CHAPTER 13 - CONNECTOR ASSEMBLY

13.1 General

1. Connectors shall be as specified on the engineering documentation. Supplemental processes applicable to connector assembly are as follows:

a. Conductors shall be assembled into crimp contacts in accordance with Chapter 12 of this Standard.

b. Conductors shall be assembled by soldering in accordance with the latest revision of NASA-STD-8739.3.

c. Connector backshells shall be potted and molded, or use stress relief boots as required, in accordance with applicable engineering documentation.

2. The mating surfaces of all unmated connectors shall be protected by covers during storage, handling, and installation of interconnecting cables and harnesses.

13.2 Assembly of Crimp-Type Connectors (Including Terminal Junctions)

1. Crimp contacts are assembled to conductors outside of the connector and are subsequently installed into the connector body. When a connector is properly assembled, contacts are captured inside the connector. Retaining clips are one means of securing contacts in place inside connector cavities. When retaining clips are present, contacts shall be fully seated and locked into place by the clip. Improperly seated contacts can "push back" causing intermittent and open circuits. In all instances, non-metal contact insertion and removal tools shall be used to prevent damage to connectors, contacts, or conductors.

CAUTION: ***ANY DAMAGED TOOL SHALL BE DISCARDED IMMEDIATELY AND REPLACED WITH A NEW TOOL. SHOULD PART OF THE TIP OF A TOOL BREAK OFF, ALL PIECES OF THE TIP SHALL BE ACCOUNTED FOR. IF ALL PIECES CAN NOT BE ACCOUNTED FOR, DOCUMENT THE INCIDENT AND THE RESPONSIBLE ENGINEERING AND/OR QUALITY REPRESENTATIVE SHALL BE NOTIFIED IMMEDIATELY.***

2. The installation of unwired contacts into an environmental connector is mandatory for high humidity and moisture environments and is optional for other applications. Terminal junctions shall not have unwired contacts installed in unused cavities. Plastic sealing plugs shall be used in all unwired contact cavities of environmental connectors.

13.3 Assembly of Solder-Type Connectors

Measures taken for stress relief of soldered connectors shall be sufficient to assure that all wire bending will take place in a flexible, unwicked part of the conductor. In all instances, stranded conductors will experience solder-wicking during attachment. The conductor will be rigid up to the point where the wicking stops and flexible beyond it. Wire movement concentrates stress at

the point where wicking stops, and normal harness handling can produce conductor fatigue and failure.

CAUTION: ***WHERE SOLDER CONTACTS HAVE FLOAT, FLUX MAY RUN DOWN ONTO THE MATING SURFACE OF THE CONTACT DURING SOLDERING. THIS CONTAMINATION CAN CAUSE INTERMITTENT CIRCUITS AND OPEN CIRCUITS WHEN CONNECTORS ARE MATED. ASSEMBLY SEQUENCES SHALL REQUIRE CLEANING OF CONTACT MATING SURFACES, THE SOLDER JOINTS, AND THE REAR SURFACES OF CONNECTORS AFTER SOLDERING OPERATIONS ON THESE TYPES OF CONNECTORS.***

13.4 Assembly of Hermetic and Environmental Connectors

Requirements for assembly of environmental and hermetic connectors are as follows:

1. **Hermetic Connectors**. Hermetic connectors provide for pressure sealing from one side of the connector to the other. These connectors are usually of the solder cup design. Solder connection requirements and accept/reject criteria shall be in accordance with the latest revision of NASA-STD-8739.3.

2. Environmental Connectors

a. **Sealing plugs.** Sealing plugs used in unwired contact cavities of environmental connectors shall be fully seated. In all instances, non-metal contact insertion and removal tools shall be used to prevent damage to connectors, contacts, or conductors.

b. **Grommet Sealing.** When a wire diameter is smaller than the grommet hole, the wire insulation diameter shall be increased by using heat shrinkable sleeving.

NOTE: ***CARE SHALL BE USED WHEN USING SHRINK SLEEVING. THE OUTER DIAMETER OF THE SLEEVING SHOULD BE SMALL ENOUGH TO ALLOW USE OF EXTRACTION/INSERTION TOOLS.***

13.5 Assembly (Torquing) of Adapters and Cable Clamps to Connectors

Adapters, cable clamps, and connector backshell tongs shall be torqued to connector bodies using calibrated tooling. During assembly (torquing backshells, securing cable clamps/tongs, etc.), strain relief members shall not be stressed or forced to rotate. Torque requirements shall be stated on the engineering documentation. Torque values shall be recorded by the responsible Quality Representative.

CAUTION: ***CARE SHALL BE EXERCISED WHEN POSITIONING AND TORQUING CONNECTOR BACKSHELL TONGS, STRAIN RELIEF CLAMPS AND OTHER STRAIN RELIEF MEMBERS. THE PROPER POSITIONING OF THESE DEVICES WILL PREVENT THE SHARP BENDING OF AND***

SUBSEQUENT DAMAGE TO HARNESSES DURING THEIR INSTALLATION OR OPERATIONAL USE.

