.1 Optical Measurements

The following Optical Power Throughput measurements shall be recorded:

P_{MSD} = Meter Optical Power Throughput (OPT), SD - Cable, Substitution Loss
P_{MSI} = Meter OPT, Initial, Substitution Loss
P_{MSF} = Meter OPT, Final, Substitution Loss
P_{SD} = OPT, SD - Cable, Substitution Loss
P_{SI} = OPT, Initial, Substitution Loss
P_{SF} = OPT, Final, Substitution Loss

4.10.12.4.2 Test Set Up

The test equipment shall be per 4.10.12.1 and calibrated per paragraph 4.10.12.2. The test set may be disconnected from the test sample during the environmental exposure.

4.10.12.4.3 Test Procedure

Replace the R Cable with the test sample. Clean the test sample to S Cable interconnection and record the OPT. Reclean the interconnection until three consecutive OPT measurement agree to within 0.03 dB. Repeat this process on the test sample to D Cable interconnection to test sample Record the final OPT as P_s and the meter monitor power as P_{MS}.

4.10.12.4.4 Substitution Loss Calculations

Induced loss shall be calculated as follows when the power is measured in watts

$$L_S \text{ (dB)} = 10 \log\left(\frac{P_{SDS}}{P_S} \bullet \frac{P_{MS}}{P_{MSDS}}\right)$$

or when the power is measured in dB

$$\text{Substitution Loss (dB)} = (P_S - P_{SD}) - (P_{MS} - P_{MSD})$$

4.10.13 Radiation Resistance

The radiation characteristics of the cabled fiber shall be determined by measuring the effects of low temperature, photo bleaching and annealing on active and inactive fibers. The optical power loss (induced attenuation) shall be measured during exposure to the radiation and during the recovery period in accordance with 4.10.12.

There shall be three 100 meter test cable specimens. Each of the three specimens shall be configured as follows:

a. Active with 1uW of optical power applied and continuously monitored.
b. Active with 10uW of optical power applied and continuously monitored.
c. Inactive and checked at 1 krad intervals.

The initial radiation dose shall be 1 rad/sec to a total dose of 4 krads to simulate an accumulation of 1 rad/day for 13 yrs. The temperature shall be exposed to an additional dose at a high dose rate to increase total dose to 8 krads. The specimens shall be allowed to return to ambient temperature while recovery is monitored.

After the fibers have fully recovered, the temperature shall be reduced to -40°C. The specimens shall be irradiated at 5 rad/sec to a total dose of 1 krad and then allowed to recover for one hour to determine annealing characteristics. Repeat the foregoing sequence a minimum of twelve times with the last four (4) cycles the low temperature shall be - 100°C. Optical power measurements shall be taken at the start, at the 1 krad level, and at the end of one hour for each cycle. All optical power measurements shall be recorded on a test data sheet.

4.10.14 Thermal Shock

The cable shall be subjected to thermal shock testing (see 3.5.4 for temperature limits) to determine the temperature cycling effects on the attenuation of fiber optic cable. Typical indications of damage resulting from this test are an excessive temporary or permanent increase in optical attenuation which exceeds specified limits and cracks, blisters and splits in the materials.

4.10.14.1 Test Equipment

The environmental chamber(s) shall have an operational range greater than -100°C to +150°C and the capacity to stabilize temperature within two minutes. The chamber inside dimensions shall be large enough to accommodate the sample and allow unrestricted air flow around the test sample.

The chamber(s) shall provide an access port or ports through which the fiber or cable ends or sensor wires may extend, and shall have the capability of sufficiently sealing the cables and wires which may extend out of the chamber so that the specified temperatures can be maintained.

A temperature recording device or devices shall be used to provide a record of the temperature throughout the test. Equipment for measuring the change in optical power in the transmitting fibers shall be the as indicated in 4.9.12.

4.10.14.2 Test Sample

A minimum 50 meter long sample of fiber optic cable shall be installed in the chamber. the lenght of the sample outside of the chamber on each end shall not exceed 10% of the lenght of the cable in the chamber. The attenuation change, in dB/km, shall be normalized to the length of sample in the chamber. The fiber cable shall be loosely coiled with a diameter no less than 12".

4.10.14.3 Test Setup

Position the sample in the test chamber so that both macro bending and micro bending of the optical fiber is minimized.

The fiber cable leading out of the chamber shall be fed up through the feed-through ports with enough length to allow hook-up to the measurement equipment. Allow room in the chamber for air circulation around the sample avoiding conductive paths between the surface of the chamber and the sample. Place the temperature sensing device between layers of the fiber optic cable as close to the center of the sample and as far from the sample's exterior as possible. Prepare the ends of the fibers to allow coupling to measurement equipment. Precondition the test sample at 25+5°C (77+9°F) and a relative humidity not to exceed 50%, for 4 hours prior to the test. Measure the induced attenuation in accordance with paragraph 4.10.12 at ambient preconditioned temperature and record the optical performance (baseline) of the sample as RT1. (Note that these same measurements are repeated during and at the conclusion of cycling).

4.10.14.4 Test Procedure

Using a two chamber test unit, move test samples from ambient conditions to the second chamber set at -95 ± 2°C (-139 ± 3.6°F). All temperature changes shall be accomplished within 2 minutes and dwell times at the temperature extremes shall be 20 minutes, at which time the optical power thruput (OPT) shall be measured and recorded. Transfer test sample to the chamber which is at +135 ± 2°C (275 ± 3.6°F). After 20 minute dwell measure OPT. Repeat for a total of 10 cycles with a final OPT measurement of ambient conditions, 25 + 5°C (77 + 9°F) recorded as RT2.

Without removing coiled sample from chamber, flex by holding coil with one hand on each side of the coil, and twist one hand with respect to the other and allow the coil to relax. Then twist the coils the same amount in the opposite direction from the relaxed position and let coils return to their relaxed position. Do not pull on the fiber leads routed out of the terminal shock cabinet during the process. Measure and record the OPT after the flexing as RT3 and calculate the change in loss between RT1 to RT2 and RT2 to RT3.

After completion of the test, remove the sample from the chamber and visually examine for changes in construction, such as permanent set, cracking, crazing, stickness, delamination, deterioration of markings, and/or anything that would degrade the performance of the sample. Uncoil the sample so that 10 meters (33 feet) of sample that was subjected to thermal shock can be inspected.

4.10.14.5 Test Documentation

The test report shall contain the date and title of test, the test personnel, identification by part number, lot number and length of the fiber optic cable tested,

indicate the soak time and temperature cycling schedule used and the number of cycles performed, sample mass including test fixtures, test results for each step (time vs temperature recording, change in attenuation), and the results of the physical examination.

