CABLE AND HARNESS
GENERAL REQUIREMENTS

Often the most overlooked and ignored component of any electrical / electronic design, cables and harnesses are essential to the accurate and rapid transmission of data and control signals.

PREFERRED
POLARIZATION / KEYING
Interconnecting cables and harnesses shall be designed with physical constraints (keying, sizing, polarization, etc.) to prevent incorrect mating / interchanging with similar sized / colored connectors.

NASA-STD-8739.4 [ 7.1 ]

PREFERRED
RIBBON CABLE
The cable assembly meets dimensional, layout, and design requirements and exhibits a smooth, flat profile, with no visible damage to the connectors or the insulation. Connectors are properly aligned and seated.

Best Workmanship Practice

PREFERRED
SHIELD TERMINATION - FLOATING
Heat shrink tubing is properly installed, tightly shrunk, and the termination is visible. Overlaps are of sufficient length to meet minimum electrical spacing.

NASA-STD-8739.4 [ 9.8.1 ], [ 9.9 ], [ 11.5 ], [ 19.6.1 ]

PREFERRED
SHIELD TERMINATION - GROUNDED
Heat shrink sections are properly installed, tightly shrunk, and the termination is visible. Overlaps meet minimum electrical spacing. Ground wire exhibits proper bend radius and strain relief.

NASA-STD-8739.4 [ 7.3.22 ], [ 9.8.1 ], [ 9.9 ], [ 11.5 ], [ 19.6.1 ]

ACCEPTABLE
SPOT TIES
Spot ties shall consist of a clove hitch, followed by a square or other similar non-slip knot (i.e.: surgeon, etc.).

NASA-STD-8739.4 [ 9.2.2 ]

ACCEPTABLE
BACKSHELL ASSEMBLY
Connector backshells, adapters, and clamps shall be assembled and torqued per engineering documentation.

NASA-STD-8739.4 [ 13.5 ]
CABLE AND HARNESS
GENERAL REQUIREMENTS (cont.)

ACCEPTABLE
BACKSHELL SCREW PROTRUSION
Screws shall protrude a minimum of 1-1/2 threads beyond the threaded hardware (e.g., nut, clamp, etc.), but shall not violate minimum electrical spacing or snag requirements, unless otherwise specified by engineering documentation. Best Workmanship Practice

UNACCEPTABLE
EXCESSIVE THREAD PROTRUSION
Excess thread protrusion represents an assembly, interference, and electrical separation problem, as well as adds unnecessary weight to the assembly. Best Workmanship Practice

ACCEPTABLE
BREAKOUT DRESS W/ FABRIC BRAID
Braiding shall be dressed to form a smooth profile across the breakout. Braiding shall not be split, slit, or punctured to provide a breakout opening. NASA-STD-8739.4 [ 9.3 ]

UNACCEPTABLE
SPLIT / SLIT BRAIDING AT BREAKOUT
Braiding shall not be split, slip, or punctured to provide an opening at the breakout. NASA-STD-8739.4 [ 9.3 ]

ACCEPTABLE
CABLE LACING
RUNNING STITCH
The lacing begins and ends with a knot. Wraps are properly spaced (relative to harness diameter) to maintain the wiring in a tight, neat bundle. Ends are properly trimmed. NASA-STD-8739.4 [ 9.2 ]

ACCEPTABLE
CABLE LAYUP
Cables containing discrete conductors shall be fabricated in one or more layers, by winding the conductors together uniformly. Layup (twist) of each layer shall be 8-16 times the outer harness diameter. NASA-STD-8739.4 [ 7.3.20 ], [ 19.6.1.e.4 ]

CABLE AND HARNESS
GENERAL REQUIREMENTS (cont.)

UNACCEPTABLE
BREAKOUT DRESS W/ FABRIC BRAID
Braiding shall be dressed to form a smooth profile across the breakout. Braiding shall not be split, slit, or punctured to provide a breakout opening. NASA-STD-8739.4 [ 9.3 ]

UNACCEPTABLE
SPLIT / SLIT BRAIDING AT BREAKOUT
Braiding shall not be split, slip, or punctured to provide an opening at the breakout. NASA-STD-8739.4 [ 9.3 ]

PREFERRED
DISCRETE WIRE HARNESSES
Harnesses exhibit a neatly organized layout, with smooth bends and sufficient stress relief. Connectors shall be straight, right-angle, or flange-mount. The use of right-angle connectors shall be minimized and restricted to applications where stress-free mounting of the cable assembly can be assured. Best Workmanship Practice

NASA WORKMANSHIP STANDARDS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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HOUSTON, TEXAS USA 77058

Released: 04.05.2002
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Page: 4
### Cable and Harness General Requirements (Cont.)

