SPACE GRADE REQUIREMENTS FOR ELECTRICAL CONNECTORS

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This is the document that was submitted to the committee for final coordination and release. Some of the details here may have been changed upon release of the final draft This is for informational purposes only and does not serve as the final EIA-710 document.

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FOR

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INTRODUCTION:

This document is designed to be a reference guide and baseline in which minimum requirements are outlined for electrical connectors that will be used in any space environment. This document will be updated as necessary. There are six space environmental categories defined as a means of providing a standard knowledge of space environmental conditions and as a reference for screening and testing. All electrical connectors are included in the scope of this document and several main categories are defined based on the current usage by the NASA community.

1.0 SCOPE AND OBJECTIVE

1.1 SCOPE

This requirements document is applicable to all types of single or multi-contact electrical connectors including: circular, rectangular printed circuit, rectangular micro-miniature, rectangular D-subminiature, rectangular rack and panel, coaxial, and hermetic. This document will be used in for determining the minimum requirements for space applications. For purposes of standardization and reference, several space environments are defined and include: habitable pressurized modules, low earth orbit, geosynchronous earth orbit, trans-atmospheric vehicle, lunar surface, martian surface. The environmental categories are designed to be used as a default when considering how to alter any test for a specific application. When performing any test or screening procedure the parameters of the operational environment will be used to govern the test conditions.

There are several tables and charts designed for cross-referencing which types of connectors need to be tested for which space environments and for cross-referencing what types of tests are necessary for what type of connector when being used in any space environment.

1.2 OBJECTIVE

The objective of this document is to provide the information concerning what the minimum requirements are for all electrical connectors being used in any space flight application. Once screened by the requirements outlined in this document with the appropriate results, a connector can be considered "space grade" for any given space environment category that governs all test conditions and requirements. If environmental parameters are not specified for any given application by project documentation the appropriate environmental category defined in this document shall be used to govern all test conditions

2.0 General Information

2.1 Related Documents

The following documents are referenced in the body of this requirements document:

NASA Specifications and Standards

MIL-STD-975, NASA
NHB8060.1
40M38277
40M38298
40M39569
GSFC-S-311-P-4
GSFC-S-311-P-10

Military Specifications and Standards

MIL-STD-1344
MIL-STD-202
MIL-C-5015
MIL-C-26482
MIL-C-38999
MIL-C-39012
MIL-C-55302
MIL-C-24308
MIL-C-39029
MIL-C-83513
MIL-C-83522
MIL-T-29504

Industry Specifications and Standards

ASTM E595
ASTM D695

EIA-364-B
EIA-364-05
EIA-364-09
EIA-364-13
EIA-364-18
EIA-364-20
EIA-364-18
EIA-364-21
EIA-364-35
EIA-364-06
EIA-364-37
EIA-364-31
EIA-364-27
EIA-364-28
EIA-364-32
EIA-364-26
EIA-364-54
EIA-364-35
EIA-364-02
EIA-364-23
EIA-364-08
EIA-364-24
EIA-364-56
EIA-364-42
EIA-364-66
EIA-364-45
EIA-364-14
EIA-364-44

2.2 Electrical Connector Categories

Circular, Power: C
D-Subminiature Rectangular: D
Micro-Miniature Rectangular: M
Printed Circuit, Rectangular: P
Coaxial: RF
Rack and Panel, Rectangular: A
Hermetic: H

2.3 NASA Approved Parts Listing:

Specification Number Kind of Connector

40M38277 Circular, C
Miniature, High-Density, Environment Resistant, Low-Silhouette, (backshells and contacts available with connector)

40M38298 Circular, C
Miniature, Environment Resistant, Special, (backshells and contacts available with connector), + 200°C.

40M39569 Circular, C
Miniature, Environment Resistant, (backshells and contacts available with connector), + 200°C

MIL-C-5015 Circular, C
Threaded Coupling, AN type, Circular Rear Release Crimp Contacts, Hermetic Solder contacts, Contact sizes 8 and larger only. MS3450, MS3452, MS3454, MS3456, MS3459.

MIL-C-26482 Circular, C
Series 2, , Miniature, Quick Disconnect, Environment Resistant MS3470, MS3472, MS3474-76, MS3449.

MIL-C-38999 Circular, C
Miniature, High Density, Quick Disconnect, Environment Resistant, Removable Crimp and Hermetic Solder Contacts:

Series 1, Bayonet Coupling, MS27466 - MS27468, MS27470, MS27471, MS27656, MS27662

Series 2, Bayonet Coupling, Low Silhouette:: MS27472, MS27474, MS27477, MS27478, MS27484, MS27497

Series 3, Scoop Proof, Threaded Coupling, Triple Start, Self-Locking: D38999/20, /21, /23 - /27

MIL-C-39012 Coaxial, RF
Radio Frequency: M39012/01-501,-503,
M39012/03-501,-503,
M39012/04-0001,-0002,-0003,
M39012/26-101,-102,-018,
M39012/28-101, -102, -018,
M39012/34-0001, -0002,
M39012/55-3006, -3007, --3009, -3010
M39012/57-3006, -3007, --3009, -3010
M39012/60-3001, -3002
M39012/61-3001, -3002

MIL-C-55302 Printed Circuit, P
Printed Circuit, Subassembly and Accessories, Non Environment Resistant, M55302/55-M55302/66.

MIL-C-24308 Rectangular, D
Rectangular, Miniature, Rack & Panel:

Nickel Finished Polarized Shell, Gold Plated Nonremovable Solder Contacts:
M24308/1-34 - M24308/1-38,
M24308/3-23 - M24308/3-27

Gold Finish Polarized Shell, High-Density, Gold Plated Removable Crimp Contacts,
M24308/6-512 - M24308/6-517
M24308/6-526 - M24308/6-531
M24308/8-335 - M24308/8-339.
M24308/8-345 - M24308/8-350.

Nickel Finished Polarized Shell, Gold Plated Removable Solder Contacts:
M24308/2-516 - M24308/2-520
M24308/4-335 - M24308/4-339

Gold Finish Polarized Shell, High-Density, Gold Plated Nonremovable Solder Contacts,
M24308/5-34- M24308/5-38
M24308/7-23- M24308/7-27

GSFC-S-311-P-4 Rectangular, A
Subminiature, Rack & Panel, Non-Magnetic:
311P405, 311P407, 311P409
Contacts: Coaxial or High Voltage,
S-311-P-4/06, S-311-P-4/08, S-311-P-4/10

GSFC-S-311-P-10 Rectangular, A
Miniature, Rack & Panel, Non-Magnetic, Polarized Shell, Combination Solder, Coaxial and High Voltage Contacts: 311P10:

MIL-C-83513 Rectangular, M
Rectangular, Microminiature, Polarized. Shell, Rack and Panel, Crimp & Solder Contacts:
M83513/1-/4, M83513/6-/9.