4.10.15 Survival Temperature

A 30 meter specimen shall be subjected to a minimum of 72 hours exposure to -133 ± 2°C. Another 30 meter specimen shall be exposed to +150 ± 2°C for a minimum of 72 hours. Both samples shall be subjected to no more the one inch of Mercury throughout the thermal exposure. The induced attenuation shall be measured and recorded before, daily, and after the test. The induced attenuation meet the requirements in paragraph 3.5.2.2.1 except the allowable change in induced loss at -133°C shall not exceed 1.0 dB. Following the test the outer jacket of the specimen shall be visually examined using 10 power magnification. The outer jacket shall show no cracks or defects.

4.10.16 Crush

Compressive load testing shall be accomplished in accordance with following procedure(Reference EIA 455-41). The following special test conditions apply to these tests:

a. The compressive load shall be at least 50 lb.
b. Apply the compressive loading rate within 5 seconds and hold for 60 seconds minimum.
c. Induced attenuation shall be measured and recorded in accordance with paragraph 3.5.2.2.1 herein while the load is applied. The induced attenuation shall be measured and recorded. The maximum value shall not exceed maximum cabled attenuation value specified in appendix A
d. Visual inspection of the outer jacket shall be made under 10 power magnification.

4.10.16.1 Test Equipment

Equipment required to perform the compressive resistance test of fiber cable shall include moveable and stationary portions of the test fixture with a flat plate with 6 mm (1/4”) radiused edges and 100 mm (4”) of bearing length and a hardness of Rockwell RB-98, minimum. Optical equipment required includes power source and power detectors

4.10.16.2 Test Sample

The specimen shall be a sample of fiber optic cable of 4 m (13 ft) length minimum and shall incorporate cladding mode stripper.

4.10.16.3 Test Procedure

Condition the specimen for 48 hours under the standard atmospheric conditions of (25°±5°C, 27-31 inches of mercury and 30-60% Relative Humidity). Place the specimen in the test apparatus, taking care that no initial stress is applied to the specimen. Secure the specimen ends so that the ends do not move in the test apparatus throughout the test. Measure optical power output and record data. Apply the specific compressive load at the specified rate. Continuously measure optical output power during the loading cycle and record data. Release the load. Allow the specimen to "rest" for a minimum period of 5 minutes. Measure optical output power after the test and record data. Remove the specimen from the test apparatus. Visually inspect the specimen (normal corrected vision) for damage. Record observations. Calculate the optical loss in the sample due to crush. The optical loss of the specimen due to crush shall not exceed the limits specified in 3.5.2.

Note : Cable exterior deformation shall not be considered as damage; cracking, splitting or similar effects shall, however, be considered as damage.

4.10.16.4 Test Documentation

Test data sheets shall include the name of test, test date and names of test personnel; sample description including cable length tested; test equipment and latest calibration date; maximum load applied and the loading rate; the before, during and after power readings; the calculated loss; visual observations and damage assessments; source, detector, and recording equipment used; launch conditions.

4.10.17 Cable Bend

The finished cable shall be bend tested to the requirements of 3.5.8 to determine the degree of cable degradation that will occur if the cable is statically bent around a corner of a given radius. Potential failure modes for this test include degraded optical performance, cracked, split, or torn cable jacket, and jacket deformation resulting in degradation of protection to the optical fiber.

4.10.17.1 Test Equipment

The test fixture shall consist of a bench equipped with a mandrel or a corner which provides a test edge that allows one end of the cable to hang free while providing a horizontal platform perpendicular to the free hanging end of the cable. The radius of the test edge shall be 12.5 mm (0.5") minimum. The cable shall be secured to the top surface at least 20 cable diameters from the radiused edge and another clamp fastened to the strength member shall be used to apply the test force to the free hanging end of the cable in a direction perpendicular to horizontal surface.

4.10.17.2 Test Specimen

The specimen length shall be a minimum of 4 m (13 ft). Attach fiber optic connectors compatible with optical loss measurement equipment.

4.10.17.3 Test Procedure

Visually examine the cable using 10 power magnification. Place two marks on the test sample at least 40 cable diameters apart. Measure optical power. Clamp the cable to the horizontal surface at one of the marks on the cable so that the mandrel or corner is approximately centered between the marks.
Do not over tighten the cable clamp. Check optical power throughput. Apply 45 N to 50 N force to the free end of the specimen for a period of one minute. Measure the optical power throughput, record on data sheet and compare to the initial measurement value. The induced attenuation shall meet the requirements of paragraph 3.5.2.2.1 during the test. Visually examine the cable under 10 power magnification for cracks, splits, tears, deformations, or other signs that the jacket integrity has been compromised.

4.10.17.4 Test Documentation

Test data sheet shall include the name of test, test date and names of test personnel. Also sample description, test equipment and latest calibration date, maximum test force applied, results of optical measurements and examinations and pass-fail criteria.

4.10.18 Jacket Shrinkage

4.10.18.1 Test Equipment

Same as for thermal shock test 4.10.14.1 except the test sample shall be per 4.10.18.2.

4.10.18.2 Test Sample

Two samples of cable under test shall be cut 1.8 meters in length from different sections of the test cable at least 50 meters apart. Cut cable specimen flush at each end and measure length to ± 0.13 mm. Remove the optical fiber from the test lelngths.

4.10.18.3. Test Setup

Coil the two test samples at a diameter no less than 12" in diameter and install the entire specimens in the test chamber. Allow room in the chamber for air circulation around the sample avoiding conductive paths between the surface of the chamber and the sample.

4.10.18.4. Test Procedure

Thermally shock for 10 cycles with temperature extremes of -95 / + 135°C and 20 minute dwell times at the temperature extremes. After completion of cycling, return to room time and measure length of jacket to ± 0.13mm. Calculate amount of shrinkage and percent of shrinkage.

4.10.18.5 Test Documentation

The test report shall contain the date and the title of test, the test personnel, identification by part number, lot number and length of the fiber optic cable tested, indicate the soak time and temperature cycling schedule used and the number of cycles performed, sample mass including test fixtures, and the test results for each step (time vs temperature recording).

4.10.1 Vacuum

A cable specimen shall be subjected to vacuum. It shall not show signs of physical damage and the optical power throughput shall meet the requirements in section 3.5.2.2.