13.6 Assembly of RF Connectors and Coaxial Contacts

Many types of RF connectors and coaxial contacts are available. Electrical performance, together with other considerations, affects the selection of the connector and coaxial cable. Depending on the requirements, assembly procedures vary from normal shop practice for cables operating at less than 1 gigahertz (GHz) to precision techniques for those operating up to 18 GHz. Generally, the following practices shall be observed:

1. The assembly shall be made in accordance with the connector manufacturer's instructions; however, many manufacturer's instructions are not adequate and may cause problems. See Appendix B for a discussion of frequently encountered workmanship problems.

2. Connectors shall not be modified.

3. Special tools necessary for the fabrication shall be specified on the assembly procedures.

4. Torque values, when applicable, shall be specified on the engineering documentation.

13.7 Process Controls for Two-Piece Crimp Rings and Stub-Type Splicing Devices

1. **Test Interval**. The crimp tools and crimped ring conductor(s) combination to be used in a production run shall be tested at the start and at the end of each work shift or production run, whichever is shorter. Test results shall be recorded and maintained for each crimp tool and crimped ring conductor(s) combination.

2. **Number of Test Samples**. A minimum of three test samples shall be prepared for each crimp tool and crimped ring conductor(s) combination, at the intervals specified in 13.7.1.

3. **Test Method**. The sample crimp rings and stub-type splicing devices shall be placed in a tensile-testing device with appropriate fixtures, and sufficient force shall be applied to pull each individual wire to the value specified in Table 13-1 without movement or pulling of the wire from the crimped ring or breaking of the wire or the crimped ring. The head travel speed of the tensile device shall be 25.4 $\pm$ 6.3 mm (1.0 $\pm$ .25 in) per minute. The holding surfaces of the tensile device clamp may be serrated to provide sufficient gripping and holding ability.

4. **Required Crimp Strength**. The tensile strength of the crimp test sample connections shall be in accordance with Table 13-1. For those crimped ring conductor(s) combinations not contained in Table 13-1, the tensile strength of the crimp connection shall be no less than 60 percent of the tensile strength of the wire.

5. **Examination of Test Samples**. Each individual test sample shall be inspected to the requirements of this document and the observations recorded and maintained.

Table 13-1. Pull Force 1/

Grounding Lead Wire Size		Applied Force Minimum Newtons (Pounds)	
AWG 24	Copper	36	(8)
AWG 22	Copper	57	(13)

1/ For wire sizes not listed, the minimum applied force shall be 60 percent of the tensile strength of the wire being pulled.

13.8 Inspection and Verification Testing

Inspection and verification of assembled connectors shall include, but not be limited to, the following tests and inspections:

1. **Visual Examination**. One hundred percent visual inspection shall be conducted for acceptable soldering, proper identification, and freedom from damage.

2. **Contact Seating**. Each contact in connectors utilizing retention clips or tines shall be push or pull tested 100 percent for seating. The results shall be recorded and shall be limited to one push test per contact insertion.

a. **Push Testing.** In applications in which the engaging (mating) ends of the pins or socket contacts are accessible, contact retention testing to the requirements of Table 13-2 shall be performed. Push testing shall utilize a tool that minimizes the possibility of accidental contact bending and applies a controlled, preset pressure to the contact before releasing the force. A typical tool design is shown in Figure 13-1. Socket testing probes shall be undersized compared to mating-pin diameters and shall not cause a mating cycle to take place.

Table 13-2. Contact Retention Test Forces

Contact sizes	Push Test Force (Newtons (Pounds)	Pull Test Force Newtons (Pounds) 1/, 2/
22, 22D and 22M	17.8 to 26.7 (4 to 6)	13.3 to 22.2 (3 to 5)
20	22.2 to 31.1 (5 to 7)	13.3 to 22.2 (3 to 5)
16	35.6 to 44.5 (8 to 10)	17.8 to 31.1 (4 to 7)
12	44.5 to 53.4 (10 to 12)	17.8 to 31.1 (4 to 7)

1/ Wire shall not be pulled to a force in excess of 80 percent of the specified minimum crimp tensile requirement. This requirement shall be met to avoid damage to the wire/contact crimp joint.

2/ These forces are based on wire size AWG 24. If smaller wire is used these values should be adjusted accordingly.