MIL-C-39029 Contacts, T
Crimp Removable:
M39029/4-110, -111, -113
M39029/5-115, -116, -118
M39029/29-214, -215, -216
M39029/30-220, -221, -222),
M39029/56-348, -351, -352, -353,
M39029/57-354,- 357, -358, -359,
M39029/58-360, -363, -364, -365,
M39029/106-(614 - 617),
M39029/107- (620-623),
M39029/63-368,
M39029/64-369.

Currently Used But Considered Non-Standard

MIL-C-83522	Fiber Optic, SMA
MIL-T-29504	Fiber Optic, Contacts

3.0 Environmental Category Definitions:

The following are definitions of special environments and the conditions that would effect the functional ability of components operating within that environment. These environments will be referred to by the appropriate abbreviations later in the document.

3.1 Industry Environmental Definitions:

IND: Industry:

Temperature: 15°C to 35°C
Atmospheric pressure: 86 to 106kPa
Relative Humidity 20% to 80%

3.2 Military Environmental Definitions

MIL: Military Aircraft

Temperature -65 °C to 230 °C.
Atmosphere: Earth.
Pressure: 49 to 760 torr.
Gas/Fluid Compatibility: 25% to 75%, Aerospace Fluids.
Electromagnetic Radiation: earth UV.
Particulate Radiation: n/a.
Atomic Oxygen: n/a.
Reduced Gravity: n/a.
Charged Plasma: n/a.

3.3 Space Environmental Definitions (SP1 - SP6):

3.3.1 Habitable Environment, Pressurized Modules, SP1:

Temperature 18.3 °C to 26.7 °C.
Atmosphere: Earth to 30% oxygen.
Pressure: 514 to 760 torr.
Gas/Fluid Compatibility: 25% to 75%, 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: n/a.
Particulate Radiation: n/a.
Atomic Oxygen: n/a.
Reduced Gravity: 10^{-6} to 10^{-3} g.
Charged Plasma: n/a.

3.3.2 Low Earth Orbit (LEO), SP2:

Temperature cycles: 6000 cycles/yr. @ - 65 °C to 120°C (EIA-364 class number 3.0).
Atmosphere: Earth to very low oxygen.
Pressure: 10^{-5} to 10^{-10} torr.
Gas/Fluid Compatibility: 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: 2220 to 5800 ESH/yr (Altitude Dependent).
Particulate Radiation: Protons, Electrons, Alpha-particles.
Atomic Oxygen: 10^{20} to 10^{22} atoms/cm^2/yr (Altitude Dependent).
Reduced Gravity: 10^{-6} to 10^{-3} g.
Charged Plasma: .3 to $5x10^4$ atoms/cm^3, .1 to .2 eV.

3.3.3 Geosynchronous Earth Orbit (GEO), SP3:

Temperature cycles: 90 cycles/yr @ - 196 °C to 128°C.
Atmosphere: Earth to very low oxygen.
Pressure: 7.5 10^{-14} torr.
Gas/Fluid Compatibility: 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: 8760 ESH/yr.
Particulate Radiation: Protons, Electrons, Alpha-particles.
Atomic Oxygen: n/a.
Reduced Gravity: 10^{-6} to 10^{-3} g.
Charged Plasma: .24 to 1.12 atoms/cm^3, 120 to 295 keV.

3.3.4 Trans-atmospheric Vehicle, SP4:

Temperature: cycles, altitude dependent @ -200 °C to 260°C.
Atmosphere: Earth to very low oxygen.
Pressure: 760 to 7.5 10^{-14} torr.
Gas/Fluid Compatibility: 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: 8760 ESH/yr (Altitude Dependent).
Particulate Radiation: Protons, Electrons, Alpha-particles.
Atomic Oxygen: 0 to 10^{22} atoms/cm2/yr (Altitude Dependent).
Reduced Gravity: 10^{-6} to 1 g.
Charged Plasma: anywhere from LEO specified values to GEO values.

3.3.5 Lunar Surface, SP5:

Temperature: 13 cycles/yr, altitude dependent @ -171 °C to 111°C.
Atmosphere: Earth to very low oxygen.
Pressure: 10^{-8} to 10^{-12} torr.
Gas/Fluid Compatibility: 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: 8760 ESH/yr.
Particulate Radiation: Protons, Electrons, Alpha-particles.
Atomic Oxygen: n/a
Reduced Gravity: .165 g.
Charged Plasma: n/a.

3.3.6 Martian Surface, SP6:

Temperature: 356 cycles/yr, altitude dependent @ -143 °C to 27 °C.
Atmosphere: Earth to .13% oxygen, 95.3% CO_2.
Pressure: 4.4 to 11.4 torr.
Gas/Fluid Compatibility: 100% RH Salt Fog, Space Fluids.
Electromagnetic Radiation: 1656 ESH/yr.
Particulate Radiation: n/a.
Atomic Oxygen: n/a
Reduced Gravity: .38 g.
Charged Plasma: 10^3 to 10^5.

4.0 General Requirements

4.1 Design and Reliability Requirements:

The following requirements are necessary for all connector types:

- Gold contact plating shall be 50 micro-inches with no localized finishes.
- Reliability Assurance Program: NHB 5300.4 (1C).
- Storage temperature range shall be: -55 to +85 °C for use in inhabitable environments, SP1 and -55 to +125 °C for use in uninhabitable environments SP2 - SP6.
- Interchangeability: with same part number.
- There shall be adequate contact location identification.
- There shall be lot traceability with adequate documentation.
- Molded inserts shall consist of two pieces or less.

The following requirements are necessary for connector types: C, RF, D, A, M

- All plating on connector shells shall be conductive and be non corrosive
- Stress corrosion prevention in accordance with MSFC-SPC-522

For connector types: C, D, A, M there shall be visual evidence of full mate and polarized shells.

All C and RF type connectors shall have resilient seals around each pin which seal the socket chamfer and they have standard screw threads.