4.10.19.1 Test Equipment

The following test equipment is required:

a. The Vacuum Chamber - The vacuum chamber must be of sufficient size to accommodate the test article. The internal pressure shall be capable of being accurately measured and monitored for the duration of the test to within ± 0.2 inches of mercury. It shall also be capable of raising the internal temperature to 135°C ± 2°C while sustaining the vacuum. The temperature shall be monitor for the duration of the test.

b. An optical test set per 4.10.12.1

c. Optical test jumpers. Two jumpers will be used to provide a low air leak interface into and out of the test chamber. ST connectors shall be modified to remove the coupling nut and spring from the connector body. The ST connectors shall be terminated using DC-002 epoxy to secure the strength member and Epo-Tec 353ND epoxy to secure the fiber. The epoxy shall be cured using a curing profile that minimized the physical stress on the fiber. The ST connectors shall be PC polished. These connectors shall be potted in an interface plate allowing the connector tips and the full length of the ferrule to be exposed. The other end of the cables shall be terminated with an SSQ 21635 pin and an SSQ 21635 socket terminated per the assembly procedure in appendix H of SSQ 21635. The substitution loss at the termini level of each jumper shall not exceed 0.6 dB.

d. Source, Reference and Detector (SRD) Optical test jumpers per 4.10.12

4.10.19.2 Test Sample

The test sample shall taken from a representative spool of fiber optic cable. The cable shall be 3.0 ± 0.1 meters long and terminated with a SSQ 21635 pin at one end and an SSQ 21635 socket at the other end. Each terminated end shall be installed into its own SSQ 21635 NZGL or NATC connector. The pin terminus shall be installed into the receptacle and the socket shall be installed into the plug. The SSQ 21635 connectors do not require backshells for this test.

4.10.19.3 Test Procedure

Install the test sample into the vacuum chamber. Clean and install the SSQ 21635 pin adapter test jumper per 4.10.19.1.c into the plug that mates to the test sample and clean and install the SSQ 21635 socket adapter test jumper into the receptacle that mates to the test article. Mate both the adapter test cables to the test sample. Set up the optical power test set, see Figure 1, to measure the induced attenuation. Verify that all optical interconnects are clean by using the methodology outlined in section 4.10.12.2.2.

Run the following vacuum and thermal profile:

a. Reduce the pressure inside the chamber to no greater than 1 inch of mercury for six hours. After the chamber stabilizes hold this condition for six hours and make induced loss measurements upon stabilization and at every hour at this condition.

b. After 6 ± 0.25 hours, increase the internal temperature to 135°C while maintaining a pressure of one inch of mercury maximum. After the chamber stabilizes hold these conditions for six hours and make induced loss measurements upon stabilization and at every hour at this condition.

c. Increase the internal pressure and reduce the temperature to reach ambient conditions. After the chamber stabilizes hold this condition for twelve hours and make induced loss measurements upon stabilization and at every hour at this condition.

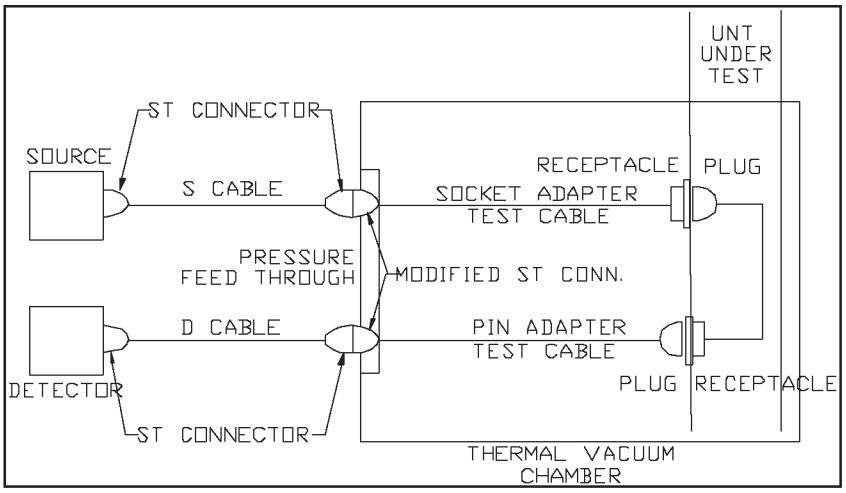


Figure 1 - Optical Test Set Up for Vacuum Stability

Remove the test sample from the vacuum chamber and perform a visual examination on the cable.

4.10.19.4 Test Documentation

The test report shall contain the date and title of test, the test personnel, identification by part number, lot number and length of the fiber optic cable tested, data verifying the thermal-vacuum conditions, test results for each step (temperature, pressure, optical loss and time), and the results of the physical examination.

5.0 Preparation For Delivery

5.1 Cleanliness

Extreme care shall be exercised during all packaging, packing, and marking procedures such that the cable cleanliness integrity and the packaging requirements of MSFC-SPEC-164 are not compromised.

5.2 Packaging Requirements

Unless otherwise specified in the contract, the requirements for packaging of fiber optic cable shall be in accordance with MIL-C-12000.

5.3 Reels And Spools

The cable on each reel or spool shall have both ends readily available for testing without unwinding. A minimum of five meters of cable shall be exposed on the inside end of the cable to facilitate attenuation measurements and removal of the required mechanical and visual samples. The inner end shall be available at the outer surface of the reeled cable. Cable shall be spooled in such a way to minimize induced fiber losses and special care shall be exercised to prevent excess stress on the cable where it exits the reel on the inside end of spool. Both ends of the cable shall be secured to a flange. The reel or spool shall have an inner diameter greater than six (6) times the minimum bend radius of the cable.

5.4 Product And Package Marking

5.4.1 Marking Of Reels And Spools

In addition to the marking specified in MIL-STD-129, each reel or spool shall be marked with the length of individual continuous lengths cable wound thereon. A warning label shall be applied to each reel to advise personnel to exercise caution in the handling of optical fibers. This label shall alert personnel to avoid skin puncture and contact with the eyes. It shall warn against staring at the output end of the fiber optic cables without eye protection (infrared viewer or equivalent) during testing when these cables are powered by high radiance light emitting diodes or lasers.

The identification marking label shall contain the following information:

CABLE, FIBER OPTICS
SSQ Part number_____
Length_____meters
Mfg. Lot No._____
Date of Mfg._____
Manufacturers Name_____

5.4.2 Space Station Critical Hardware

Each reel and spool shall be identified with a removable tag. The tag shall be attached and removed in a manner such that the reel or spool will not be damaged or contaminated or otherwise rendered unsuitable for use. The tags shall be fluorescent international orange with black letters on both sides and shall read as follows.

CRITICAL SPACE STATION HARDWARE
DO NOT REMOVE UNTIL INSTALLATION

The tag size shall be commensurate with the unit size and the lettering size shall be legible to a person with normal sight at a distance of 3 feet.

5.4.3 Packaging Labels

Each unit, intermediate, and final package/container shall be affixed with a self adhering label. The labels shall be fluorescent international orange with black letters and shall read as follows.

CRITICAL SPACE STATION HARDWARE

FOR USE IN MANNED SPACE FLIGHT. MATERIALS, MANUFACTURING, AND WORKMANSHIP OF THE HIGHEST QUALITY STANDARDS ARE ESSENTIAL TO ASTRONAUT SAFETY.