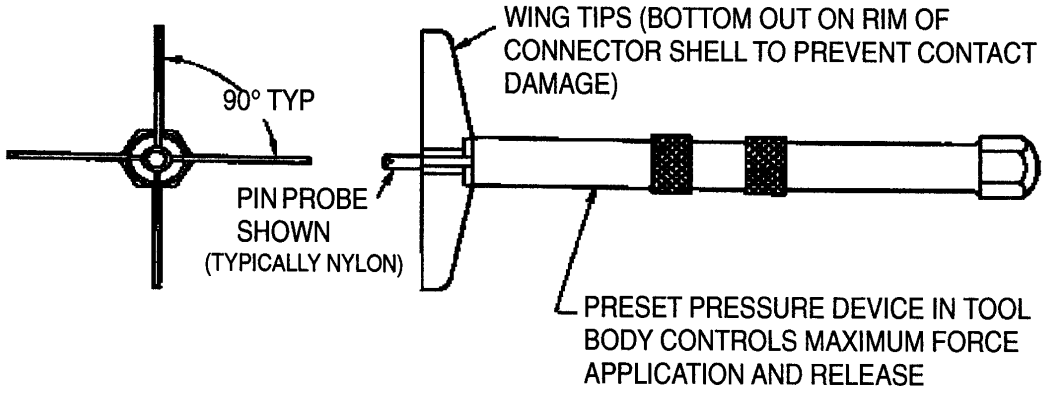

Figure 13-1. Typical Push Test Tool

b. **Pull Testing**. On terminal junctions and certain insertable crimp-contact connectors, contacts are not exposed for push testing. Pull force contact retention testing to the requirements of Table 13-1 shall be performed only on devices in which the contact engaging (mating) ends are not accessible. Pull force testing shall be performed by pulling on the wire terminated in the contact as illustrated in Figure 13-2. The wires to be pulled (except for shielded wire) shall be free of ties, cable clamps, or any wire-harness shielding devices within 127 mm (5 inches) of the terminal junction sealing grommet surface (see Figure 13-2). When the wire breakout to the terminal junction is less than 127 mm (5 inches) in length, then ties and clamps may be removed only to the point where the wires leave the main bundle. Pull the insulated wire perpendicular to the wire exit face of the connector device. Wire shall not be pulled to a force in excess of 80 percent of the specified minimum crimp tensile requirement. This requirement shall be met to avoid damage to the wire/contact crimp joint.

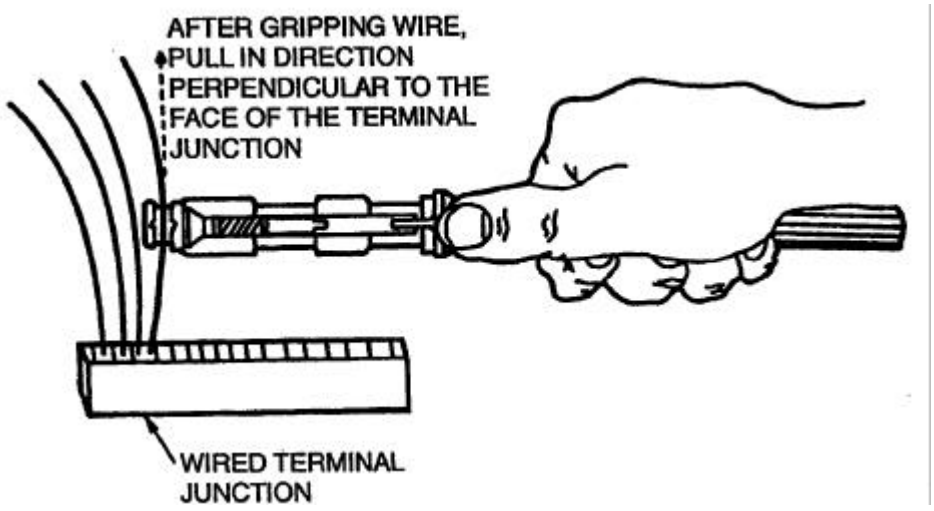

Figure 13-2. Application of Retention Tool for Gripping Wire (Typical)

NOTE: ***WHEN THE WIRE IS PULLED AT ANY ANGLE EXCEEDING 5° FROM THE PERPENDICULAR, THE CONTACT MAY BIND INSIDE THE CONNECTOR AND GIVE A FALSE READING.***

c. When a shielded wire is being pulled, the wire shall be gripped between the sealing grommet of the terminal junction module and the shield termination.

3. **Solder Contacts**. All solder contacts that have float shall be free of flux and other contamination and should be checked to assure they have normal float characteristics after soldering and cleaning.

4. **Coaxial Cable Requirements**. Coaxial cables shall pass electrical requirements (e.g., voltage standing wave ratio (VSWR), insertion loss, and other performance tests specified on the engineering documentation). Prior to assembly or installation, the following inspections shall be conducted, as appropriate.

a. Verify proper strip length and assembly of center conductor into contact.

b. Verify proper securing of the outer conductor.

c. Verify that the center contact location meets requirements for proper mating.

d. Visually verify undamaged condition of mating surfaces and coupling means.

5. Torque Verification. Verify that torque of connector backshells, strain relief clamps, etc., is as specified in the engineering documentation.

CHAPTER 14 - HARNESS IDENTIFICATION

14.1 General

The interconnecting cabling and wiring shall be identified and marked per the engineering documentation and the latest revision of NHB 1700.1(V1-B), NASA Safety Policy and Requirements Document.