#### Acceptable Cable Lacing Spots Ties

Ties are neat, tight, and properly spaced (relative to harness diameter) to maintain the wiring in a tight, neat bundle. Ends are properly trimmed.

*NASA-STD-8739.4 [9.2.2]*

#### Unacceptable Loose Cable Lacing

The lacing has not been properly installed, resulting in a loose, unorganized bundle.

*NASA-STD-8739.4 [19.6.2.d.4]*

#### Acceptable Cable Straps / Ties

Plastic straps should have metal tangs that lock securely into the ribbed portion of the strap.

*NASA-STD-8739.4 [7.3.4]*

#### Acceptable Conductor Dress

All wires are dressed with even bends and sufficient strain relief. Conductor crossover is minimized.

*NASA-STD-8739.4 [19.6.1.e]*

#### Unacceptable Trimmed Cable Ties

The strap end shall be trimmed off, flush with the back end of the strap head.

*NASA-STD-8739.4 [9.6.1.e.5]*

#### Acceptable Cable Ties / Tie Wraps

The cable ties / tie wraps are sufficiently tight to prevent lateral movement along the cable bundle under normal handling, but can be rotated in place. Strap ends have been trimmed off square and flush with the face of strap head.

*NASA-STD-8739.4 [9.6]*

#### Unacceptable Untrimmed Cable Ties

The strap end shall be trimmed off, flush with the back end of the strap head.

*NASA-STD-8739.4 [9.6]. [19.6.2.d.5]*

### NASA Workmanship Standards

**National Aeronautics and Space Administration**

**Johnson Space Center**  
**Houston, Texas USA 77058**

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Acceptable Identification
Each cable / harness shall be identified by a permanent label / marking. Each connector shall be identified by a permanent label / marking affixed directly to the connector body, or to the cable adjacent to the connector.

NASA-STD-8739.4 [14.2.1, 14.2.2]

Acceptable Insulation Wrap
Non-conductive tape / insulation wrap may be used in applications in which the use of heat-shrinkable tubing is impractical. Tape and wrapping materials shall be installed per engineering documentation. Best Workmanship Practice

NASA-STD-8739.4 [9.7]

Acceptable Overall Harness Shielding
An overall braided metallic shield provides mechanical and electrical protection (EMI/RFI) to the harness. Metallic shielding shall exhibit a smooth and tight finish, with a uniform distribution of coverage and no projecting strands.

NASA-STD-8739.4 [11.1.3]

Acceptable In-Line Splice
The splice exhibits a smooth profile, proper strain relief, and is located in an area of the harness not subjected to flexure.

Best Workmanship Practice

Acceptable Connector Savers
The use of connector savers is recommended. Connector savers shall meet the same requirements as a flight connector.

NASA-STD-8739.4 [17.2.7]

Acceptable Fabric Braided Sleeving
Prewoven fabric (unvarnished) braid sleeving may be installed over the wire harness. Sleeving shall be snug, secured at both ends, and shall not slide freely. Ends shall be not be frayed or unraveled, and shall be tucked under.

NASA-STD-8739.4 [9.3.4]

Acceptable Fabric Braided Sleeving Alternate End Dress
The end of the braid may be secured by connector clamps, other hardware, or potting.

NASA-STD-8739.4 [9.3.2]

Acceptable Metal Braid Sleeving
Metal braid sleeving may be installed over harnesses by either direct weave or by use of prewoven tubing. An insulation / separation layer shall be installed between the harness and the metal braid.

NASA-STD-8739.4 [9.7]

Acceptable Polyimide / Nylon Braid Sleeving Hot Knife Sealing
Polyimide or nylon braids (for use on ground support equipment) may have their ends sealed by use of a "hot knife" or similar instrument.

NASA-STD-8739.4 [9.3.4]

Acceptable Discoloration / Scuffing Connector
Slight scuffing or discoloration is acceptable, provided there is no impact to form, fit, or function, and there is no exposure of base metal.

Best Workmanship Practice

NASA-STD-8739.4 [19.6.2.e.9]

Acceptable Discoloration / Scuffing Insulation
The cable does not exhibit evidence of insulation damage, such as cuts, nicks, scrapes, crushing, cold flow, or burns. Slight scuffing or discoloration is acceptable.