The label size shall be commensurate with the package size and the lettering size shall be legible to a person with normal eyesight at a distance 3 feet and shall be logically applied to both sides of bags, top and bottom or top and two sides, depending on box geometry, of small boxes, and the top and at least 2 sides of the final container.

5.5 Unit Protection And Wrapping

Unless otherwise specified each deliverable unit shall, as a minimum, be wrapped in an electrostatic free transportable polyethelene bag conforming to MIL-B-81705, Type II. Bags shall be heat sealed or sealed with a reusable sealing device manufactured from material conforming to MS90376, Material B. The sealing method shall eliminate spillage and exclude particulate contaminates. Staples, tape or other static generating materials, shall not be used. The same information required by 5.4.1 for marking of reels and spools plus the date of packaging shall be permanently and legibly marked (1) on a low sulfur content card in and readable through the bag, (2) on the bag, or (3) a combination of marking on a card and the bag.

5.6 Unit Packaging

Each bagged reel or spool unit shall be packaged in individual containers (paper product boxes are acceptable) to insure damage free delivery and storage. The information required by 5.4.1 and the date of packaging shall be permanently and legibly marked on the container.

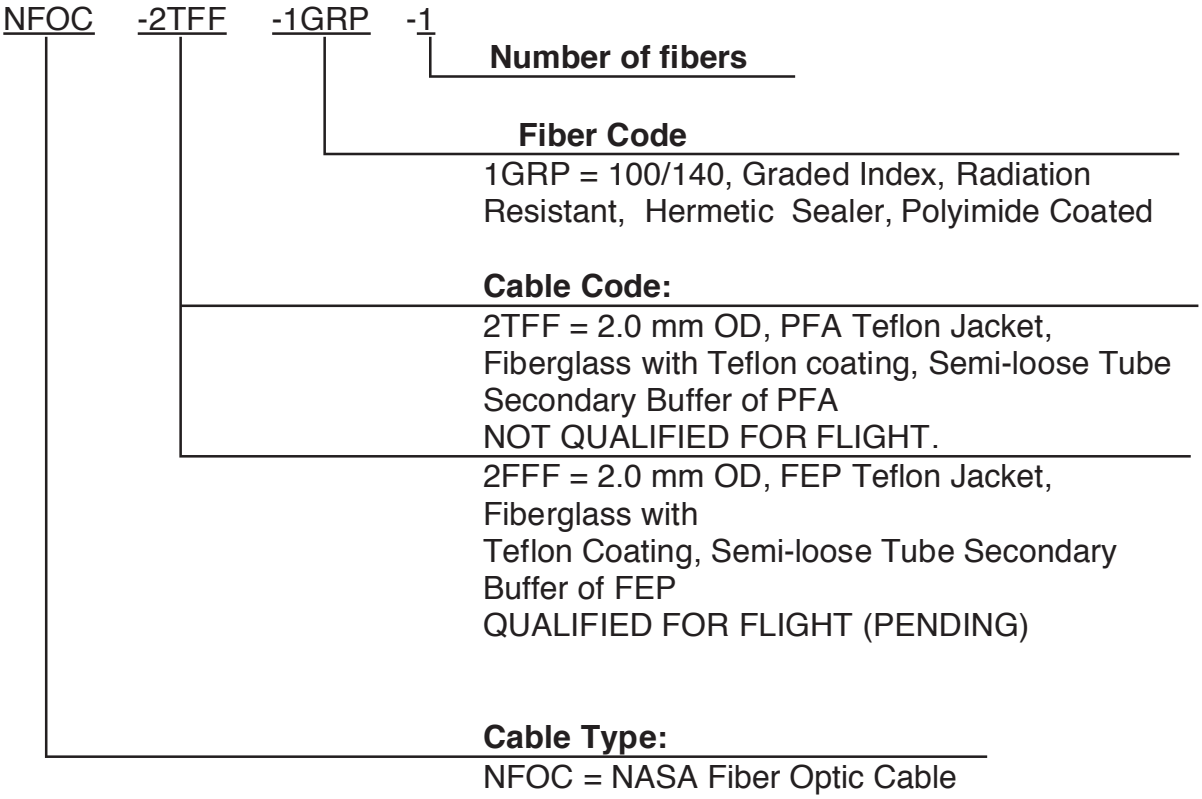
5.7 Packing Containers

Each packaged unit (Reference paragraph 5.2) shall be packed in containers such that damage free delivery is assured. Containers shall comply with the Consolidated Freight Classification Rules or other carrier regulations applicable to the mode of transportation. Each packed container shall be prominently marked with the same information required by 5.4.1 plus the quantity of reels or spools in the package and the date of packaging.

6.0 Notes

6.1 Part Numbers

The Specification Custodian part number consists of the part numbers shown on the applicable Appendix..



6.2 Approved Source (s) Of Supply

Only the item described by this drawing when procured from the supplier(s) listed on the applicable Appendix is approved by the Specification Custodian for use in the Application (s) specified. A substitute item shall not be used without prior testing and approval by the Specification Custodian. Identification of approved source (s) of supply is not to be construed as a guarantee of present or continued availability as a source of supply.

Part Type:	Approved Source of Supply	CAGE No.
NFOC-2TFF-1GRP-1	Brand-Rex Company An Affiliate of Cablec Corporation 1600 West Main Street Willimantic, CT 06226-1128	71124

7.0 Requirements Verification Matrix

TABLE III, REQUIREMENTS VERIFICATION MATRIX

VERIFICATION METHOD:			VERIFICATION PHASES:			
TBS = TO BE SUBMITTED BY SUPPLIER			D = DEVELOPMENT			
S = SIMILARITY			Q = QUALIFICATION			
I = INSPECTION			A = ACCEPTANCE			
D = DEMONSTRATION						
T = OPERATIONAL TEST						
N/A = NOT APPLICABLE						
TBS = TO BE SUPPLIED BY CABLE SUPPLIER						
SECTION 3	PARAGRAPH		D	Q	A	SECTION 4
PARAGRAPH	TITLE					PARAGRAPH
3.0	REQUIREMENTS	N/A				
3.1	ITEM DESCRIPTION	N/A				
3.2	GENERAL REQUIREMENTS	N/A				
3.2.1	DATA REQUIRED FOR DESIGN APPROVAL	TBS				
3.2.1.1	CROSS-SECTIONAL DRAWINGS	TBS				
3.2.1.2	EXCEPTIONS AND DEVIATIONS	TBS				
3.2.2	DATA REQUIRED FOR FINAL DESIGN APPROVAL	TBS				
3.2.2.1	TEST PROCEDURES	TBS				
3.2.2.1.1	QUALIFICATION TEST PROCEDURES	TBS				Appendix C.1
3.2.2.1.2	ACCEPTANCE TEST PROCEDURES	TBS				Appendix C.2
3.2.2.1.3	DESTRUCTIVE PHYSICAL ANALYSIS PROCEDURE	TBS				Appendix C.4
3.2.2.2	QUALIFICATION TEST REPORTS	TBS				
3.2.2.3.	TOP ASSEMBLY DRAWING	TBS				
3.2.2.4	MATERIALS LIST	TBS				