14.2 Permanent Identification

The interconnecting cabling and wiring shall be provided with permanent identification. The following minimum requirements shall be used:

1. **Cable and Harness**. Each cable and each harness shall be permanently identified. The identification marking shall be capable of passing all environmental testing that may be required for the projected use and remain legible.

2. **Connectors**. Each connector shall be identified. The identification may be placed directly on the connector or on the cable near the connector. In all cases, identification shall resist abrasion, either as applied or with the aid of an overcoat.

3. **Temporary Identification**. All temporary identification shall be removed from each completed harness by the end of the fabrication process.

4. **Locating Tape**. Marking tape used to position and locate harnesses and cables may be either permanent or temporary in nature. Permanent type marking tapes shall meet environmental requirements.

14.3 Verification of Identification

Identification shall be verified visually by the responsible Quality Representative or designee for correctness, legibility, size, and proper location.

CHAPTER 15 - INTERCONNECTING HARNESS AND CABLE CLEANING

15.1 General

Interconnecting flight cable and harness assemblies shall be clean and free of contamination prior to installation on the spacecraft. Cleanliness shall be an ongoing effort. Practices for flight assemblies shall include assembly in a clean environment and the use of protective plastic sheeting or other coverings over harnesses not undergoing active assembly.

15.2 Cleaning the Harness Assembly

Particles and debris shall be cleaned from the harness or cable assembly by vacuum-removal methods. Brushing with solvent shall be used as required to remove other contamination. Only solvents as per paragraph 6.9 shall be used.

15.3 Cleaning Harness Connectors

The following cleaning procedures shall be used with connectors:

1. For solder-type connectors, flux rundown into the mating part of socket contacts shall be removed. Solvent cleaning by brushing may be used. Contact surfaces of pins, sockets, and connector bodies shall be free of flux residue (see Figure 15-1), solder splash, metal flakes, moisture, and other contaminants that may jeopardize the integrity of the connector system.

2. Crimp-type multipin and coaxial electrical connectors shall be solvent-cleaned by brushing before assembly to the harness or unit cable. Contact surfaces of pins and sockets and the interior surfaces of the connector shall be free of contaminants.

3. The internal surfaces of dust covers and connector covers shall be cleaned by solvent brushing before the covers are fitted onto cleaned connectors.

4. If necessary, connectors that were subjected to frequent mating and demating operations during fabrication and test shall receive additional cleaning prior to the final mating. Visual examination of the contact surfaces of connectors shall not reveal the presence of contaminants such as metal flakes or large dust particles. If required, additional cleaning shall be performed by vacuum removal methods and solvent-brushing.

15.4 Cleaning Coaxial Connectors (Assembled)

Coaxial connectors shall not have accumulated contaminants such as metal flakes, dirt, moisture, and other foreign materials. The connector interface shall be cleaned by brushing with solvent, vacuum procedures, or a combination thereof until the contaminants have been removed.

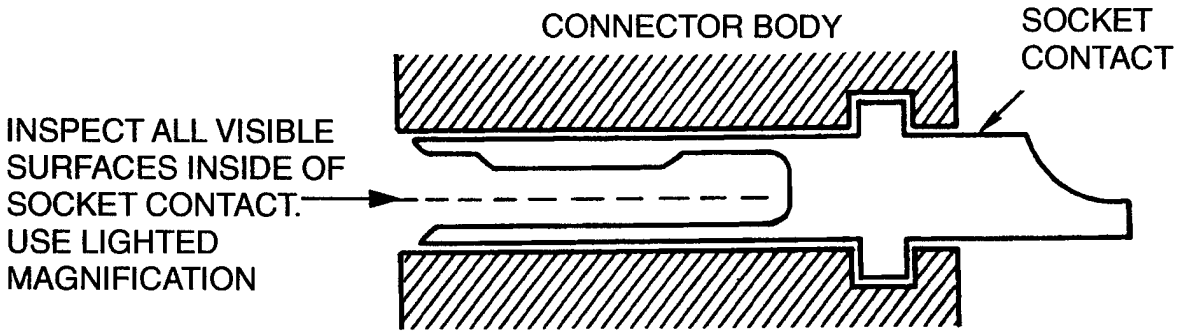

Figure 15-1. Visual Examination Inside the Socket Contact for Flux Residue

CHAPTER 16 - INTERCONNECTING HARNESS AND CABLE HANDLING AND PROTECTION

16.1 General

Interconnecting harnesses and cables often receive their maximum stresses when they are moved, handled, or installed in their permanent locations. Harnesses shall be handled with considerable care and attention.

16.2 In-Process Protection

Harnesses and cables shall be protected during fabrication as follows:

1. Keep a large harness mounted on its own wiring board until final inspection.

2. Protect all connectors, cables, and harnesses not on a wiring board or fixture by wrapping individually in bubble wrap or an approved clean cushioning material and placing them in a sealed plastic bag or equivalent.