NASA-STD-8739.4 [9.4]

Acceptable Fabric Braided Sleeving
Prewoven fabric (unvarnished) braid sleeving may be installed over the wire harness. Sleeving shall be snug, secured at both ends, and shall not slide freely. Ends shall be not be frayed or unraveled, and shall be tucked under.

NASA-STD-8739.4 [9.3]
### Cable and Harness General Requirements (cont.)

#### Acceptable Solder Sleeve Termination
The solder sleeve has been properly installed and tightly shrunk. Overlaps are of sufficient length to meet minimum electrical spacing. Solder fillet is visible, fully flowed, and smooth.

**NASA-STD-8739.4 [19.6.11.4]**

#### Unacceptable Solder Sleeve Termination
The solder sleeve has not been completely shrunk and is improperly positioned, resulting in a poor fit that does not provide a good mechanical grip or seal, and which does not meet minimum overlap requirements.

**NASA-STD-8739.4 [9.8.1], [9.11]**

#### Acceptable Solder Sleeve Termination
The shield and drain wire have been properly terminated, per engineering documentation.

**NASA-STD-8739.4 [19.6.11.2]**

#### Acceptable Spiral Wrap sleeving
Spiral wrap shall be tight, uniformly spaced, and shall not overlap. Ends shall be trimmed to eliminate sharp edges.

**Note:** Spiral wrap shall not be used on spacecraft or launch vehicles.

**NASA-STD-8739.4 [9.5]**

#### Acceptable TIE / WRAP Spacing at Breakout
Lacing or tie wraps have been placed on both sides of the harness breakouts. Ties are neat and tight.

**NASA-STD-8739.4 [9.6]**

#### Acceptable Shield / Drain Wire
The shield and drain wire have been properly installed and tightly shrunk. Strain relief is acceptable.

**NASA-STD-8739.4 [11.4]**

#### Acceptable UNIFORM CONDUCTOR TENSION
The conductors exhibit uniform tension throughout the length of the harness. No bunching, bowing, looping, kinks, etc.

**NASA-STD-8739.4 [19.6.1.e.3]**

#### Acceptable UN-used / Spare Conductors
Unused or spare conductors shall be terminated by folding the unstripped end back on itself and then sealed with insulation sleeving or wrap. Conductor ends shall be secured to prevent unwanted movement, protrusion, or snagging.

**NASA-STD-8739.4 [19.6.1.e.19]**

#### Acceptable Damage Connector
Damage to the connector (i.e.: cuts, gouges, cracks, deformed features, bent pins, exposed base metal, etc.).

**NASA-STD-8739.4 [19.6.1.e.1]**

#### Acceptable Exposed Power Contacts
Active signal / live voltages shall be confined to connectors with sockets to preclude the exposure of voltage points when the connector is disconnected.

**NASA-STD-8739.4 [7.3.18]**

#### Acceptable Splice Assembly Profile
The location of splices shall be staggered to minimize the increase in profile to the harness. Final assembly profile shall not impact form, fit, or function.

**Best Workmanship Practice**

#### Acceptable Strain Relief
The cable (shielded / unshielded) should be dressed to ensure that the strain relief mechanism transfers structural stresses from the connector to the cable sheath (or strength member) rather than to the individual conductors.

**Best Workmanship Practice**

#### Unacceptable Damage, Insulation
Damage to the cable jacket, ribbon, or conductor insulation (i.e.: cuts, pinching, nicks, scrapes, crazing, crushing, cold flow, exposed conductors, punctures, thinning, or burns).

**NASA-STD-8739.4 [19.6.2.e.9]**

#### Unacceptable Exposed Power Contacts
Active signal / live voltages shall be confined to connectors with sockets to preclude the exposure of voltage points when the connector is disconnected.

**NASA-STD-8739.4 [7.3.18]**

**NASA Workmanship Standards**

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CABLE AND HARNESS
GENERAL REQUIREMENTS (cont.)

