MEGGITT

MEGGITT SAFETY SYSTEMS INC

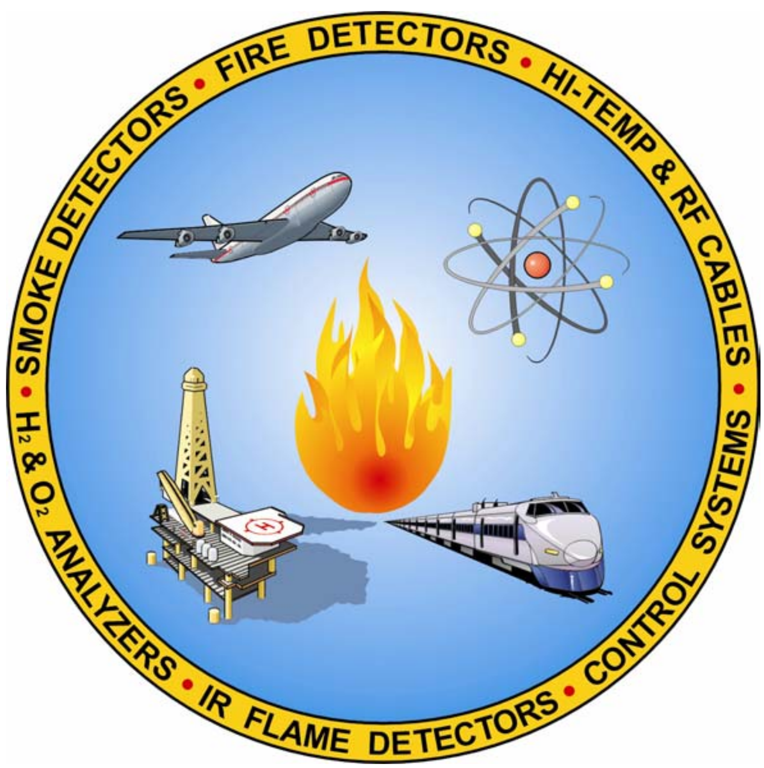
SUMMARY OF CABLE ASSEMBLY QUALIFICATION TESTS

Meggitt Safety Systems Inc.

Cable Assemblies

For Aerospace Applications

Space and Aircraft



September 19 2003

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1.0 INTRODUCTION

This report describes the qualification test programs that have been conducted on SiO_2 cable assemblies manufactured by Meggitt Safety Systems Inc. (MSSI).

Based on prior experience and successful performance as a key Microwave Cable assembly supplier to major airframe programs, MSSI is capable of meeting all customer qualification test requirements by similarity to the ones performed for other applications. MSSI is the leading supplier of the high temperature RF/Microwave cable assemblies.

1.1 Background and History

The SiO_2 cable line is a mature product, having it's beginning with a McGraw Edison patent around 1950. Electronic Specialty acquired the rights to the SiO_2 state-of-the-art cable product line from McGraw Edison in 1965. At that time Electronic Specialty was a major supplier of a variety of microwave components and systems, including antennas for the defense industry. In early 1972, Tasker Industries, a subsidiary of Whittaker Corporation, acquired Electronic Specialty including, of course, the SiO_2 cable product line. After less than a year, Whittaker spun this product off into a separate division named Electronic Resources (ERI), which grew quickly until ERI was the dominant supplier of SiO_2 cable assemblies for the aerospace, military, and nuclear industry.

In 1997 Whittaker Corporation combined the Safety Systems Division from Concord, California with ER in the Simi Valley, California facilities combining the two product lines in a move that greatly benefited both organizations. The benefits in terms of engineering and manufacturing capabilities was predictable, the technological synergism was not quite as obvious but was equally successful as new applications for the cable technology in the aircraft instrumentation sector are continuing to develop.

Safety Systems, the resulting entity has been a major force in aircraft fire detection and industrial fire/gas protection systems for over thirty-five years. The Company has a proven track record in the development of innovative fire protection solutions for aircraft, selling to airframe manufacturers, engine/APU system suppliers, and airline end users. The extensive research, development, and production capabilities of the Company have always been fully directed towards a single goal. That is, to provide world-class support and technological innovation of the core products that include pneumatic fire/overheat detectors, state-of-the-art optical flame detectors, cargo smoke detectors, linear fire/explosion suppressors, multi-function system controllers and the recently absorbed SiO_2 cable systems.

The latest Corporate move occurred in 1999, when Whittaker assets were acquired by Meggitt PLC, a UK company. Meggitt Safety Systems Inc. as we are now known, is still housed in the 125,000 square foot modern facility located approximately thirty-five miles northwest of Los Angeles in Simi Valley, California.