3. Harnesses that are not being worked on shall have appropriate protection.

4. Protect all unmated connectors with clean dust covers (connector caps).

16.3 Completed Interconnecting Harness and Cable Storage Protection

Completed harnesses and cables shall be protected as follows:

1. Wiring harnesses may either be stored on the wiring board or otherwise protected.

2. Overstressing and excessive flexing of wires shall be avoided during connector cleaning and mating/demating operations. This is especially important for solder-type connectors.

3. All unmated connectors (including test equipment) shall be protected with clean dust covers (connector caps) when not in use. After the cleanliness of the connector has been verified visually, it shall be protected with a clean dust cover until it is ready for final mating.

4. Protect all connectors, cable, and harnesses by wrapping them individually in bubble wrap or an approved clean cushioning material and placing them in a sealed plastic bag or equivalent.

CHAPTER 17 - CONNECTOR MATING

17.1 General

Although most electrical connectors are considered to be durable, each of them has a finite life. During testing and system checkout, certain connectors may be subject to frequent mating and demating. When this situation exists, wear and potential damage can be reduced by the use of ”connector-savers". Connector-savers transfer the wear from the flight connector to nonflight jumper harness connectors. It also prevents uncontrolled (and possibly damaged) test equipment connectors from mating directly with the cable or harness assembly connectors. Any connector, including connector savers, mating with flight hardware shall be in accordance with engineering documentation.

17.2 Connector Mating and Demating

The following practices and precautions shall be exercised in mating and demating connectors:

1. Prior to connector mate/demate operations, verify that the circuit has been de-energized.

2. Examine connectors for contamination, pin, and shell damage prior to mating.

3. All flight qualified, ac/dc power interface and test equipment connectors that mate with flight and support equipment connectors shall be protected against damage and contamination during mating and demating operations, and when they are in a demated condition.

4. Caution shall be applied to mating and demating operations to preclude damage to connectors. In some cases a demating tool may be utilized.

5. Harness connectors mated to test tees or breakout boxes shall be provided with stress relief to restrict flexing of connectors and cables.

6. Mate/demate operations between the flight hardware, support equipment connectors, system test equipment, and also in final assembly shall be performed by authorized personnel only.

7. The use of connector savers is recommended. A connector saver can be a short harness jumper that has a mating interface connector to engage the unit. The other end of the harness has the same interface as the unit. Connector savers shall be clearly marked. Connector savers shall meet the same requirements as a flight connector.

8. Interfacial seals, which are not bonded to the connector shall be examined and, if necessary, replaced with new, clean seals prior to final mating.

9. When required, a log of mate and demate operations and a bent pin log shall be kept for flight connectors.

10. Flight connectors shall be torqued as specified on engineering documentation.

11. Electrostatic discharge (ESD) protective caps shall be installed on exposed connectors of harnesses that are attached to ESDS hardware.

17.3 Coaxial Connector Mating

The final mating of coaxial connectors shall be done using the torque values given in Table 17-1. When mating coaxial connectors, the cable assemblies shall be held such that only the connector coupling is rotated.

CAUTION: ***THERE SHOULD BE NO RELATIVE MOTION OF THE CABLES OR THE CONNECTOR BODIES WHILE THE CONNECTOR IS BEING TORQUED.***

Table 17-1. Mating Torque Values for Coaxial Connectors

Connector Type	Coupling Nut Torque Newton-Meters (Inch-lbs)	Coupling Nut Torque Newton-Meters (Inch-Ounces)
SMA	0.8 to 1.1 (7 to 10)	
PRECISION TNC	0.9 to 1.4 (8 to 12)1/	
TNC	0.5 to 0.7 (4 to 6)	
N	0.7 to 1.1 (6 to 10)	
SMC		0.3 to 0.4 (35 to 50)
PRECISION N	0.9 to 1.4 (8 to 12)1/	

1/ Typical values. Use manufacturer's recommendations if different.

CHAPTER 18 - TESTING AND INSPECTION

18.1 General

Completed interconnecting harnesses and cables shall be verified as meeting all applicable functional, electrical, and design requirements. Visual examination and electrical testing shall be performed as required.

18.2 Testing

1. Acceptance testing shall be conducted on all interconnecting cable and harness assemblies immediately following fabrication.

2. All acceptance testing shall be conducted in accordance with test procedures approved by the procuring Agency prior to use.

3. Records of all acceptance testing shall be complete and shall be traceable to the cable or harness assembly being tested.

4. Adapter cables, breakout boxes, and/or connector savers shall be used to conduct any and all electrical tests on interconnecting cable and harness assemblies. Hand probes shall not be used directly in the cable or harness connectors.

5. At a minimum, the electrical acceptance tests on potted-type connectors shall be performed immediately before the potting operation and after final assembly.