TABLE III, CONTINUED, REQUIREMENTS VERIFICATION MATRIX,

VERIFICATION METHOD:			VERIFICATION PHASES:			
TBS = TO BE SUBMITTED BY SUPPLIER						
A = ANALYSIS			D = DEVELOPMENT			
S = SIMILARITY			Q = QUALIFICATION			
I = INSPECTION			A = ACCEPTANCE			
D = DEMONSTRATION						
T = OPERATIONAL TEST						
N/A = NOT APPLICABLE						
TBS = TO BE SUPPLIED BY CABLE SUPPLIER						
SECTION 3	PARAGRAPH		D	Q	A	SECTION 4
PARAGRAPH	TITLE					PARAGRAPH
3.2.3	BASELINE/CONFIGURATION CONTROL	TBS				Appendix D
3.2.3.1	BASELINE CONTROL DOCUMENT	TBS				Appendix D
3.2.3.2	BASELINE CONTROL DEVIATIONS	TBS				Appendix D
3.3	MATERIALS	N/A				
3.3.1	GENERAL	A				
3.3.2	FUNGUS					
3.3.3	OFFGASSING/TOXICITY, ODOR, FLAMMABILITY AND OUTGASSING	N/A				
3.3.3.1	OFFGASSING/TOXICITY					
3.3.3.2	ODOR					
3.3.3.3	FLAMMABILITY					
3.3.3.4	OUTGASSING					
3.3.4	ATOMIC OXYGEN EFFECTS					
3.4	DESIGN AND CONSTRUCTION					Appendix A
3.4.1	OPTICAL FIBER					
3.4.1.1	OPTICAL FIBER BUFFER					
3.4.2	CABLE					
3.4.2.1	STRENGTH MEMBER					
3.4.2.2	CABLE JACKET					
3.4.2.3	COLOR					Appendix A
3.4.2.4	LENGTHS AND SPLICES					
3.4.2.5	CABLE WEIGHT					

TABLE III, CONTINUED, REQUIREMENTS VERIFICATION MATRIX

VERIFICATION METHOD:			VERIFICATION PHASES:			
TBS = TO BE SUBMITTED BY SUPPLIER A = ANALYSIS S = SIMILARITY I = INSPECTION D = DEMONSTRATION T = OPERATIONAL TEST N/A = NOT APPLICABLE TBS = TO BE SUPPLIED BY CABLE SUPPLIER			D = DEVELOPMENT Q = QUALIFICATION A = ACCEPTANCE			
SECTION 3 PARAGRAPH	PARAGRAPH TITLE		D	Q	A	SECTION 4 PARAGRAPH
3.5 3.5.1 3.5.1.1 3.5.1.2 3.5.2 3.5.2.1 3.5.2.2 3.5.3 3.5.4 3.5.5 3.5.6 3.5.7 3.5.8	PERFORMANCE FIBER NUMERICAL APERTURE OPTICAL FIBER BANDWIDTH CABLE ATTENUATION RATE INDUCED ATTENUATION RADIATION RESISTANCE THERMAL SHOCK STORAGE TEMPERATURE CYCLING FLEXING CRUSH CABLE BEND					Appendix A
3.6 3.6.1	IDENTIFICATION MARKING DURABILITY OF IDENTIFICATION					
3.7	WORKMANSHIP					

APPENDIX A ITEM DETAIL SPECIFICATION

SPECIFICATION CUSTODIAN: McDONNELL DOUGLAS SPACE SYSTEMS COMPANY
SPACE STATION DIVISION
5301 BOLSA AVE
HUNTINGTON BEACH, CA. 92647

INTERNATIONAL SPACE STATION PROGRAM OFFICE

SSQ 21654 Rev. B
April 30, 1996

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center, Houston, Texas

10.0 Scope

This Appendix defines the detail dimensional, material and performance requirements for a single element, multimode, fiber optic cable for use in near earth orbit and internal and external installations.

20.0 Applicable Documents

None.

30.0 Requirements

30.1 Fiber Characteristics

Attenuation (Cabled) - 4 dB/km @ 1290 ± 10 nm Maximum
Numerical Aperture - 0.30 ± .02 @ 1290 ± 10 nm
Bandwidth - 200 MHz-km @ 1290 ± 10 nm Minimum
Proof Strength - 200,000 psi Minimum
Core Ovality - 5%
Cladding Ovality - 4 %
Core/Cladding Offset - 98% Minimum
Cable Weight - 5.5 lbs/1000 ft. Maximum
Color - Violet per Mil-Std-104
Temperature: Operating -100°C/+75°C
Storage -100°C/+85°C

30.2 Physical Dimensions And Materials

The physical dimensions and materials for the cable are defined in Table A-1 and Figure A-1. Dimensions are SI metric.

Table A-1, FIBER/CABLE DIMENSIONS

Find	Item	Dimension	Material	Construction
A B	Core Cladding	100±2um 140±2um	Doped Silica	Drawn
C	Hermetic Coating	0.025-0.05 um Thickness	Carbon Based Hermetic Sealer	Chemical Vapor Deposition
D	Primary Buffer	170±2um	Polyimide	Coat with Heat Cure
E	Secondary Buffer	380-760±25um	FEP-Teflon	Extruded
F	Strength Member	1.7mm OD	Teflon Impregnated Fiberglas	Braided
G	Outer Jacket	2.10±0.05mm .49mm Thick	PFA-Teflon	Extruded

40.0 Quality Assurance Provisions

The requirements of SSQ 21654 paragraph 4.0 apply.

50.0 Packaging

Packaging of product produced to the requirements of this appendix shall be packaged in accordance with 5.0 of this specification.

60.0 Notes

None

Figure A-1. Cable Configuration

APPENDIX B CABLE PREPARATION FOR TERMINATION PROCEDURE

SPECIFICATION CUSTODIAN: McDONNELL DOUGLAS SPACE SYSTEMS COMPANY
SPACE STATION DIVISION
5301 BOLSA AVE
HUNTINGTON BEACH, CA. 92647

INTERNATIONAL SPACE STATION PROGRAM OFFICE

SSQ 21654 Rev. B
April 30, 1996

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center, Houston, Texas

10.0 Scope

10.0 This Appendix defines the detail requirements for preparation of the cable for termination to connectors and termini.

20.0 Applicable Documents

None.