UNACCEPTABLE
IMPROPER BEND RADIUS
The harness exhibits a bend radius that is less
than the minimum recommended for the
conductor type(s) used and overall harness
diameter.
NASA-STD-8739.4 [ 7.3.21 ]

UNACCEPTABLE
IMPROPER CABLE TIE / WRAP TENSION
Cable tie / wrap tension is too loose, allowing
lateral movement along the cable bundle under
normal handling.
NASA-STD-8739.4 [ 19.6.2.d.4 ]

UNACCEPTABLE
IMPROPER CABLE TIE / WRAP TENSION
Cable tie / wrap tension is too high, resulting in
def ormation and pinching of the wire insulation.
NASA-STD-8739.4 [ 19.6.2.d.3 ]

UNACCEPTABLE
IMPROPER LACING KNOT
The cable lacing has been secured with a bow-
 knot, rather than a square / non-slip knot. This tie
may eventually loosen.
NASA-STD-8739.4 [ 19.6.2.d.4 ]

UNACCEPTABLE
IMPROPER ROUTING
Cables and harnesses shall be routed so that
they are protected from abrasion, cold flow, cut
through, vibration, chafing, flexing, and sharp
edges.
NASA-STD-8739.4 [ 7.3.14 ]

UNACCEPTABLE
IMPROPER SPlice GAUGE / SIZE
Replacement conductors shall be of the same
voltage and current rating as the original
conductor.
Best Workmanship Practice

UNACCEPTABLE
IMPROPER CABLE TIE / WRAP TENSION
Cable tie / wrap tension is too high, resulting in
def ormation and pinching of the wire insulation.
NASA-STD-8739.4 [ 19.6.2.d.3 ]

ACCEPTABLE
SPLICE / SOLDER SLEEVE RESTRAINT
Cable ties / lacing shall be installed at both ends
of a splice or solder sleeve, but placement shall
not violate stress relief requirements.
Best Workmanship Practice

UNACCEPTABLE
SPLICE / SOLDER SLEEVE RESTRAINT
Cable ties / lacing shall not be installed across
the splice / solder sleeve body, unless sufficient
protection is provided to prevent compression
damage to the termination and/or to the insulation
of adjacent conductors.
Best Workmanship Practice

ACCEPTABLE
STRESS RELIEF
Wires exiting from the connector shall be stress
relieved.
NASA-STD-8739.4 [ 7.3.22 ]

UNACCEPTABLE
INSUFFICIENT STRESS RELIEF
The placement of cable ties / straps shall not
negate strain relief in cables or harnesses.
Best Workmanship Practice

UNACCEPTABLE
TIE / WRAP SPACING
Cables and harnesses shall be routed so that
they are protected from abrasion, cold flow, cut
through, vibration, chafing, flexing, and sharp
edges.
NASA-STD-8739.4 [ 7.3.14 ]

UNACCEPTABLE
INCORRECT TIE SPACING
Ties are neat, light, and properly spaced (relative
to harness diameter) to maintain the wiring in a
tight, neat bundle.
NASA-STD-8739.4 [ 9.2 ], [ 19.6.1.e.5 ]

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### CABLE AND HARNESS
#### GENERAL REQUIREMENTS (cont.)

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<thead>
<tr>
<th>UNACCEPTABLE</th>
<th>IMPROPER TERMINATION</th>
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<tr>
<td>Solder and/or crimped terminations that do not meet the requirements of NASA-STD-8739.3 and/or NASA-STD-8739.4 shall be cause for rejection.</td>
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<td>NASA-STD-8739.4 [ 13.1 ]</td>
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<th>UNACCEPTABLE</th>
<th>INCOMPLETE COVERAGE OF METAL Braid</th>
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<tr>
<td>Metal braid sleeving shall exhibit uniform coverage, to provide electrical and mechanical protection to the underlying harness.</td>
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<tr>
<td>NASA-STD-8739.4 [ 19.6.2.b.8 ], [ 19.6.2.e.5 ]</td>
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<tr>
<th>UNACCEPTABLE</th>
<th>INCORRECT LACING MATERIAL</th>
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<td>Waxed lacing shall not be used for spaceflight applications.</td>
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<td>NASA STD-8739.4 [ 19.6.2.d.2 ]</td>
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<tr>
<th>UNACCEPTABLE</th>
<th>PROJECTING SHIELD STRANDS</th>
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<tr>
<td>The shield strands have been improperly dressed, resulting in projecting strands that may result in an electrical short or sharp object (puncture / snag) concern.</td>
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<tr>
<th>UNACCEPTABLE</th>
<th>SPLICES IN FLEXURE ZONE</th>
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<td>Splices shall not be installed in areas where the harness is designed to flex.</td>
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<th>UNSEALED ENVIRONMENTAL CONNECTOR</th>
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<td>Sealing plugs or unused pins shall be installed in all unwired / unused holes to retain the environmental rating of the connector.</td>
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