6. Acceptance testing, at a minimum, shall include the following tests which shall be performed in the order listed:

a. **Continuity.** Interconnecting cable and harness assemblies shall be tested for point-to-point electrical continuity.

b. **Dielectric Withstanding Voltage (DWV).** The interconnecting cable or harness assembly shall withstand the application of 1050 $\pm$ 50 volts Root Mean Square (RMS), 60 Hz or 1500 $\pm$ 75 Vdc, but shall not exceed the maximum rating of the connector. Leakage current shall not exceed 1 milliampere when applied voltage is maintained for not more than 1 minute. The test potential shall be applied for at least 5 seconds at a rate of no less than 500V per second until the desired test potential is reached. The test potential shall be applied between the following: (1) each conductor and all other conductors in the cable or harness assembly; (2) each conductor and connector shell; (3) each conductor and shield; (4) between shields; and (5) between shield and connector shell/ground, except when shields are connected to ground. For the dc test, the time of application of the test potential may be reduced to the time required for steady state current to be established. There shall be no evidence of electrical breakdown or arc-over. Following the testing, the connectors shall be visually inspected for degradation due to the test.

NOTE: ***CABLE OR HARNESS ASSEMBLIES WITH A LARGE CAPACITANCE, (E.G., LONG RUNS GENERALLY OVER SIX FEET , A LONG CABLE, OR A HARNESS INCORPORATING SHIELDING) SHOULD BE TESTED USING THE DC POTENTIAL OPTION TO AVOID ERRONEOUS INDICATIONS OF FAILURE.***

c. **Insulation Resistance (IR).** The insulation resistance between each conductor and all other conductors, between each conductor and shield, and between each conductor and connector shell, between shields, and between shields and connector shell/ground except when shields are connected to ground shall be greater than 100 megohms at an applied voltage of 500 + 50Vdc for a minimum of 1 minute, or as specified in the test procedure.

7. Coaxial cable assemblies shall be given appropriate dielectric withstanding voltage (DWV), insertion loss, Voltage Standing Wave Ratio (VSWR), and time domain reflectrometry (TDR) testing in accordance with and as specified in the engineering documentation.

8. Post installation testing shall be performed to assure that individual wire conditions have not been degraded by installation operations. The post installation test requirements shall be those continuity, DWV, and IR tests required by paragraph 18.1 or as directed and specified on the approved engineering documentation. The tests shall be performed after installing the cables or harness in place, but before mating connectors.

WARNING: ***OPERATORS SHALL USE APPROPRIATE SAFETY PRECAUTIONS WHEN WORKING WITH HIGH VOLTAGES.***

CHAPTER 19 - QUALITY ASSURANCE PROVISIONS

19.1 General

1. **Workmanship**. Workmanship shall be of a level of quality adequate to assure that the processed products meet the performance requirements of the engineering documentation and criteria delineated herein.

2. **Inspection**. Inspection for acceptability shall be performed. Conductors shall not be physically disturbed to aid inspection. Inspections shall be made at appropriate points during assembly, at the completion of assembly, and after installation to establish that the appropriate requirements have been met. Inspection may include visual inspection, mechanical measurements, electrical testing, and other methods as deemed necessary. Inspection and testing points shall be specified on the applicable planning documents.

3. **Method of Inspection**. Visual inspection of all connections shall be performed in-process and after final assembly, as appropriate.

4. **Quality Assurance**. Quality Assurance has the responsibility to verify compliance with all requirements of this document. Specific functions are as follows:

a. Verify that all tests, inspections, and measurements, including contact retention tests, specified by this document have been performed.

b. Verify that all personnel who assemble or inspect hardware in accordance with this document have been trained and certified as specified in Chapter 5 of this Standard.

c. In-process surveillance of all assembly operations to verify that all processes and procedures implementing the requirements of this document are current, approved, adequate, and being properly implemented.

d. Verify that contacts, connectors, and conductors have been inspected prior to being assembled.

e. Verify and monitor that the facility cleanliness, environmental conditions, and lighting requirements of Chapter 6 of this Standard are being met.

f. Verify and monitor that fabrication of assemblies is accomplished in a contamination controlled area conforming to the requirements approved by the procuring activity.

g. Verify and monitor that procedures defining cleaning, drying, handling, and packaging are approved and their requirements are followed.

h. Verify that all torque requirements are met.

i. Inspect that crimp terminations are in accordance with Chapter 12 of this Standard.

j. Inspect that connector solder cup terminations are in accordance with NASA-STD-8739.3.

k. Inspect that solder sleeve terminations were fabricated and installed as directed by engineering documentation.

l. Verify installation processes and acceptance/rejection criteria for solder sleeve termination devices were defined and approved.

m. Verify that other processes such as potting and molding, necessary to fabricate a cable or harness, are defined by the engineering documentation and approved. This shall include accept/reject criteria.