Safety System's parent company is Meggitt PLC, a publicly owned company listed on the London Stock Exchange. Through its Controls subsidiary and other operating units, Meggitt has been supplying high quality products to the aerospace community since 1942. Safety Systems brings to Meggitt a shared interest in performance-critical applications for the served market and compatible product lines featuring the state-of-the-art, high reliability instrumentation systems to aircraft and power generation systems around the world.

1.2 Cable Technology

MSSI has been manufacturing stainless steel, all-welded hermetic cables with non-organic materials for applications in extreme environments for more than 40 years. MSSI has designed, developed and delivered radiation and temperature resistive Silicon Dioxide (SiO_2) insulated cable assemblies to the Military and Avionics Industry since 1960. The basic cable and connector technology is applied to a myriad of configurations in critical high temperature and vibration applications on military aerospace platforms. MSSI products are found wherever reliable performance in harsh environments is required.

The core technology in the MSSI cables is the use of silicon dioxide (SiO_2) as the dielectric insulator, resulting in extraordinary stability of the electrical and mechanical properties of this material under severe environmental extremes. The SiO_2 is extruded over the conductors, e.g., copper; or other alloys depending on the specific application. The extrusion process provides the design flexibility that facilitates the manufacture of an almost unlimited array of conductor configurations and sizes. The resulting extrusion is then loaded into a stainless steel (or other metal alloy) tube, and drawn down to size. In the final configuration, the SiO_2 maintains conductor position in the tube relative to the other conductors and the outer sheath maintaining precise spacing for stable electrical performance. The unique spherical shape of the SiO_2 particle holds the conductor spacing through cable bending operations, usually encountered during routine installation operations, hence electrical performance is not compromised in any way.

This characteristic permits forming and routing at installation with a very tight bend radius nominally three times the cable diameter without causing any damage to the cable. MSSI cable assemblies continue to operate in temperatures above 2000^{o}F.

1.3 Design And Construction

Figure 1.0 illustrates the construction of the coaxial cable.

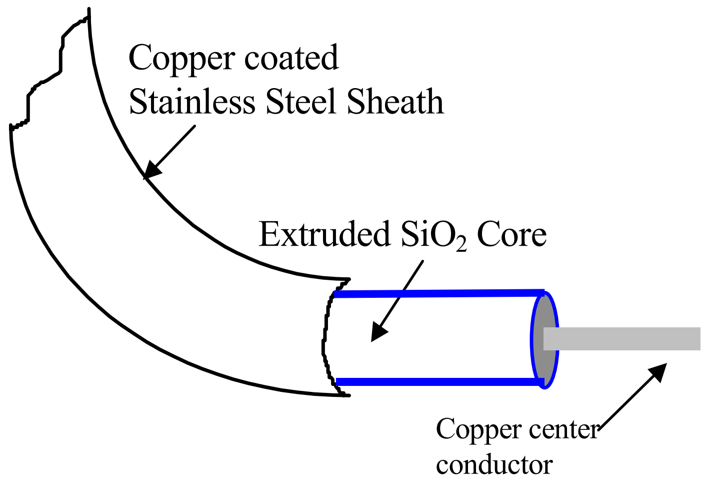

Figure 1.0 – Cable Construction

1.4 Electrical Characteristics

The SiO_2 cable assemblies used for the electrical penetrations will have the following electrical characteristics:

- Low insertion loss
- Low VSWR
- Superior phase stability vs. temperature
- Superior insertion loss stability vs. temperature
- Excellent EMI and EMP characteristics

1.5 Mechanical Characteristics

The cable assemblies used for the signal penetrations are designed with the following mechanical properties:

• Jacket (sheath) Material	304L Stainless Steel
• Wall Thickness	0.015 inches
• Wire Material	Copper or Nickel coated Copper
• Dielectric Material	99.8% pure SiO_2
• Minimum Bend Radius	3x Cable Outside Diameter

1.6 Reliability

The SiO_2 cable reliability requirements fall into the aerospace category and MSSI's aerospace cable reliability data can be used as a basis for projected claims for the similar basic cable/connector construction.

Field reliability for the aerospace cable (as used on F-18, F-14) demonstrated an MTBF in excess of $1x10^8$ operating hours. Calculated MTBF, per Mil-HDBK-217, is also in excess of $1x10^8$ operating hours in the dynamic aircraft environments.

1.7 Qualification

MSSI SiO_2 cables and connectors have been qualified to industry recognized standards and specifications such as MIL-T-81490 and MIL-PRF-39012. Typical qualification tests conducted on representative cable systems are listed below:

- RF Leakage
- High Power
- High Vacuum
- Hermeticity, Leak Rates less than $1x10^{-8}$ cc/sec Helium
- Thermal and radiation aging to demonstrate hardware life of 40 years
- Corrosion resistance
- Humidity
- Chemicals and Fluids
- Shock
- Temperature Shock and cycling
- Pull-off and retention
- Vibration

1.8 Installation And Handling

There are no special handling requirements for the cable assemblies. The recommended minimum bend radius for the cable is three times the cable diameter. MSSI will provide installation procedures if requested, and can make available training or on-site support if required.