30.0 Requirements

Cable termination and handling procedures shall include, but not be limited to the items listed below. They are shown in the preferred order for incorporation into the procedure.

30.1 Title Page

The title page shall contain the following:

a. Document number, title and latest revision date or letter.
b. Approval - indicated by supplier's official signatures and dates.
c. A cross-reference between the supplier's part number(s) and the SSQ part number(s).

30.2 List Of Tools And Materials Required

30.3 Sequence Of Operations

30.4 Inspection Criteria

This section shall list accept/reject criteria related to the cable preparation operation. Sketches shall be provided when required to describe specific characteristics and defects.

APPENDIX C1, QUALIFICATION TEST PROCEDURE

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INTERNATIONAL SPACE STATION PROGRAM OFFICE

SSQ 21654 Rev. B
April 30, 1996

National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center, Houston, Texas

10.0 Scope

This appendix provides the instructions for the preparation of qualification test procedures and documents the supplier Qualification Test Procedures that have been approved by the Specification Custodian.

20.0 Applicable Documents

None

30.0 Requirements

Qualification test procedure documents shall include, but not be limited to, the items below. The items are listed in their preferred order for incorporation into a procedure.

30.1 Title Page

The title page shall contain the following:

a. Document number, title, and latest revision date or letter.
b. Approval - indicated by supplier's official signatures and dates.
c. A cross-reference between the supplier's part number(s) and the SSQ part number(s)

30.2 Table Of Contents

The table of contents shall list as a minimum the main headings such as References, Scope, etc., with the applicable page number. Sub-headings shall be listed if the document is very large. A list of figures, illustrations, and tables shall be included in the document when these exceed five and the document exceeds twenty pages.

30.3 Scope

The scope shall include the purpose, objectives, explanations, etc., of the document, its arrangement, and the testing it covers.

30.4 Description Of Article (s) To Be Tested

The description shall include the following information:

a. Identification of the article(s) to be tested by name, part number and nomenclature. Each part number including applicable dash numbers shall be listed.

b. A general description of the cable.
c. A sketch or photograph of the cable, to supplement the description and assist in defining size, form, control locations and other pertinent configuration information, may be inserted.

30.5 References

The references shall include the other written material referred to in the text, tables, data sheets, etc., of the procedure. Only that material actually referred to shall be listed. References such as drawings, specifications, documents, etc., shall include the identifying number, title, source and applicable revision date.

30.6 Conditions And Tolerances

The atmospheric conditions for each environmental test must be specified as to the temperature, pressure and relative humidity with tolerances. The input power requirements necessary to perform the test on the test article shall be specified with acceptable tolerances. Overall tolerances on environmental test conditions shall be specified.

30.7 Data Verification

Quality control verification of data shall be as specified.

30.8 Test Equipment.

List the test equipment, special tools, etc., required to accomplish the test giving required quantity and complete identification. Test equipment must be specified by manufacturer, part number, and test capability and must have quality control certified calibration for equipment and facility accuracy. Total system accuracy shall be specified for all test equipment. Schematics and descriptions shall be included for nonstandard equipment. Schedules for the periodic calibration and certification of equipment used shall be included.

30.9 Facilities

List the pertinent facilities required, including power, environment, and special facilities requirements.

30.10 Failure And Retest Instructions

These requirements, in accordance with paragraph 4.7.6 in the body of this specification, shall be included in the procedures.

30.11 Test Procedures

A separate section of test directions shall be provided for each test required by the specification. The test directions shall include the name of test, a complete list of test equipment, methods of mounting the test article, and step by step procedures for testing. Locations of monitoring devices shall be specified. Sketches of test setups, shock and vibration spectra, schematics of nonstandard test equipment and detailed sequence of individual tests shall be provided. Special warnings or precautions as necessary during functional or environmental testing shall also be included.

NOTE: If the supplier's proposal has been accepted on the basis that portions or all of the qualification will be accomplished by similarity, this must be stated in the test procedure. The applicable qualification test information shall be submitted as part of the qualification test procedure.

30.12 Test Sequence Or Schedule

This section will contain a complete schedule of the testing covered by 30.11 above.

30.13 Data Recording Instructions

Data to be recorded and recording instruments to be used shall be defined. The procedures and format to be used for data recording shall be shown.

30.14 Qualification Test Report

This section will depict the format and the information which will be included in the report.

30.15 Active Page Record

The active page record shall contain a list of active pages with the latest revision date or symbol for each page.

30.16 Revision Page

The revision page shall contain the revision symbol, description of revision, date of revision, and signature of person(s) authorizing revision.

40.0 Quality Assurance Provisions

The requirements of SSQ 21654 paragraph 4.0 apply.

50.0 General notes

The supplier Qualification Test Procedures will be included in their entirety in subsequent releases of this appendix upon their approval by the Specification Custodian.

APPENDIX C2, ACCEPTANCE TEST PROCEDURES

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SSQ 21654 Rev. B
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National Aeronautics and Space Administration
International Space Station Program
Johnson Space Center, Houston, Texas

10.0 Scope

This appendix provides the instructions for the preparation of acceptance test procedure and documents the supplier Acceptance Test Procedure that have been approved by the Specification Custodian.

20.0 Applicable Documents

None

30.0 Requirement

Acceptance test procedure document shall include, but not be limited to, the items listed in paragraph 30.2. The items are listed in their preferred order for incorporation into a procedure.

30.1 Format

30.1.1 Sheet Numbering

The supplier may use his own system for sheet (page) numbering. If the supplier does not have an established system the following method is preferred:

a. Each sheet of document shall be numbered.

b. At initial release, number the sheets with consecutive whole Arabic numbers beginning with 1 for the title sheet.

c. For document revisions, use the decimal system when t is necessary to add sheets between existing sheets.

For example:

(1) Three sheets added between sheets 5 and 6 would be numbered 5.1, 5.2, and 5.3

(2) Two sheet added between sheets 5.2 and 5.3 would be numbered 5.21 and 5.22.

The following decimal system of numbering headings and titled main and subparagraphs shall be followed:

1. First main paragraph heading
1.1 First main subparagraph under 1
1.1.1 First subparagraph under 1.1
1.1.1.1 First subparagraph under 1.1.1
1.1.1.2 Second subparagraph under 1.1.1
1.1.2 Second subparagraph under 1.1
1.1.3 Third main subparagraph under 1
1.2 Second main subparagraph under 1
2. Second main paragraph heading
2.1 First main subparagraph under 2, etc.

30.1.3 Style

The procedure documents shall be written in outline style. Paragraphs and sentences shall be kept short. Conditions shall be enumerated by subparagraphs or tables rather than by long complex statements.

30.1.4 Abbreviations

Abbreviations shall be kept to a minimum. The first usage of a nonstandard abbreviation in a procedure shall spell out the abbreviation, e.g., Test Support Equipment (TSE).