19.2 Magnification Aids

Inspection optics shall conform to the requirements of paragraph 6.7. Visual inspection shall be aided by magnification between 4X and 10X. Additional magnification shall be used, as necessary, to resolve suspected anomalies or defects.

19.3 Documentation Verification

Quality Representatives shall verify that all required documentation is current and approved. The documentation shall include:

1. Records:

   a. Results of the visual examination as per paragraph 5.2-1.

   b. Evidence of operator and inspector certification as per paragraph 5.5.

   c. Production and inspection tool calibration as per paragraph 6.3.

   d. Tensile testing as per paragraphs 12.3.4 and 13.7.5

   e. Torque requirements as per paragraph 13.5.

   f. Contact retention test records as per paragraph 13.8.2

   g. Connector mate/demate log and bent pin log as per paragraph 17.2-9.

   h. Results of all acceptance testing as per paragraph 18.2-3.

2. Procedures:

   a. Cabling and harnessing program as per paragraphs 4.4 and 5.1.

   b. Training and certification program as per paragraph 5.4-3.b.

   c. Tooling and equipment operation as per paragraph 6.3-1.e.

   d. Calibration system as per paragraph 6.3-2.c.

   e. Electrostatic Discharge Control Program as per paragraph 6.4.

   f. In-process storage and handling as per paragraph 6.5.

   g. Compounds and special design requirements used for staking of lacing knots as per paragraph 9.2.

h. Acceptance testing for cable and harness assemblies as per paragraph 18.2-2.

19.4 Documentation Authorization.

Quality Representative shall verify that the following documentation has been approved by the procuring NASA Center prior to implementation:

1. Special engineering requirements as per paragraph 1.1-2.
2. Nonstandard processes, materials, or parts as per paragraph 4.1-3.
3. Departures from this Standard as per paragraph 4.2.
4. Repair as per paragraph 4.5-2.
5. Engineering documentation for special tools as per paragraph 6.3-3.
6. Special solvents as per paragraph 6.9.
7. Acceptance test procedures as per paragraph 18.2-2.

19.5 Verification of Tools, Equipment, and Materials

1. **Tools and Equipment.** Tools and equipment shall be verified for conformance to the applicable requirements found in paragraphs 6.3, 6.6, and 12.3. Verify that special tooling is identified on assembly procedures as per paragraph 13.6-3.

2. **Material**. All materials shall conform to the requirements of paragraphs 6.8 and 6.9. Material controls shall be implemented to ensure that only conforming materials are used. Materials not conforming or not required for the operations involved shall be removed from the work area or tagged nonusable.

19.6 Inspection Criteria

1. **Acceptance Criteria**. Acceptance criteria are described in Chapters 1 through 18, Appendix A and the following:

a. Stripped Conductor:

(1) The insulation shall be uniform and shall exhibit no damage except slight discoloration when thermal strippers have been used.

(2) The conductor shall be clean and free from damage. Strands shall be twisted together in the original lay, or as nearly as possible to the original lay.

(3) Shield strands shall be clean. The number of nicked shield strands shall not exceed 10 percent of the total number of strands.

(4) Flat conductors shall be clean and free of damage.

b. Shield Terminations:

(1) Shield terminations shall be free of projecting strands.

(2) The wire insulation and shrink sleeving shall be free of punctures, cuts, and nicks.

(3) Metal crimp rings/ferrules are tightly and symmetrically crimped.

(4) The solder inside the solder sleeve shall show evidence of proper flow and fillet to the ground wire and shield braid.

(5) The solder sleeve may exhibit discoloration.

(6) The insulation sleeving shall be uniformly shrunk and provide proper covering of the termination.

(7) Solder sleeves are as specified in the engineering documentation.

(8) The solder fillets along the interfaces shall have a smooth, concave appearance.

c. Crimped Connections:

(1) Contact deformed only by tool indentations.

(2) Crimp indents properly located in the correct area of the contact.

(3) Wire strands visible in inspection hole of barrel.

(4) Metal ferrules tightly and symmetrically crimped.

(5) The clearance between the wire insulation termination and the crimp contact barrel is between .25mm (.01 in) to .75mm (.03 in) for wire sizes AWG 20 and smaller, and .25mm (.01 in) to 1.25mm (.05 in) for wire sizes AWG 18 and larger.

d. Cable and Harness Ties:

(1) Properly tied clove hitch and square or other non-slip knot.

(2) Correct and uniform spacing of ties for bundle size.

(3) Correct material as specified on the engineering documentation.

(4) Lacing terminated with a closing stitch and ends trimmed.

(5) No damage to or contaminants on the tie or adjacent wiring.

(6) Strap or tie properly secures wire bundle.

e. Cable and Harness Assemblies:

(1) Connectors are not damaged.

(2) Pin/sockets meet retention force requirements and are not damaged.

(3) Even distribution of tension throughout cable and harness.

(4) Length of wire twist is between 8 and 16 times the outer diameter of the harness.

(5) Cable and harness ties are properly spaced.