1.9 Applications

The SiO_2 cable is uniquely suited for applications where stable, reliable performance in harsh environments is required. Meggitt Safety Systems is a manufacturer of high performance microwave coaxial cable assemblies and connectors that are used extensively in aerospace applications. MSSI's precision microwave assemblies are currently qualified and used on numerous high-performance platforms where quality, reliability and overall performance are paramount.

MSSI has been producing high performance microwave cable assemblies for aerospace applications for over 30 years. Our cable assemblies have been flight qualified on platforms such as the AH-64, AV-8B, A-6, B-1B, B-2, C-17, C130, F-14, F-15E, F-16, F/A-22, GPSW, Inmarsat, MX Missile, SR-71, Space Shuttle, Tomahawk, U-2, F-5, J-Stars, Trident, AH-1, UH-60 and others.

Common applications include Electronic Warfare systems, radar systems, satellite systems cryogenic feedthroughs, high power interconnects, phase and amplitude stable interconnections, high temperature umbilicals, delay lines, antenna elements and interconnect cables, calibrated test cables, preformed cable assemblies with complex bends and configurations requiring tight bend radius. Some of the applications where these cable systems are deployed include signal transmission from high power transmission devices into antenna systems. Some of our repeat customers for these applications include:

- BAE Systems
- Boeing
- Harris Corporation
- ITT Aerospace
- L3 Com
- Lockheed Martin
- Mitsubishi Electric Corporation (MELCO)
- Northrop Grumman
- Raytheon
- TRW

1.10 General Requirements

The SiO_2 cable system solutions utilizes component designs and materials where Meggitt Safety Systems has a long history of installed performance and both in-house and independent validation of basic design characteristics. The component designs and hardware integration were selected on the basis of projected ability to meet system criteria for environmental levels and required operating life. A broad brush list of salient features of SiO_2 cable systems include:

- High insulation resistance even at elevated temperatures
- Totally free of organic materials that eliminate normal aging concerns
- Proven glass to metal sealing techniques for rugged, hermetically sealed connectors
- Extremely rugged and durable steel jacketed cables (extreme bending, crimping, and denting, will not adversely affect operation)

2.0 DETAILED TEST PROGRAMS

2.1 List of Qualification Tests, customer name and Platforms

GRUMMAN ECM EQUIPMENT CABLE ASSEMBLIES ER Report No. 703	
Specification Reference	Specification EW05230900, Department of the Navy. Specification EWO5230903, Department of the Navy, and MIL-T-81490
Description of test samples	Five test samples successfully completed the test program. All test samples used 0.090 diameter cable and TNC Male connectors.
VSWR Test	2 to 18 GHz, 1.50:1 Maximum
Velocity of Propagation	80 percent minimum
Impedance	50 +/- 1 Ohm
RF Leakage Test	-60dB minimum, test per MIL-C-55427
Pull Test	Connector to cable pull of 75 pounds
Torque Test	50 inch-pound applied cable to connector
Thermal Shock Test	Five cycles, -65^0 to $+200^0$F
Chemical Resistance	Cleaner/Brightener, MIL-C-5410; Stripper, Epoxy MIL-R-81294A
Vibration Test	5 to 2000 sine vibration test with levels up to 15 g's, at temperatures of room, -65°F and $+160^0$F
Impact Shock Test	Four pound weight, with 1/8 by 1/8 inch striking surface, dropped for four inches
Flexure Test	+/- 30^0/ft for 400 cycles +/- 10^0/ft for 10,000 cycles
Abrasion Resistance (Sand and Dust Test)	MIL-STD-202, Method 110, Test Condition B, 30 minutes
Concentrated Load	50 pound weight applied to cable via two inch diameter plate