All C type connectors only shall have wire sealing grommets and lubricated coupling ring grooves,

All T types, or socket contacts shall be closed entry with chamfered entrance spring action. There shall be an inspection hole on crimp contacts.

4.2 General Prohibitions

Cadmium Plating
Zinc Plating
Dissimilar Metals
Recycled (Regrind) Dielectric Materials
Silver Underplate or Overplate
Localized Contact Finish
Pure Tin

5.0 Test Conditions and Screening Requirements

Unless specifically stated otherwise for the project requirements, tests and examinations required by this document or any referenced document shall be conducted by the conditions of the test specified and adjusted to the parameters of the applicable operating environment.

5.1 Visual and Dimensional Inspection (All Types)

The connectors and contacts shall be examined, in accordance with EIA-364-18 to determine compliance with the materials, dimensions, specifications, design and construction, finish and identification specified by project documentation. At a

minimum magnification of 3X and using high intensity lighting visual inspection shall verify that the connectors/contacts are properly marked, free of defects, and fabricated with good workmanship.

5.2 Durability (All Types):

The ability of the contacts or the connectors to meet the specified number of mating and unmating cycles shall be tested in accordance with EIA-364-09 or MIL-STD-1344 Method 2016. The number of cycles shall be 500 for all types of connectors and shall show no mechanical or electrical defects to the operation of the connector.

5.3 Mating and Unmating Forces / Coupling Torque (All Types)

The mating and unmating forces of the connector shall be determined in accordance with EIA-364-13 or MIL-STD-1344 Method 2013.

C and M Types: The mating and demating forces shall be no more than 10 oz times the number of contacts in the connector.

D Type: The mating and demating forces are detailed in the chart below where all the units are in pounds.

	Unmating Minium (pounds)		Unmating Maximum (pounds)		Mating Maximum (pounds)	
Shell Size	Non-Hermetics	Hermetics	Non-Hermetics	Hermetics	Non-Hermetics	Hermetics
1	.75	1.50	6.0	7.00	10.0	7.25
2	1.00	2.00	10.0	13.00	17.0	13.00
3	1.75	3.25	17.0	21.25	28.0	21.25
4	2.50	4.50	24.0	31.25	39.0	31.25
5	3.25	5.50	30.0	42.25	49.0	42.25
6	4.50	----	39.0	-----	65.0	----

Table 1

P Type: After mating and demating 3 times, the maximum mating force shall be .56 oz times the number of contacts and .08 oz times the number of contacts minimum withdrawal force for standard size contacts. For low insertion force contacts the maximum mating force shall be .25 oz times the number of contacts and minimum withdrawal force shall be .04 oz times the number of contacts.

RF Type: Coupling torque shall be 2 inch lbs of torque max. for SMA and TNC types.

5.4 Contact Insertion, Release and Removal Force (Types C and D, Not For Hermetics)

Contacts shall be tested in accordance with EIA-364-05 or MIL-STD-1344 Method 2012 whichever is appropriate given the conditions of the environment and the application of the connector. This test can be conducted on the non-hermetic removable contact connector types C and D.

C Type: The axial force necessary to remove a size 22 contact shall not exceed 10 pounds and the axial force necessary to insert a removable contact shall not exceed 15 pounds.

D Type: The axial force necessary to remove a contact shall not exceed 4 pounds and the axial force necessary to insert a removable contact shall not exceed 4 pounds.

5.5 Dielectric Withstanding Voltage (All Types):

The ability of the connector to operate safely at its rated voltage and withstand momentary over voltages shall be determined by compliance with EIA-364-20 or MIL-STD-1344 Method 3001 test V or MIL-STD-202 Method 301 (for RF types). Under the specified voltages and time duration there shall be no evidence of breakdown. The test voltage is applied at a frequency of 60 Hz. The magnitude of the test voltage for screening and other test conditions, shall be as follows:

C Type: Use 800 Vrms AC on wired and unmated connectors. 2 milliamperes is the maximum allowable leakage current. Six readings minimum shall be taken. Tests shall be applied to all contact positions for 1 minute minimum on all connectors.

D Type: 1000 Vrms AC for 10 seconds applied from contact to contact, and then from contact to shell.

M Type: Under Condition 1 in MIL-STD-1344 Method 3001, mated or unmated use 600 Vrms AC for 10 seconds.

P Type: Use 1000 Vrms AC for 60 seconds between the closest contacts and between contacts and hardware. Connectors may be board mounted.

RF Type: AC Voltage applied between contact and body: SMA type apply 500 Vrms, 750 Vrms, or 1000 Vrms per cable size in reference specification. For TNC types apply 1500 Vrms.

5.6 Insulation Resistance (All Types)

The insulation resistance of the connector, unless otherwise stated or unnecessary for a given environment, shall be determined in accordance with EIA-364-21 or MIL-STD-1344 Method 3003 for high temperature, 200 °C and ambient temperature, 25°C. The magnitude of the voltage shall be 500V dc. The ambient test is the minimum requirement for all types of connectors except the C type in which a high temperature test shall be performed for environmental categories that specify high temperatures.

C Type: For the ambient test MIL-STD-1344 Method 3003 use test condition B with connector wired and mated. Simulated contacts and special techniques may be used. The insulation resistance shall be no less than 5000 Megohms.

M and D Type: If using MIL-STD-1344 Method 3003 use test condition B with connectors mated. Measure between 50% (four minimum) adjacent pairs and between 50% (6 minimum) contacts adjacent to shell and shell. Resistance shall be no less than 5000 Megohms unconditioned. After step 6 of MIL-STD-1344 Method 1002 (Humidity) the resistance shall be no less than 1 Megohm. After 24 hours of humidity conditioning under the same test method the resistance shall be no less than 1000 Megohms.

P Type: Connector shall be mated and may be board mounted. Apply voltage from pin to pin and pin to hardware of plug half. Resistance shall be no less than 5000 Megohms.

RF Type: In accordance with MIL-STD-202 Method 302 Condition B measure between the center contact and the body. Resistance shall be no less than 5000 Megohms.

5.7 Contact Retention (Crimp Removable Connectors)

Two connectors of any given lot size shall be tested in accordance with EIA-364-35 or MIL-STD-1344 Method 2007. The test conditions and acceptance requirements of the contact retention for crimp removable contacts are as follows:

C Type: For crimp removable contacts. The applied axial load shall be: 10 pounds +/- 1% for size 22 contacts, 15 pounds +/- 1% for size 20 contacts, and 25 pounds +/- 1% for size 16, 12, 10 and 8 contacts. For the given applied load the axial displacement shall be equal to or less than .30 mm.