30.1.5 Nomenclature

Complete nomenclature, including part numbers, should be used in text and procedures when the nomenclature is first mentioned. Second and succeeding references to the nomenclature need not include the part number. Shortened nomenclature may be used if it is complete when first mentioned and if it cannot be confused with nomenclature associated with a different article or application.

30.2 Sequence And Content

30.2.1 Title Page

The title page shall contain the following:

a. Document number, title, and latest revision date or letter.

b. Approval - indicated by supplier's official signatures and dates.

c. Issue Number - assigned to each issue of the document to control distribution and implement a keep-up-to-date policy.

d. A cross-reference between the supplier's part number and the SSQ 21654 part number.

30.2.2 Table of Contents

The table of contents shall list as a minimum the main headings such as References, Scope, etc., with the applicable page number. Sub-headings shall be listed if the document is very large. A list of figures, illustrations, and tables shall be included in the document when these exceed five and the document exceeds twenty pages.

30.2.3 Scope

The scope shall include the purpose, objectives, explanations, etc., of the document, its arrangement, and the testing it covers.

30.3.4 Description of Article (s) To Be Tested

The description shall include the following information:

a. Identification of the article(s) to be tested by name, part number and nomenclature. Each part number including applicable dash numbers shall be listed.

b. A general description of the article(s) giving the normal use or function of the article(s).

c. A sketch or photograph of the article, to supplement the description and assist in defining size, form, control locations and other pertinent configuration information, may be inserted.

d. Functional schematic diagrams as applicable shall be included in the document or by references.

30.2.5 References

The references shall include the other written material referred to in the text, tables, data sheets, etc., of the procedure. Only that material actually referred to shall be listed. References such as drawings, specifications, documents, etc., shall include the identifying number, title, source and applicable revision date.

30.2.6 Test Equipment and Facilities

30.2.6.1 Test Equipment

Test equipment must be specified by manufacturer, part number, and test capability and must have quality control certified calibration for equipment and facility accuracy. Total system accuracy shall be specified for all test equipment. Schematics and descriptions shall be included for nonstandard equipment. Schedules for the periodic calibration and certification of equipment used shall be included.

30.2.6.2 Facilities

List the pertinent facilities required, including power, environment, and special facilities requirements.

30.2.7 Calibration and Certification

Where the article under test is to be used as test equipment, calibration certification procedures shall be included. The paragraphs to be followed during periodic recertification of the article shall be listed or suitably identified.

30.2.8 Test Set-Up

The test set-up explanation shall include the following:

a. A description of the article(s), subsystem, or system to be tested and of the test equipment required shall be included. Any pretest positioning of controls and components shall be described.

b. Diagrams (sketches and functional schematics), to provide complete test connection information by identifying pin numbers, connector part numbers, test points, stimulation points, etc., shall be incorporated or referenced.

c. Any visual or special inspection of the article(s), required prior to conduct of the test, shall be defined.

30.2.9 Test Procedure

This portion of the document shall contain a clear and concise, step-by-step plan to be followed in the testing of the article, part, subassembly, or system.

a. The procedure shall be command-response type of instruction stating what should be done and what should be obtained.

b. Each step to be performed by the technician during testing shall be identified by a paragraph number.

c. Steps pertaining to equipment operation and test connections required during the test shall be clearly described.

d. Where portions of the acceptance functional test are covered by other procedural documents, reference to those documents, in lieu of repeating, may be made only when:

(1) The procedures involved are lengthy.
(2) Significant savings in preparation and maintenance man-hours is realized without undue loss of efficiency by the user.

e. Discretion should be exercised by the procedures writer in determining whether reference material should or should not be repeated in the subject document. Other criteria to consider are:

(1) The susceptibility of the reference information to change and the resultant effect on the subject document.
(2) The number of documents the user will require on hand and the cumbersome aspects of jumping from one information source to another in order to accomplish the test.

f. When a reference document is used for some of the testing procedure, the test equipment and those data sheets required shall be either in the basic document or in the reference document and appropriately referred to.

g. Where procedures of a functional test are to be repeated in subsequent portions of the test, they should be repeated in the document for clarity and continuity unless they are excessively long or are repeated frequently. The requirement for the user to refer to earlier paragraphs of the document should be held to a minimum.

h. Warnings, cautions, and notes shall be included to highlight important and/or

specify precautionary measures which, if not followed, could result in personnel injury or equipment damage. Warnings and cautions shall be blocked with a border to make it clearly noticeable to the reader.

(1) WARNINGS shall be used to highlight precautionary measures which, if not followed, could result in injury to personnel.

Use HEAVY border

(2) CAUTIONS shall be used to highlight precautionary measures which, if not followed, could result in equipment damage.

Use LIGHT border

(3) NOTES Shall be used when it is desirable to highlight or qualify a procedural step which does not involve personnel or equipment safety.

30.2.10 Figures, Illustration, Diagrams, Etc.

Figures, illustrations, diagrams, etc., shall be numbered with Arabic numerals and referred to a "Figure 1", "Diagram 16", "Table 4", etc.. These shall be on regularly numbered pages and placed toward the end of each document section or volume immediately ahead of the data sheets. Whenever possible do not exceed 8 1/2 x 11" size pages because of the additional time required for reproduction.

30.2.11 Active - Change Page

The Active - Changed Page shall contain a list of active pages with latest revision date and/or letter for each page.

30.2.12 Revision Page

The revision page shall contain the revision symbol, description of revision, date of revision, and signature of person(s) authorizing revision.

30.3 Revisions

To facilitate review of revisions to the acceptance test procedure, a capital letter "R" should be placed in the right hand margin of each page opposite the changed text. This or equivalent method may be used to indicate revisions.

40.0 Quality Assurance Provisions

The requirements of SSQ 21654 paragraph 4.0 apply

50.0 General Notes

The supplier Acceptance Test Procedures will be included in their entirety in subsequent releases of this appendix upon their approval by the Specification Custodian.

APPENDIX C3, RECEIVING INSPECTION PROCEDURE

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INTERNATIONAL SPACE STATION PROGRAM OFFICE

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National Aeronautics and Space Administration
International Space Station Program
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10.0 Scope

This appendix provides the receiving inspection procedure to be used by the cable user for inspection of cable conforming to the requirements of SSQ 21654.

20.0 Applicable Document

TBD

30.0 Requirements

TBD

40.0 Quality Assurance Provisions

TBD

50.0 General Notes

The receiving inspection procedure requirements identified by TBD will be included in a subsequent revision of this specification.