TEXAS INSTRUMENTS PHASE MATCHED CABLES **ER Report No. 1002A**	
Specification Reference	**Specification Control Document, Texas Ins., 675254-1**
Description of Test Samples	**.142 diameter cable with SMA type connectors**
Phase Match vs. Temperature	**The absolute phase shift of the cable with respect to temperature was plotted in five-degree temperature steps from -65^{0}F to +70^{0}F.**
VOIGHT AERONAUTICS DIV. **LTV - ECM CABLE ASSEMBLIES** **ER Report No. 1002**	
Specification Reference	**Procurement Specification, 204-28-99a, LTV And MIL-T-81490**
Description of Test Sample	**Three test samples successfully completed the test program. All test samples were 0.142 diameter cable with Male TNC connectors.**
Velocity of Propagation	**80 percent minimum**
RF Leakage	**-60dB minimum, test per MIL-C-55427**
Pull Test	**Connector to cable pull of 75 pounds**
Impact Shock Test	**Four pound weight, with 1/8 by 1/8 inch striking surface, dropped from four inches**
Torque Test	**50 inch-pounds applied cable to connector**
Concentrated Load Test	**50 pound weight applied to cable via two inch diameter plate**
Thermal Shock Test	**Five cycles, -65^{0}F to 200^{0}F**
High Power Test	**200 watts average and 2 kW peak, at a temperature of 248^0 F and an altitude of 50,000 feet**
Vibration Test	**5 to 2000 sine vibration test with levels up to 15 g's, at temperatures of room, -65^{0}F and +160^{0}F**
Temperature Test	**Operation at -55^{0}C and 120^{0}C**
Shock Test	**15 g's at 22 millisecond duration**
Salt Spray	**Federal Test Method 151, Method 811, 5 percent solution for 50 hours**

NAVAL AIR SYSTEM COMMAND TEM TRANSMISSION LINE ER Report No. 1010	
Specification Reference	Naval Air System Command, Specification Control Document 174AS126
Description of Test Sample	.142 diameter cable with SMA type connectors
VSWR and VSWR Stability Test	1.4:1 maximum over frequency range of 2 to 18 GHz
Insertion Loss, IL Stability and IL Uniformity	X-Y plots over frequency range of 2 to 18 GHz. Uniformity of 0.3dB.
Impedance	50 +/- Ohms
Velocity of Propagation	80 percent
Tensile Load	75 pound pull test on connectors while monitoring insertion loss and VSWR
Leak Test	Helium leak test of 10^{-8} cc/sec.
Thermal Shock Test	25 cycles of -65^{0}F to +200^{0}F
Torque Test	15 +/- 2 inch-pounds, five times, with VSWR and insertion loss monitored
ER ABRASION TEST ER Report No. 1011	
Specification Reference	MIL-C-5756B(ASG)
Description of Test Sample	Three samples, ER standard cables; .090 inch diameter, .142 inch diameter, and .296 inch diameter
Abrasion Test	600 oscillation of squirrel cage abrasion tester at 20 +/- 2 oscillations per minute
AVERAGE POWER TEST .296 CABLE ER Report No. 1012	
Specification Reference	None
Description of Test Sample	.296 diameter cable with Warnecke -7 connectors. (Special interface to mate with Warnecke crossed field amplifier tube.)
RF Power Test	1250 watts, CW, at 7.14 GHz was applied to the test unit. There was no damage as a result of the test. The temperature rise was plotted at various power levels.
FLEXURE TEST .142 DIAMETER CABLE ER Report No. 1014	

Specification Reference	MIL-T-81490
Description of Test Sample	.142 diameter cable with TNC connectors
Flexure Test	+/- 75 degrees for 400 cycles per MIL-T-81490. No damage noted.
Post Electrical Test	VSWR and insertion loss measured from 2 to 18 GHz
LONGITUDINAL FLEXURE TEST .142 DIAMETER CABLE **ER Report No. 1015**	
Specification Reference	None
Description of Test Sample	.142 diameter cable, 21 inches long, with TNC connectors. A three-inch service loop, parallel to the cable axis, was centered between the connectors.
Longitudinal Flexure Test	Plus and minus one inch longitudinal flexure at the rate of 60 cycles per minute. A total of 1000 cycles was performed. There was no evidence of damage as a result of this test.
Post Electrical Test	VSWR and insertion measured from 2 to 18 GHz
SERVICE LOOP FLEXURE TEST .142 DIAMETER CABLE **ER Report No. 1019**	
Specification Reference	None
Description of Test Sample	.142 diameter cable, with a two inch service loop perpendicular to the cable axis. The cable was terminated with TNC connectors.
Flexure Test	Plus and minus one inch longitudinal flexure at the rate of 40 cycles per minute. A total of 1000 cycles was performed. There was no evidence of damage as a result of the test.
Post Electrical Test	VSWR measured from 4 to 18 GHz and insertion loss measured from 2 to 18 GHz.
ROTATIONAL FLEXURE .296 DIAMETER CABLE **ER Report No. 1020**	
Specification Reference	None