(6) Clamps are properly placed.

(7) Cable and harness are not distorted by ties or clamps.

(8) Minimum crossover.

(9) Proper bend radius of breakouts.

(10) Proper identification.

(11) All exposed metal is covered as defined on the applicable drawing.

(12) Heat shrinkable sleeving or nonconductive tape extends at least 5.1 mm (0.2 inch) beyond exposed metal.

(13) Sleeving is uniformly shrunk.

(14) Sleeving is free of cracks, punctures, and charred or burned areas.

(15) Location of shield terminations on wire as per engineering documentation.

(16) Braid is terminated properly.

(17) Cable or harness dimensions and configurations are in accordance with engineering documentation.

(18) Cable or harness is clean.

(19) Unused wires properly terminated.

(20) Routing does not expose cables and harnesses to abrasion, cold flow, or cut-through.

(21) Spiral sleeving with plastic straps are installed correctly.

(22) Protective separator applied over wire bundle beneath metal braid shielding, if required.

(23) Connector back shells and strain relief clamps are tightened as specified by engineering documentation.

(24) High strength copper alloy is used for AWG 24 and smaller conductors.

(25) Proper handling and protection.

f. Coaxial Cables:

(1) Proper strip length and assembly of center conductor into contact.

(2) Proper securing of outer conductor.

(3) Center contact location meets requirements for proper mating.

(4) Mating surfaces and coupling means are undamaged.

(5) Connector back shells and strain relief clamps are tightened as specified by the engineering documentation.

g. Solder Sleeves:

(1) The solder shall be visible through the insulation sleeving.

(2) The solder fillets along the interfaces shall have a smooth, concave appearance.

(3) Solder sleeves shall not be damaged. Slight discoloration resulting from the heating process is permissible.

(4) Solder sleeves shall cover all exposed metal in the spliced area.

(5) There shall be no protruding wire strands from under or through solder sleeves.

2. **Rejection Criteria**. The following are unsatisfactory conditions and shall be cause for rejection:

a. Stripped Conductor:

(1) Damaged, crushed, cut, or charred insulation.

(2) Nicked, gouged, damaged, or severed conductors.

(3) Frayed conductor strands.

(4) Severed shield braid strands.

b. Shield Terminations:

(1) Loose or projecting strands.

(2) Nicked shield strands exceeding 10% of the total number of strands.

(3) Wire insulation with cuts, punctures, or crushing.

(4) Metal ferrules crimped with improper alignment.

(5) Cracked, charred, or split insulation sleeving.

(6) Cracked or fractured solder.

(7) Insufficient solder or poor wetting.

(8) Improper sleeving coverage.

c. Crimped Connections

(1) Metal ferrules crimped with improper alignment.

(2) Cracks in crimp barrel.

(3) Birdcaging of conductor.

(4) Wire strands not visible in inspection hole.

(5) Peeling or flaking of plating on contact.

(6) Damaged or deformed crimp contact.

(7) Crimp indents not located in the correct area on the contact.

(8) Tarnished, corroded, or contaminated crimp contact.

(9) Improper insulation clearance.

(10) Insulation whiskers that extend into the crimp barrel.

d. Cable and Harness Ties:

(1) Improperly laced ties.

(2) Incorrect material.

(3) Wire bundle damaged or deformed by tie.

(4) Loose ties.

(5) Ends not trimmed.

(6) Damaged or contaminated ties or wiring.

(7) Incorrect spacing of ties for bundle size.

(8) Improper handling or protection.

e. Cable and Harness Assemblies:

(1) Projecting strands on shield terminations.

(2) Wire insulation with cuts, punctures, or crushing.

(3) Metal ferrules crimped with improper alignment.

(4) Cracked, charred, or split insulation sleeving.

(5) Improper sleeving coverage.

(6) Birdcaging of conductor.

(7) Peeling or flaking of plating on connectors or pins/sockets.

(8) Damaged or deformed contacts.

(9) Damaged insulation in excess of slight discoloration.

(10) Tarnished, corroded, or contaminated contact.

f. Coaxial Cables:

(1) Improper strip length and incorrect assembly of center conductor into contact.

(2) Improper securing of outer conductor.

(3) Center contact location does not meet requirements for proper mating.

(4) Damaged mating surfaces and coupling means.

(5) Connector back shells and strain relief clamps are not tightened as specified by the engineering documentation.

g. Solder Sleeves:

(1) The solder connection is not visible through the insulation sleeving.

(2) Solder fillet(s) having an uneven and broken flow and/or a convex appearance.

(3) Solder fillet not visible at the interfaces of the stranded wire to shield braid, or stranded wire to stranded wire.

(4) Solder fillet is along only one side of the stranded wire to shield braid, or stranded wire to stranded wire interface.

(5) Solder sleeves do not cover all the metal exposed by the splice installation.

(6) Solder sleeves are split, burned, or damaged.

(7) Wire strands protrude from under or through solder sleeves.