D Type: For crimp removable contacts, apply a load of 9 pounds in both axial directions. Contact displacement shall be equal to or less than .30 mm.

M Type: For pre-wired crimp contacts, apply 5 pounds to individual wire pigtails for 6 seconds minimum. Load shall not cause any displacement of wire or contact.

P Type: Test 7 pairs of contacts minimum and use 5 pounds of load. Load shall not cause any displacement of contact.

RF Type: Determine the center contact retention on captivated center contact types only. Use a load of 6 pounds applied in both axial directions. Load shall not cause any displacement of contact.

5.8 Contact Resistance (All Types Hermetics Only):

Two connectors of any given lot size shall be tested in accordance with EIA-364-06 or MIL-STD-1344 Method 3004 and pass all requirements. The test and acceptance criteria for resistance of connector contacts shall meet the following conditions and requirements:

C Type: For solder type contacts, apply conditions and requirements of Table IV in section 3.17 of MIL-C-38999.

D Type: For testing the non-removable solder socket contacts, 20 % of the contacts shall be tested for four minutes while mated. Test currents and acceptable contact resistances are listed in Table VI of MIL-C-24308.

M Type: 20 % of the mated contact pairs shall be tested (7 minimum). Measurements shall not exceed .03 ohms (75 millivolts per contact pair at 2.5 amps).

P Type: Seven mated pairs shall be tested as a minimum and shall not exceed 20 milliohms per mated pair.

5.9 Contact Engagement and Separation Forces: (All Types But RF)

For solder type non removable contacts (of which hermetics are a subset) the connector engagement and separation forces of all connectors shall be tested in accordance with EIA-364-37 or MIL-STD-1344 Method 2014. The test conditions and acceptance requirements are as follows:

C Type: This test is conducted during inspection prior to assembly and conducted on socket contacts. Measurements shall comply with MIL-C-39029.

D Type: For socket contacts only, insert and remove maximum diameter pin gage (MS3197). Insert minimum diameter pin gage and measure separation force during removal of pin. Insert and remove maximum diameter pin gage three times and measure engagement force during the third cycle. All measurements shall comply with table IX of MIL-C-39029.

M Type: Engagement force shall be 6 oz per contact maximum and the separation force shall be .5 oz per contact minimum.

P Type: Test shall be conducted on all sockets in the connector. Insert MS3197 test pins to a depth of .140 +/- 02 inch. Maximum engagement force shall be 12 oz. per contact for 22 size contacts and 4 oz per contact for low insertion force contacts. Minimum separation force is .5 oz per contact for each type.

5.10 Humidity Cycling

This test is not crucial for space flight but is included for reference purposes when applicable. The ability of the connectors and their materials to withstand the effects of high humidity and heat shall be evaluated in accordance with EIA-364-31 or MIL-STD-1344 Method 1002 Condition II. Unless deemed necessary by special environmental considerations steps 7a and 7b will not be required. The conditions of humidity shall be altered accordingly to meet the requirements of any special environmental constraints. The default conditions of testing and acceptance requirements are as follows:

C Type: Shall be tested while mated and shall show no deterioration after cycling. Insulation resistance shall be no less than 100 Megohms.

D Type: Connectors shall be tested while wired but unmated. No vibration test is necessary as in 7B. After 24 hour conditioning period insulation resistance shall be measured (see Insulation Resistance requirement). At the completion of the test, moisture shall be removed and insulation resistance and DWV (see Dielectric Withstanding Voltage requirements) shall be measured.

M Type: Connector shall be fully wired and mated. Steps 7a and 7b are not required. After 24 hour conditioning period insulation resistance shall be measured (see Insulation Resistance requirement) and DWV shall be measured (see Dielectric Withstanding Voltage requirements).

P Type: Connectors tested while fully mated with a load voltage of 100 Vdc. At the completion of the test, moisture shall be removed and insulation resistance shall be tested.

RF Type: Connector shall be tested mated and cabled. At the completion of the test, moisture shall be removed and the dielectric withstanding voltage shall be tested.

5.11 Mechanical Shock (Specified Pulse for All Types)

The ability of the connectors to meet the mechanical shock requirement shall be evaluated in accordance with EIA-364-27 or MIL-STD-1344 Method 2004. If necessary the parameters of the test shall be adjusted to the constraints of the operational environment. The mated connectors shall have an applied test current for the series circuit contacts of 100 milliamperes. The circuit shall function adequately with no discontinuities larger than 1 microsecond or larger than what would be considered necessary for any given application. Other test conditions and acceptance requirements are as follows:

C Type: The Connectors shall be mated. The pulse shall be a half sine wave of 300 Gs magnitude with a duration of 3 milliseconds.

D and M Type: Use test condition E of MIL-STD-1344 Method 2004 (50 Gs sawtooth) with connectors mated. One shock shall be applied in each of the three major axes of the connector. The connectors shall be mated. A minimum of 8 inches of wire or cable shall be unsupported behind the receptacle rear and 4 inches behind the plug rear.

P Type: Use test condition G of MIL-STD-1344 Method 2004 (100 Gs, sawtooth) with connectors mated. One shock in both directions along each of the three orthogonal connector axes (total of six).

RF Type: One shock shall be applied to each of the three orthogonal connector axes. Discontinuity duration, waveform, and intensity of shock shall be determined by the operational environment and the application of the connector.

5.12 Materials Tests: Flammability, Odor, Toxicity (Non-Metal Shell D, M and P Types)

The materials in all non metal shell connectors of D, M, and P types shall be able to withstand these tests in accordance to the NASA handbook NHB 8060.1. These materials tests are only necessary when the connectors are used in habitable compartments, environmental category SP1, during space flight. The requirement for flammability (Test 1) is that the materials, once exposed to a flame in an environment of 30 % oxygen do not propagate that flame and ignite adjacent materials.

5.13 Thermal Vacuum Outgassing, (All Types):

All non metallic materials used in any type connector shall meet the requirements in accordance with ASTM-E595. This test is essential for any part being used in any of the space flight categories SP1-SP6. The material shall not exceed the 1% total mass loss (TML) or .1% collected volatile condensable materials (CVCM) requirement when tested. NASA Publication 1124 "Outgassing Data for Selecting Spacecraft Materials" or the MSFC Handbook 527 "Materials Selection List for Space Hardware Systems" can be used as references for materials selection.