Description of Test Sample	**.296 diameter cable, six-feet in length, with a right angle bend on one end and an off-set bend on the other end. The cable was installed in a two inch ID tube.**
Rotational Flexure Test	**The cable was subjected to a +/- 30 degree rotational twisting at the rate of 20 cycles per minute. The cable completed 23,000 cycles prior to failure.**
LOCKHEED MISSILES AND SPACE COMPANY **TRIDENT PROGRAM RE-ENTRY VEHICLE** **ER Report No. 1024**	
Specification Reference	**Product Specifications, XWS 16646, Lockheed LMSC**
Description of Test Samples	**Six test samples successfully completed the test program. All six samples were .090 diameter cable with Male SMA connectors.**
VSWR Test	**2200-2290 MHz, 2.25:1 max.**
Non-Operating Temperature	**-20^{0}F to +120^{0}F**
Sinusoidal Vibration Test	**5 to 2000 Hz, up to 20 g's**
Humidity Test	**Operation at 120^{0}F and a humidity of 95 percent minimum**
High Pressure Test	**75 pound per square inch**
Operating Life	**Fifty hours at 1200 watts peak, 2290 MHz**
Shock Test	**Pyrotechnic shock with levels up to 1200 g's**
Random Vibration	**20 to 80 Hz, 0.02 g^2/Hz 80 to 180 Hz, +6dB/octave 180 to 2000 Hz, 0.10 g^2 /Hz 13.8 G RMS overall**
Acceleration	**Operation at 110 g's**
Low Pressure, Operating	**0.17 mm Hg with unit operating at 1200 watts peak**
ROCKWELL INTERNATIONAL **SPACE SHUTTLE** **ER Report No. 1028**	
Specification Reference	**Modified Procurement Specification, MC409-0049, Rockwell International**
Description of Test Samples	**Twelve test samples successfully completed the test program. 2 each, .090 diameter cable; Male/Female TNC, Male/Female Bulkhead TNC.**

	2 each, .142 diameter cable; Male/Female TNC, Male/Female Bulkhead TNC, Male/Female HN, Male/Female Bulkhead HN.
	4 each, .532 diameter cable; Male/Female TNC, Male/Female Bulkhead TNC, Male/Female HN Male/Female Bulkhead HN.
VSWR Test	**225- 400 MHz, 1.10:1 Max.** **960-1220 MHz, 1.15:1 Max.** **1740-2300 MHz, 1.20:1 Max.** **4200-4400 MHz, 1.25:1 Max.**
VSWR Stability Test	**The VSWR is measured while applying a side load of 10 times the cable OD in pounds.**
Dielectric Strength Test	**1000 volts RMS on all cables except for .090 diameter which was tested at 500 volts RMS**
Random Vibration Test	**5-50 Hz, +6dB/Octave** **50-250 Hz, 2.0 g^2 /Hz** **250-2000 Hz, -6dB/Hz** **29.7 G RMS overall**
Thermal Shock Test	**Five thermal cycles of -270^{0}F to +350^0 F, one hour soak at each temperature**
Humidity Test	**Ten day cycle of 160^{0}F and a humidity of 95 percent minimum**
EVALUATION TEST **.090 DIAMETER CABLE SYSTEMS** **ER Report No. None**	
Specification Reference	**None**
Description of Test Sample	**.090 diameter cable of various lengths, with SMA and TNC connectors**
Insulation Resistance	**1.7 x 10^{13} ohms-ft. at voltages up to 1000 volts at room temperature.**
	1.5 x 10^7 ohms-ft. at voltages up to 250 volts at 1000^0 F.
Impedance	**52.4 ohms with a uniformity of +/- 1 ohm**
RF Power Handling	**Peak power up to 9kW for TNC cables. Peak power up to 20kW for SMA cables.**
VSWR	**Less than 1.5:1 to 18 GHz through temperature range of -54^{0}C to +215^0 C. Less than 1.5:1 during 1 inch diameter bend.**
Insertion Loss	**Insertion loss graphs over temperature range of -45^{0}C to +215^{0}C, with little change noted. Also, insertion loss during bend tests.**
RF Phase Characteristics	**Phase tracking plotted over temperature range of -54^{0}C to +215^0 C.**
PRESSURE-TEMPERATURE TEST **TWIN LEAD SEAL ASSEMBLY** **ER Report No. 1031**	

Specification Reference	**None**
Description of Test Samples	**Ceramic twin lead seal assembly for use with thermocouples**
Temperature Cycle Leak Test	**Temperature cycling from 70^{0}F to 1100^{0}F in a 30 minute interval. A 270 PSI, He. differential was maintained and the leak rate monitored. There was no evidence of leakage as a result of the test.**
Post Electrical Test	**None**

RANDOM VIBRATION AND SHOCK TEST
CABLE ISOLATION ASSEMBLY
ER Report No. 1032

Specification Reference	**None. (QTP 14-30-03610)**
Description of Test Samples	**.142 diameter cable, with SMA Male connectors. Isolator welded in center of cable.**
Random Vibration Test	**Random vibration with level of 0.04 g^2/Hz (8.g G RMS). Insertion loss monitored during test.**
Shock Test	**Pyrotechnic shock test with g levels up to 1000**
Post Electrical Test	**VSWR and insertion loss measured after test from 2.2 to 2.29 GHz**