APPENDIX C4, PROCEDURE, DESTRUCTIVE PHYSICAL ANALYSIS

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INTERNATIONAL SPACE STATION PROGRAM OFFICE

SSQ 21654 Rev. B
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National Aeronautics and Space Administration
International Space Station Program
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10.0 Scope

This appendix provides the procedures for Destructive Physical Analysis to be used for the analysis of cable conforming to the requirements of SSQ 21654.

20.0 Applicable Documents

TBD

30.0 Requirements

TBD

40.0 Quality Assurance Provisions

TBD

50.0 General Notes

The Destructive Physical Analysis procedure requirements identified by TBD will be included in a subsequent revision of this specification.

APPENDIX D, SUPPLIER CONFIGURATION CONTROL DOCUMENTATION

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10.0 Scope

This appendix contains the details for configuration baseline control. It defines the procedure for establishing and maintaining control of the critical aspects of the product configuration. It also contains the supplier Baseline Control Documents that have been approved by the Specification Custodian.

20.0 Applicable Documents

30.0 Requirement

30.1 General

The manufacturer of fiber optic cable to be supplied to this specification shall prepare, implement and maintain a Baseline Control Document (BCD) in accordance with the requirements herein.

30.2 Baseline Control Documentation

The supplier shall establish a Baseline Control Document (BCD) containing data as defined in Sections I through V below. Baseline control is required for only those items contained in Section I of the BCD. For Section I items, the revision of the drawing, material specification, and manufacturing procedure in effect and approved at CDR shall be recorded in the BCD. Changes required after CDR baseline control has been established shall have approval by Specification Custodian in accordance with 30.3.

30.2.1 Section I

Section I shall list Engineering top assembly drawings, sub-tier drawings, material specifications, and critical manufacturing procedures/processes as designated by Specification Custodian. The procedures/processes currently designated critical are as follows:

TBD

30.2.2 Section II

Section II shall list all manufacturing procedures/processes other than those designated as critical in Section I. This list to be updated as required to add new, or delete non-applicable or obsolete manufacturing procedures/processes.

30.2.3 Section III

Section III shall list the Quality Assurance Program Plan and related Quality Assurance documentation on which the Specification Custodian approval is based, and the supplier in-house procedure for control and performance of rework. List to include document number, title or description of document and revision status.

30.2.4 Section IV

Section IV shall list Manufacturers (sub-contractors) used by the supplier to perform specific operations such as drawing fiber. Tabulation to include the company name, address, and operation performed.

30.2.5 Section V

Section V shall provide a list identifying all manufacturing documents and work orders showing manufacturing operations and sequencing, inspection points, and test operations. The manufacturing procedures and work orders for final assembly of the cable are to be included in the BCD. These documents are to be kept up to date by submittal of revised pages or instructions for page markups.

30.2.6 Change Control Procedure

The manufacturer's procedures for identifying and controlling changes to items defined in 30.2.1. This shall identify the manufacturer's system for compliance with the requirements of 30.3. Upon incorporation into a formal baseline, changes to this SSQ shall be contractually processed and authorized per SSP 41170.

30.2.7 Product Assurance Program Plan

The manufacturer's plan to establish, implement and maintain the baseline control program identified in this appendix shall be submitted to the Specification Custodian.

30.2.8 Procuring Activity Representative Participation

The baseline control document shall clearly identify, where applicable, those processes that require the participation of the procuring activity's representative.

30.2.9 Non-Critical Documentation

Documentation for materials and processes that are not included in the critical documents list (para.30.2.1) and are used in the manufacturing of the product to be supplied to this specification, shall be made available for review by the Specification Custodian upon request.

30.3 Change Control

The manufacturer shall designate a focal point (program manager when used) with responsibility to identify major and minor changes with the qualifying activity. The manufacturer's configuration control system shall be in accordance with SSP 41170 and provide for review, by the program focal point, of all changes to the configuration baseline prior to implementation of the change. The program focal point shall have the authority to delay implementation of any change to product being supplied to this specification until coordination with the Specification Custodian is complete.

30.3.1 Major Change Procedure

When a major change has been identified a Supplier Change Proposal (SCP) shall be submitted to the Specification Custodian. The Specification Custodian shall provide a written response within twenty working days after receipt of the SCP, indicating approval, disapproval or identifying a delay in response, the reason for the delay and any additional information that is required from the manufacturer in order to evaluate the change. The manufacturer shall ensure that the change is not implemented on product to be supplied to this specification until approval has been received from the Specification Custodian. In general, any change to an item in Section I of the BCD (30.2.1) is defined as major and requires submittal of an SCP.

30.3.2 Minor Change Procedure

Minor changes shall not be implemented without Specification Custodian approval. Changes that have been identified as minor by the supplier, shall be submitted to the Specification Custodian when released.

30.4 Baseline Audits

Following configuration baseline approval, an audit team will periodically examine the manufacturer's facilities and equipment, review his critical processes and audit the implementation of the baseline control. The date, location, time of audit and extent of participation of manufacturer personnel required to accomplish the task will be established on a schedule which is mutually acceptable to the Specification Custodian and the manufacturer. A current copy of the supplier's BCD shall be made available for use in conducting the audit. Upon completion of the audit, the manufacturer will be provided an exit critique and will be provided with a written report of the results of such an audit. A schedule for correction of any significant deficiencies will be required and will subsequently be reviewed for completeness, adequacy and timeliness of committed closure actions.

40.0 Quality Assurance Provisions

The requirements of SSQ 21654 paragraph 4.0 apply

50.0 General Notes

50.1 Baseline Control Documents

The supplier Baseline Control Documents will be included in their entirety in subsequent releases of this appendix upon their approval by the Specification Custodian.

50.2 Definitions

In addition to the definitions in the general specification, the following definitions apply to this appendix.

50.2.1 Critical Documents

The document or specification which controls or specifies a critical process or material and has been selected for inclusion in the critical document list.

50.2.2 Major Change

A change to a critical document that could introduce deviations in item materials, processes, finishes, dimensions, tolerances, parameters, characteristics or reliability. Major change items as identified in 30.3.1 shall be agreed upon by the manufacturer and Specification Custodian and shall be clearly defined in the baseline control documentation.

50.2.3 Minor Change

Any change not defined as major (see 50.2.2).

50.2.4 Baseline

The set of documentation which describes and controls the cable design and the complete manufacturing process.

50.2.5 Baseline Control

The entire procedure by which the hardware design, manufacturing processes, materials and sub items associated with an item are controlled for compliance with applicable requirements and specifications.

50.2.6 Program Product Assurance Plan

The document that describes the manufacturer's product assurance program. It shall describe the design, manufacturing, inspection and test controls which ensure compliance with the applicable requirements and quality standard dictated by the specification.

50.2.7 Supplier Change Proposal (SCP)

A request for approval of a change to configuration controlled item. An SCP is the vehicle by which a manufacturer notifies and obtains Specification Custodian approval of changes.