5.14 Vibration (All Types)

The ability of the connectors to meet vibration requirements shall be evaluated in accordance with EIA-364-28 or MIL-STD-1344 Method 2005 Random Condition VI. The duration and intensity of the test shall be adjusted by the parameters of the application environment. Unless otherwise defined by the application environment use the detailed conditions provided below.

C Type: For bayonet coupling, breech coupling, and threaded coupling use Cond VI. Perform test for each of the three orthogonal axes for a minimum of 7 minutes per axis.

D Type: Use Condition IV or a range of 10 to 2000 Hz at 20 Gs peak and a total current of 100 microamperes.

M Type: Use test Condition III range of 10 to 2000 Hz at a peak of 15 Gs .

P Type: Use test Condition III.

RF Type: Environment and application shall determine which test will be used. Contact resistance shall be measured after test and comply with application parameter.

5.15 Thermal Cycling (All Types):

The ability of the connector to withstand the extremes of high and low temperatures shall be evaluated in accordance with EIA-364-32 or MIL-STD-1344 1003 condition A. The temperature extremes and duration of exposure shall be determined by the application environment: SP1 - SP6 for space flight. When the requirements of a given application environment are not specified the following conditions may be used as a default:

C Type: The temperature cycling shall be conducted with connectors mated, 5 times from the temperature extremes -65 °C to +200 °C or to the maximum temperature rating of the connector.

D and P Type: Unmated connectors shall be tested over 5 cycles from the temperature extremes -65 °C to +125°C.

M Type: Unmated connectors shall be tested over 5 cycles from the temperature extremes of -55 °C to +125°C.

RF Type: With connectors mated, use a temperature range of -65 °C to +200 °C or adjust to parameters of environment for 5 cycles. Measure contact resistance before and after test.

5.16 Salt Spray Corrosion (All Non-Gold Plated Types)

This is not considered essential for space flight applications but is included for reference purposes when applicable. For any non gold plated connectors, the ability to withstand a corrosive environment shall be tested in accordance with EIA-364-26 or MIL-STD-1344 Method 1001. The test conditions and acceptance requirements shall be determined by the operational environment parameters.

5.17 Magnetic Permeability (Type: D)

For D type connectors only, the magnetic permeability shall be tested in accordance with EIA-364-54 or MIL-STD-1344 Method 3006. Connectors shall have a relative permeability less than 2 mu.

5.18 Insert Retention (Types: C, D, and M)

When tested in accordance with EIA-364-35 or MIL-STD-1344 Method 2010 connectors shall retain their inserts in the proper location within the shell and there shall be no evidence of cracking, breaking or separation from the shell or loosening of parts.

C Type: Connectors shall be tested unmated but may be wired. The axial load shall be 75 pounds/square inch.

D Type: For non-hermetic types, inserts shall not be dislocated from their original positions or damaged when an axial load of 60 pounds/square inch is applied. For hermetic types, inserts shall stay intact and undamaged with a load of 200 pounds/square inch.

M Type: The test shall be conducted on metal shell connectors only. The pressure of the load shall be increased gradually at a rate of 10 pounds/square inch (psi) per second until a load of 50 psi is reached. The load shall be applied axially.

5.19 Air Leakage (Hermetic Types C, D, and RF)

Hermetic connectors shall be tested in accordance with EIA-364-02 or MIL-STD-1344 Method 1008.

C Type: The air leakage rate shall be no greater than 1.00×10^{-7} cm^3/s for 1 atmosphere.

D Type: The air leakage shall be no greater 1.04×10^{-5} cm^3/s at one atmosphere. The leakage rate does not apply to the flange to the mounting surface joint.

RF Type: The air leakage rate shall be no greater than 10^{-8} cm^3/s.

5.20 Low Level Contact Resistance (Types M and P Only)

The low level signal contact resistance shall be tested in accordance with EIA-364-23 or MIL-STD-1344 Method 3002. The contact resistance test shall meet the following conditions and requirements:

M Type: The contact resistance shall be 28 milliohms for contact size 24 and wire AWG 26, 25 milliohms for contact size 26 and wire AWG 25.

P Type: A minimum of seven mated contact pairs shall be tested. Using a test current of .001 amps the contact resistance shall be as specified in table II section 3.18 of MIL-C-55302.

5.21 Crimp Tensile Strength (M and P Type Only)

The crimp tensile strength shall be tested in accordance with EIA-364-08 or MIL-STD-1344 Method 2003. The acceptance criteria is as follows:

M Type: The wire shall not break or pull out of the non removable crimp contacts at less than 5 pounds and wire breakage other than at the crimp shall not be considered a failure.

P Type The wire shall not break or pull out of the non removable crimp contacts at less than 25 pounds for 20 AWG wire, 15 pounds for 22 AWG wire, 10 pounds for 24 AWG wire, 5 pounds for 26 AWG wire, 3 pounds for 28 AWG wire, 1.5 pounds for 30 AWG wire.

5.22 Maintenance Aging (Non-Hermetic C and D Types)

Connectors shall be tested in accordance with EIA-364-24 or MIL-STD-1344 Method 2002 when application requires such information on circular and D-subminiature types. This test may not be relevant to all applications of space flight.

C Type: The contact installing and removal forces shall not exceed the following: for contact size 22, 10 pounds (44 Newtons); for sizes 20 and 16, 20 pounds (89 Newtons); for size 12, 30 pounds (133 Newtons); for size 10 and 8, 35 pounds (156 Newtons).

D Type: The mating/unmating forces as well as the contact insertion and removal forces shall meet the requirements listed in 5.1.3 and 5.1.4.

5.23 Resistance to Solder Heat (D and M Types Only)

This test is for solderable, non-removable contacts only on D-subminiature and micro-miniature connectors. The test shall be conducted in accordance with MIL-STD-202 Method 210 (or EIA-364-56).

D and M Type: Test 20% or seven contacts minimum. A solder iron rated for 25 watts shall be used. The solder iron shall be heated to 360°C. It shall be applied to the termination for a period necessary to hold the solder in a liquid state for a time duration of 4 to 5 seconds. After the test a visual inspection shall be performed at a magnification of 10. The contact shall meet the contact retention requirement and shall have no evidence of distortion or damage..