DESIGN APPROVAL
SANDERS HIGH POWER CABLE ASSEMBLY
ER Report No. 1033

Specification Reference	**Sanders WHK20004**
Description of Test Sample	**.270 and .296 diameter cable terminated in various connector types**
Vibration Test	**Vibration test conducted in accordance with MIL-STD-202, Method 204A, Test Condition C**
Post Electrical Tests	**VSWR and insertion loss (See specification)**

EXTREME TEMPERATURE PERFORMANCE
.296 CABLE
ER Report No. 1034

Specification Reference	**None**
Description of Test Sample	**.296 diameter cable**
Temperature Test	**Subjected the cable to temperatures of -302^{0}F and +1250^{0}F while monitoring insertion loss for change. Connectors remained at room ambient.**

Post Electrical Test	**N/A**
PRESSURE TEST **.142 CABLE ASSEMBLY** **ER Report No. None**	
Specification Reference	**None**
Description of Test Sample	**.142 cable assembly with SMA connector and TNC Female. SMA connector and cable subjected to 1500 psig fluid pressure.**
Post Test Data	**Visual only. No damage**
THREE POINT BENDING **.142 CABLE** **ER Report No. 1035**	
Specification Reference	**None**
Description of Test Sample	**.142 cable**
Bend Test	**Compared required bending force of ER cable with other type stainless jacketed cables. Springback also measured.**
Post Test	**N/A**
DESIGN APPROVAL TEST **DELAY LINE** **ER Report No. 1037**	
Specification Reference	**Sanders WHK10023**
Description of Test Sample	**90 nanosecond delay line made from 60 feet of .275 cable and 10 feet of .142 cable**
Vibration Test	**Test in accordance with MIL-STD-810, Test Method 514, Category B, Procedure 1, with levels modified to 15 g's 50 to 100 Hz and 10 g's 100 to 500 Hz.**
Post Tests	**VSWR, insertion loss and delay**
ROTATIONAL FLEXURE **.142 CABLE** **ER Report No. 1039**	
Specification Reference	**None**
Description of Test Sample	**.142 diameter cable with SMA Male connectors**
Rotational Flexure Test	**Rotational flexure from 0 to 90^0 and return to 0. Unit completed 100,000 cycles with no failure.**
Post Test	**VSWR and insertion loss**

CONNECTOR LOAD TEST TYPE .142 TNC ER Report No. 1042	
Specification Reference	None
Description of Test Sample	TNC connector, .142 cable
Connector Load Test	Apply tensile load to failure. Minimum load was 455 pounds.
Post Test	N/A
CONCENTRATED LOAD TEST **ER Report No. 1044**	
Specification Reference	MIL-T-81490
Description of Test Sample	.142 diameter cable assembly and .296 diameter cable assembly
Concentrated Load Test	A force up to 500 pounds was applied to the cable via a two inch diameter plate. There was no damage or degradation of electrical parameters.
Post Test	VSWR and insertion loss, 2 to 12.4 GHz.
RF LEAKAGE **ER Report No. 1045**	
Specification Reference	MIL-T-81490
Description of Test Sample	TNC Connector, Type .275, .296, and .301 diameter
RF Leakage Test	Measurements made in the 8 to 18 GHz band at maximum amplitude. All connectors met specification.
SALT SPRAY TEST **ER Report No. 1046**	
Specification Reference	MIL-STD-810
Description of Test Sample	One standard TNC connector, one gold plated connector welded on .142 diameter cable
Salt Spray Test	Test was conducted in accordance with MIL-STD-810.There was no evidence of damage.
Post Test	VSWR and insertion loss, 2 to 16 GHz
ROTATIONAL FLEXURE TEST **.142 CABLE** **ER Report No. 1048**	

Specification Reference	None
Description of Test Samples	.142 diameter cable, spliced, and terminated with SMA and TNC connectors
Rotational Flexure Test	Rotational flexure from 0 to 90^0 and return to 0. Unit completed 100,000 cycles with no failure.
Post Test	VSWR and insertion loss, 4 to 8 GHz
FIRST ARTICLE TEST AMECOM DELAY LINE **ER Report No. 1051**	
Specification Reference	AMECOM ESK 55696
Description of Test Sample	25 nsec delay line made from .090 diameter cable
Insertion Loss	9.OdB from 1.72 GHz to 4.2 GHz at temperatures of -54°C and $+71^0$C
VSWR	1.3:1 from 1.72 GHz to 4.2 GHz
Phase Dispersion	+/- 1.5^0 maximum
Delay Time	25.035 nsec.
Delay vs Temperature	Maximum phase change -54^0C to $+71^0$ C, 29.5 degrees
ROTATIONAL FLEXURE TEST .275 DIAMETER CABLE **ER Report No. 1054**	
Specification Reference	None
Description of Test Sample	.275 diameter cable terminated in TNC Male connectors
Rotational Flexure	Rotational flexure from 0 to 160^0 and return to 0. The test unit completed 46,500 cycles.
Post Test	None
HIGH LEVEL VIBRATION SPACE SHUTTLE **ER Report No. 1056**	
Specification Reference	Rockwell MC409-0021
Description of Test Sample	Four .142 diameter cable assemblies, four .296 diameter cable assemblies, and two .532 diameter cable assemblies

Random Vibration	**The cables were subjected to the following levels: 20 to 90 Hz +9dB 90 to 350 Hz 1.6 g2 Hz 350 to 2000 Hz -6Db Failures occurred after 19 minutes and testing was discontinued.**
Post Test	**None**

3.0 PURPOSE

The purpose of this document is to show the similarity of the Coaxial Transmission Line proposed and Coaxial Transmission Lines for which qualification test data is available. Based on this data, qualification by similarity is requested.

3.1 APPLICABLE DOCUMENTS

3.1.1 Military Specification MIL-T-81490.

3.1.2 Test Report No. 703, Electronic Resources Part Number 10-11-00250, 10-11-00251, 10-11-00252, 10-11-00253.

3.1.3 Test Report No. 1002, Electronic Resources Part Number 15-30-00079 through 15-30-00109.

3.1.4 Test Report No. 1011, Abrasion Test.

3.2 MECHANCAL CONSTRUCTION

The transmission lines manufactured at Electronic Resources are designed to meet or exceed all requirements of the referenced specifications. The Electronic Resources transmission lines utilize the following construction methods and materials to ensure reliable operation in extreme environmental conditions.

3.2.1 All welded construction

3.2.2 Silicon dioxide dielectric

3.2.3 Ceramic connector dielectric seal

3.2.4 Inner conductor OFHC copper

3.2.5 Composite stainless/copper clad outer jacket

3.2.6 True hermetic seal of 10^{-8} cc/sec of He.

The transmission lines proposed by Electronic Resources, are identical to the transmission lines for which similarity is claimed except for the diameter of the raw cable used in the 10-11 series cable assemblies. All are manufactured in accordance wit the same controls, material specifications ad construction techniques. All transmission lines utilize “EW” TNC type connectors.

3.3 SPECIFICATION MATRIX

The matrix of Table 1 compares the requirements of part numbers 10-30-00079 through 15-30-00109 manufactured for Vought Aeronautics Division of LTV, and part numbers 10-11-00250 through 10-11-00253 manufactured for Grumman Aerospace Corporation with the requirements of MIL-T-81490.

3.4 CONCLUSION

Based on the direct similarity between the coaxial transmission lines present herein, and the qualification reports of similar assemblies, qualification by similarity is requested.

SPECIFICATION MATRIX

TEST	**MIL-T-81490**	**ERI REPORT NO. 703**	**ERI REPORT 1002**
VSWR	Sweep VSWR measurements and VSWR stability	1.5:1, 2-18 GHz All other parameters same as MIL-T-81490.	Same as MIL-T-81490, for bands tested.
Insertion Loss	Sweep Data with stability and uniformity	Meets MIL-T-81490	Meets MIL-T-81490
Velocity of Propagation	80 percent minimum	80 percent minimum	80 percent minimum
Impedance	50 ± 1.0 ohms	50 ± 1.0 ohms	50 ± 1.0 ohms
RF Leakage (RF Interface)	MIL-T-81490, Test Report (Cavity Method) Avail.	MIL-C-55427 (60 dB) (Triaxial Method)	MIL-C-55427 (60 dB) (Triaxial Method)
Vapor Leak Rate	1 x 10^{-5} /sec/ft	10^{-8} cc/sec of He	10^{-8} cc/sec of He
Temperature	MIL-T-81490	N/A	See Power Handling
Altitude	MIL-T-81490	N/A	See Power Handling
Thermal Shock	MIL-T-81490	Meets MIL-T-81490	Meets MIL-T-81490