5.24 Solderability (D and M Types)

The test for solderability shall be conducted in accordance with MIL-STD-202 Method 208 (or EIA-364-52). This test shall be conducted on D-subminiature and micro-miniature connectors.

5.25 Impact (Special Cases C Type Only)

The test for impact damage shall be conducted on circular type connectors that are considered environment resisting, have straight strain relief clamps and have either threaded coupling or breech coupling. This test is not for bayonet coupled connectors. The test for impact shall be performed in accordance with MIL-STD-1344 Method 2015 or EIA-364-42. The drop height shall be 4 feet (1.2 m). The number of drops shall be 8 total. The plate shall be indexed at 36 ° intervals. The plugs shall have no caps or covers installed.

5.26 Shell to Shell Conductivity (C Type Only)

The test for shell to shell conductivity on circular connectors that have conductive plating only shall be performed in accordance with MIL-STD-1344 Method 3007. The maximum voltage potential drop across assemblies shall be:

C type connectors with spring fingers:
bayonet coupling

2.5 mV for silver plating
50 mV for stainless steel plating
1 mV for space grade electroless nickel plating or corrosion resistant steel with electrodeposited nickel plating threaded or breech:
2.5 mV for corrosive resistant plating
10 mV for hermetic or non hermetic connectors with corrosive resistant steel plating.
1 mV for any hermetic or nonhermetic types with electrodeposited nickel
For corrosive resistant composite types, 3 mV initial and 6 mV after conditioning

C type connectors without spring fingers, bayonet or breech coupling, 200 mV.

5.27 EMI Shielding (C Type Only)

To measure the EMI shielding effectiveness, circular connectors with spring fingers, conductive plating and multiple contacts shall be tested in accordance with MIL-STD-1344 Method 3008 or EIA-364-66. The EMI shielding capabilities of mated shells shall not be less than what is specified below for a given connector coupling type and a given frequency.

Electroless Nickel Coated Connectors:

- Bayonet, scoop-proof shall have a minimum leakage attenuation of 50 dB for the frequency range 100 to 10000 MHz.
- Bayonet, non scoop proof, low silhouette, shall have a minimum leakage attenuation of 45 dB for the frequency range 100 to 1000 MHz.
- Threaded or Breech (electroless nickel over composite) shall have a minimum leakage attenuation of 65 dB for the frequency range 100 to 10000 MHz.

TABLE 2
MINIMUM ALLOWABLE LEAKAGE ATTENUATION (dB) VS. OPERATING FREQUENCY

Frequency MHz	Threaded or Breech, Steel or Steel plating	Threaded or Breech, Nickel plating *
100	80	90
200	75	88
300	73	88
400	71	87
800	66	85
1000	65	85
1500	59	76
2000	55	70
3000	52	69
4000	50	68
6000	48	68
10000	45	65

*(Nickel plating over steel connectors are included in this category)
The above is information extracted from MIL-C-389999

5.28 Firewall Protection (C Type Only)

Circular connectors with a firewall barrier (and steel or nickel plating) shall be tested in accordance with MIL-STD-1344 Method 1009 or EIA-364-45. A mated connector pair shall prevent passing of a flame for 20 minutes. Current shall be applied for 5 minutes and in the 6th minute the connector shall draw no more than 2 Amps given that a potential of 100 to 125V at 60 Hz is being applied to adjacent contacts. Wire bundles shall be clamped to fixed points at least 20 cm behind the connector.

5.29 Ozone (C Type Only)

For circular connectors only, the wired, mated connectors shall be tested in accordance with MIL-STD-1344 Method 1007 or EIA-364-14. After ozone exposure the connectors shall show no evidence of dielectric cracking or any other type of degradation or damage.

5.30 Atomic Oxygen (Non Metal Shell D, M, P Types)

All non metal shell connectors shall be tested for atomic oxygen degradation. Fluence levels shall be approximately 10^{21} atoms/cm^2 at an energy level of 5 eV and an exposure time of 40 hours. Atomic oxygen materials testing can be accomplished at Marshall Space Flight Center. Connectors shall show no signs of degradation or eroding.

5.31 Contact Pin Strength (D Type Only)

For D-subminiature connectors with non removable contacts, the contact pin strength shall be tested as follows. Contacts shall be mounted in a suitable fixture and a gradual force shall be applied to the pin at a maximum rate not faster than what it takes to move the head of the machine by 2.5 cm per minute. The maximum load shall be applied for no more than one minute. The maximum distance that the pin has moved permanently with respect to its initial position shall not exceed .005 inches (.13 mm) given a force of 2 pounds. For more details refer to MIL-C-24308 section 4.7.24.

5.32 Cable Retention (D Type Only)

For D-subminiature connectors attached to flat cables only, the unmated wired connector with strain relief shall be mounted by normal mounting means to a test fixture. An axial force of 8 ounces per contact shall be applied. the force shall be applied 6 inches (15 cm) from the mating face of the connector to the cable and shall pull away from the connector in the direction that will put the maximum amount of stress on the contact-cable interface. The contact-cable interface shall withstand the force applied without mechanical damage.

5.33 Residual Magnetism (D Type Only)

D-subminiature connectors without gold plating over copper shall be tested in accordance with NASA Goddard specification S-311-P-10 for residual magnetism. The connector shall be fully assembled prior to testing and tested in a magnetically quiet area in which machines, electronic equipment, vehicles and personnel traffic are restricted. The fluxmeter shall be warmed up for a minimum of fifteen minutes. The probe shall be mounted in a nonmagnetic stand and shall be in a horizontal position at full cable length from the meter. With the meter preset to the appropriate scale, align the probe in a magnetic east-west direction or orient to obtain a zero reading on the meter. Pass the connector three times at a rate of no more than 12 inches (30 cm) +/- 4 inches (10 cm) per second between the poles of a magnet with a field strength of approximately 5000 gauss. The connector shall not contact the pole pieces of the magnet. Immediately after, place the connector to with in 1/8 inch of the probe tip and orient the specimen for a maximum magnetism reading. The measurement unit shall be in gamma where one gamma is equivalent to 10^{-5} gauss.

5.34 RF Insertion Loss (RF Type Only)

When required by the project application, radio frequency (RF) coaxial connectors shall be tested in accordance with MIL-C-39012 section 3.27 for testing connector insertion loss using the testing apparatus and parameters specified. The insertion loss should meet the value stated in the product specification.