SPECIFICATION MATRIX

TEST	MIL-T-81490	ERI REPORT NO. 703	ERI REPORT 1002
Vibration	MIL-T-81490, para. 4.12.1 thru 4.12.4	MIL-T-81490, para. 4.12.1 thru 4.12.4	MIL-T-81490, para. 4.12.1 thru 4.12.4
Power Handling	200 watts average and 3.0 KW peak at 8.0 GHz and 16 GHz based on type.	N/A	2 KW peak and 200 watts average at +248°F and 50,000 feet.
Impact Shock	4 pound 1/8 x 1/8 area from 4 inches	4 pound 1/8 x 1/8 area from 4 inches	4 pound 1/8 x 1/8 area from 4 inches
Flexure	MIL-T-81490	ASNAE 68-38	N/A
Torque	50 in./lb.	50 in./lb.	50 in./lb.
Tensile Load (Pull Test)	75-pounds	75-pounds	75-pounds
Abrasion	MIL-T-81490	See Report No. which shows MIL-T-81490	1011 attached compliance with
Concentrated Load	2 inch diameter / 50 pounds	2 inch diameter / 50 pounds	2 inch diameter / 50 pounds
Chemical Resistance	MIL-T-81490 using JP-6 fuel, hydraulic Fluid, Cleaner/Brightener, Epoxy Stripper	Test using Cleaner/Brightener (MIL-C-5410) Stripper, Epoxy (MIL-R-8129A)	N/A
Explosive Resistance	MIL-STD-810, Method 511, Procedure 1	N/A	N/A
Humidity	MIL-STD-810, Method 507	N/A	N/A
Salt Fog	MIL-STD-810, Method 509 (48 hours)		MIL-E-5272 (50 hours)

MIL-PRF-39012 Qualification Summary for Space Applications

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TEST DESCRIPTION	QUALIFICATION METHOD	TEST REQUIREMENT
Visual Inspection	Inspection, MSSI	MIL-C-17 Section 3.6 and II-218
Bendability	Test, MSSI	MIL-C-17 Section 3.7.21
Insulation Resistance	Test, MSSI	MIL-PRF-39012, Section 3.11 & STP-5295, Section 4.3
Dielectric Withstanding Voltage	Test, MSSI	MIL-PRF-39012, Section 3.17 & STP-5295 Section 4.2
Return Loss (VSWR)	Test, MSSI	MIL-C-17, Section 3.7.8 & STP-5295 Section 4.9
Insertion Loss	Test, MSSI	MIL-PRF-39012, Section 3.27 & STP-5295 Section 4.10
Mating Characteristics	Test, MSSI	MIL-PRF-39012 Section 3.7
Helium Leak Test	Test, MSSI	MIL-PRF-39012, Section 3.9 & STP-5295 Section 4.1
X-Ray	Test, Laboratory	MELCO Specification FPS652224 Table 4
Center Contact Resistance	Test, MSSI	STP-5295 Section 4.5
Vibration (random)	Test, Laboratory	MIL-STD-202 Method 214

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TEST DESCRIPTION	QUALIFICATION METHOD	TEST REQUIREMENT
Shock	Test, Laboratory	MIL-STD-202 Method 213, Condition F and MIL-PRF-39012 Section4.7.16
Return Loss (VSWR) Insertion Loss with Temperature	Test, MSSI	STP-5295 Section 4.9 and 4.10
Thermal Shock	Test, Laboratory	MIL-STD-202 Method 107 and MIL-PRF-39012 Section4.7.17
Return Loss (VSWR) Insertion Loss with Temperature	Test, MSSI	STP-5295 Section 4.9 and 4.10
Force to engage/disengage	Test, MSSI	MIL-PRF-39012 Section 3.5
Coupling Proof Torque	Test, MSSI	MIL-PRF-39012 Section 3.6
Permeability of nonmagnetic materials	Analysis	MIL-PRF-39012 Section 3.8
Return Loss (VSWR)	Test, MSSI	MIL-C-17, Section 3.7.8 & STP-5295 Section 4.9
Insertion Loss	Test, MSSI	MIL-PRF-39012, Section 3.27 & STP-5295 Section 4.10
Workmanship	Test, MSSI	MIL-PRF-39012 Section 3.30
Moisture Resistance	Test, MSSI	MIL-STD-202 Method 106 and MIL-PRF-39012 Section4.7.18

MIL-PRF-39012 Qualification Summary for Space Applications

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TEST DESCRIPTION	QUALIFICATION METHOD	TEST REQUIREMENT
Corona Level	Test, MSSI	MIL-PRF-39012 Section 4.7.19
RF High Potential Withstanding Voltage	Analysis	MIL-PRF-39012 Section 3.23
Cable Retention Force	Test, MSSI	MIL-PRF-39012 Section 3.24
Coupling Mechanism Retention force	Test, MSSI	MIL-PRF-39012 Section 3.25
Contact Resistance	Test, MSSI	MIL-PRF-39012 Section 3.16
Helium Leak Test	Test, MSSI	MIL-PRF-39012, Section 3.9 & STP-5295 Section 4.1
Microsection		MELCO Specification FPS652224 Table 5
Connector Durability	Test, MSSI	MIL-PRF-39012 Section 3.15
Helium Leak Test	Test, MSSI	MIL-PRF-39012, Section 3.9 & STP-5295 Section 4.1