5.35 VSWR (RF Type Only)

When required by the project application, radio frequency (RF) coaxial connectors shall be tested in accordance with MIL-C-39012 section 3.14 for testing for the voltage standing wave ratio value using the testing apparatus and parameters specified. The VSWR should meet the value stated in the product specification.

5.36 Coupling Proof Torque (RF Type Only)

For radio frequency coaxial connectors only. The connector shall be engaged with its mating part and have the coupling nut tightened to the torque value quoted in the product specification sheet. After one minute the connector and its mating part shall be disengaged. The coupling mechanism for threaded types shall not be dislodged and dimensions of the connector shall remain as stated in the product specification.

5.37 Corona (RF Type Only)

Radio frequency connectors shall be tested in accordance with EIA-364-44 and show no signs of corona discharge at altitudes of 70,000 feet (148 meters).

5.38 Flammability (All Non-Metal Shell Types) SP2-SP6

For all non-metal shell connectors used in external environments SP2-SP6 a test for flammability shall be performed in accordance with ASTM D635. It is important to note that some materials may sustain more burn damage in a vacuum environment due to the lack of convection heat transfer. It may be necessary to conduct flammability tests under vacuum conditions.

5.39 UV Weathering (All Non-Metal Shell Types) SP2-SP6

This test is necessary for all non-metal shell connectors being used in any of the external environments SP2 - SP6. The connector shall be tested for total mass loss as a result of ultraviolet exposure in a vacuum environment or it shall be tested for degradation as a result of ultraviolet exposure only. The total sample exposure shall be adjusted by the operating environmental parameters stated under each environmental category. Testing of this nature can be conducted by Marshall Space Flight Center.

TABLE 3: Screen Test Requirement vs. Environmental Category

Test/Screen	Test Method	Requirement	Environmental Category							
Electrical Connectors (types: C, D, M, P, RF)			**MIL**	**IND**	**SP1**	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
Mechanical Tests and Requirements:										
Visual/Dimensional	section 5.1.1				X	X	X	X	X	X
All Types	EIA-364-18			X						
Mating Force/ Coupling Torque	MIL-STD-1344 Method 2013	10 oz x # of contacts for C, M: D type use table 1 in 5.3	X		X	X	X	X	X	X
All Types	EIA-364-13	see section 5.3 for RF and P.		X						
Durability	MIL-STD-1344 Method 2016	500 times	X		X	X	X	X	X	X
All Types	EIA-364-09	section 5.2		X						
Impact	MIL-STD-1344 Method 2015	8 times at 4ft.	X		X	X	X	X	X	X
Special Cases, C Type	EIA-364-42	section 5.25		X						
Crimp Tensile Strength	MIL-STD-1344 Method 2003	M Type: no breakage or pull out for 5 lbs or less.	X		X	X	X	X	X	X
M & P Types	EIA-364- 08	more specific for P, section 5.21		X						
Insert Retention	MIL-STD-1344 Method 2010	C: 75 psi, D: 60 psi, 200 psi for H(&D) s, M: 50 psi max	X		X	X	X	X	X	X
C, D & M Types	EIA-364-35	section 5.18		X						
Contact Retention	MIL-STD-1344 Method 2007	10 lbs for size 22 contacts on C, 9 lbs for D, 5 lbs for P, M and 6 lbs for RF	X		X	X	X	X	X	X
All Types of Crimp Removable	EIA-364-29	section 5.7		X						
Cable Retention	MIL-STD-1344 Method 1006	8 oz per contact	X		X	X	X	X	X	X
D Type Only	EIA-364-38	section 5.32		X						

Test/Screen	Test Method	Requirement	Environmental Category							
Electrical Connectors (types: C, D, M, P, RF)			**MIL**	**IND**	**SP1**	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
Mechanical Tests and Requirements:										
Contact Engagement/ Separation force	MIL-STD-1344 Method 2014	solder type contacts	X		X	X	X	X	X	X
C, D, M & P Types	EIA-364-37	section 5.9		X						
Contact Insertion/ Removal	MIL-STD-1344 Method 2012	C: less than 15 lbs (insert) less than 10 lbs (removal) for contact size 22. D: 4 lbs for intertion/ removal	X		X	X	X	X	X	X
(Not for Hermetics) C & D Types	EIA-364-05	Section 5.4		X						
Maintenance Aging	MIL-STD-1344 Method 2002		X		X	X	X	X	X	X
(Not for Hermetics) C & D Types	EIA-364-24	Section 5.22		X						
*** Vibration**	MIL-STD-1344 Method 2005	Test cond. VI is default	X		X	X	X	X	X	X
All Types	EIA-364-28	Section 5.14		X						
Mechanical Shock (Specified Pulse)	MIL-STD-1344 Method 2004	C: 300 Gs, D,M: 50 Gs, P: 100 Gs	X		X	X	X	X	X	X
All Types	EIA-364-27	Section 5.11		X						
External Bending Moment	EIA-364-43	Optional and not covered in detail in this document		X	X	X	X	X	X	X
Resistance to Soldering Heat	MIL-STD-202 Method 210	360 °C for 4 to 5 sec.	X		X	X	X	X	X	X
D and M Types	EIA-364-56	Section 5.23		X						
Solderability	MIL-STD-202 Method 208		X		X	X	X	X	X	X
D and M Types	EIA-364-52	Section 5.24		X						

Test/Screen	Test Method	Requirement	Environmental Category							
Electrical Connectors (types: C, D, M, P, RF)			**MIL**	**IND**	**SP1**	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
Mechanical Tests and Requirements:										
Contact Pin Strength D Type Only	MIL-C-24308	Section 5.31	X		X	X	X	X	X	X
Coupling Proof Torque RF Type Only	Section 5.36				X	X	X	X	X	X
Electrical Tests and Requirements:										
Shell to Shell Conductivity	MIL-STD-1344 Method 3007	Section 5.26 Maximum Potential depends on plating.	X		X	X	X	X	X	X
C Type only	?			X						
Dielectric Withstanding Voltage	MIL-STD-1344 Method 3001	Test condition I for sea level, Test condition IV for high altitude (.200 Km)	X		X	X	X	X	X	X
All Types	EIA-364-20	Section 5.5		X						
Magnetic Permeability	MIL-STD-1344 Method 3006	relative permeability less than 2.0 mu	X		X	X	X	X	X	X
D Type	EIA-364-54	Section 5.17		X						
Insulation Resistance (Ambient and High Temperature)	MIL-STD-1344 Method 3003	IR > 5000 Mohms, at 500 Vdc, unconditioned. Default: Ambient = 25 °C	X		X	X	X	X	X	X
All Types	EIA-364-21	High Temp = 200 °C Section 5.6		X						
Contact Resistance	MIL-STD-1344 Method 3004	references MIL-C-38999, MIL-C-24308.	X		X	X	X	X	X	X
All Hermetic Types	EIA-364-06	Section 5.8		X						
EMI Shielding	MIL-STD-1344 Method 3008	minimum leakage specified for different coupling types	X		X	X	X	X	X	X
C Type only	EIA-364-66	Section 5.26		X						

Test/Screen	Test Method	Requirement	Environmental Category							
Electrical Connectors (types: C, D, M, P, RF)			**MIL**	**IND**	**SP1**	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
Electrical Tests and Requirements:										
VSWR RF Type Only	MIL-C-39012	Can also use EIA-364-67 for Characteristic Impedance.	X	X	X	X	X	X	X	X
RF Insertion Loss RF Type Only	MIL-C-39012		X	X	X	X	X	X	X	X
Low Level Signal Contact Resistance M and P Types Only	MIL-STD-1344 Method 3002	7 pairs of contacts	X		X	X	X	X	X	X
	EIA-364-23			X						
Enviromental Tests and Special Requirements:										
***Thermal Cycling**	MIL-STD-1344 Method 1003	In the range specified by environmental category conditions, 5 cycles, storage temp.range:.-55 to +85 °C : SP1, -55 to +125 for SP2-SP6. Section 5.15	X		X	X	X	X	X	X
	EIA-364-32			X						
Salt Spray (Corrosion)	MIL-STD-1344 Method 1001.2	Not considered a minium requirement for space flight environments. For non-gold plated connectors	X		X	X	X	X	X	X
	EIA-364-26			X						
Ozone C Type Only	MIL-STD-1344 Method 1007.1	Section 5.29	X		X					
	EIA-364-14			X						
Humidity	MIL-STD-1344 Method 1002.2	Condition II. Not always necessary for space flight applications.	X		X	X	X	X	X	X
	EIA-364-31	Section 5.10		X						
Flammablility **D, M & P**	NHB 8060.1	30% oxygen materials test for non metal shell connectors. Essential for SP1 environment applications. Section 5.12			X					
Flammablility	MIL-STD-1344 Method 1012	For military type environments.	X			X	X	X	X	X
All Types	ASTM D635	For SP2-SP6 environments. Section 5.38		X						
Corona, RF Only	EIA-364-44	Corona free at 70,000 ft		X	X	X	X	X	X	X

Test/Screen	Test Method	Requirement	Environmental Category							
Electrical Connectors (types: C, D, M, P, RF)			**MIL**	**IND**	**SP1**	**SP2**	**SP3**	**SP4**	**SP5**	**SP6**
Enviromental Tests and Special Requirements:										
Outgassing (Thermal Vacuum) All Types	ASTM 595E	Materials Test: 1% TML, .1% CVCM Section 5.13			X	X	X	X	X	X
Odor	NHB 8060.1	For non metal shell connectors. Section 5.12			X					
Toxicity	NHB 8060.1	For non metal shell connectors. Section 5.12			X					
Residual Magnetism D Type Only	GSFC: S-311-P-4	Details of test in Section 5.33			X	X	X	X	X	X
UV Weathering	TML test as a result of UV exposure.	Test procedure and testing can be conducted by Marshall Space Flight Center. Test is environment dependent. Section 5.39				X	X	X	X	X
Firewall Protection	MIL-STD-1344 Method 1009	Details in Section 5.28	X		X	X	X	X	X	X
C Type Only	EIA-364-45			X						
Air Leakage Hermeticity	MIL-STD-1344 Method 1008	Hermetic Types Section 5.19	X		X	X	X	X	X	X
C, D and RF Types	EIA-364-02			X						
Atomic Oxygen	Section 5.30	For non-metal shell connectors. Testing available through Marshall Space Flight Center.			X	X	X	X	X	X

Table 4 : Screen Test vs. Connector Type						
Test	Notes	Power Circular	D-Rectangular	Micromini Rectangular	PC Board	Coaxial
Visual		X	X	X	X	X
Mating Force/ Coupling		X	X	X	X	X
Durability		X	X	X	X	X
*Impact	Special Cases	X				
Crimp Tensile Strength				X	X	
Insert Retention		X	X	X		
Contact Retention	Crimp Removable	X	X	X	X	X
Cable Retention			X			
Contact Eng/Sep Force	Solder Contacts	X	X	X	X	
Contact Ins/Rem Force	Non Hermetics	X	X			
Maintenance Aging	Non Hermetics	X	X			
Vibration		X	X	X	X	X
Mechanical Shock		X	X	X	X	X
Resist. to Sold. Heat			X	X		
Solderability			X	X		
Contact Pin Strength			X			
Coupling Proof Torque						X
Shell to Shell Conduct.		X				
DWV		X	X	X	X	X
Magnetic Permeability			X			
Insulation Resistance	Ambient	X	X	X	X	X
Insulation Resistance	High temp	X				
Contact Resistance	Hermetics	X	X	X	X	X
EMI Shielding		X				
Low Level Signal				X	X	
RF Insertion Loss						X
VSWR						X
Thermal Cycling		X	X	X	X	X
*Salt Spray	Non-gold plating,	X	X	X	X	X
Ozone		X				
*Humidity	non crucial for SP2 - SP6	X	X	X	X	X
**Flammability 30% O_2	SP1, (NHB 8060.1)		X	X	X	
**Flammability	ASTM D635, SP2-SP6	X	X	X	X	X
Outgassing	SP1- SP6	X	X	X	X	X
**Toxicity	SP1, (NHB 8060.1)		X	X	X	
**Odor	SP1, (NHB 8060.1)		X	X	X	
Residual Magnetism	SP1- SP6, Non Au over Cu		X			
**UV Weathering	SP2- SP6		X	X	X	
Firewall Protection		X				
**Atomic Oxygen			X	X	X	
Air Leakage (hermetics)		X	X			X
Corona						X
* Test or screen is non-crucial for space flight environments. ** Test or screen for non-metal shell connectors only.						