AEROSPACE INFORMATION REPORT

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Superseding AIR4004

Guide for Installation of Electrical Wire and Cable on Aircraft Landing Gear

RATIONALE

This SAE Aerospace Information Report (AIR) provides information and criteria updates to reflect the latest standards used in wire, connector, and conduit selection and requirements for brackets, clamps, and other auxiliary components typically used to dress the landing gear. The report also includes a comprehensive list of the related documents to easily search for more information outside the scope of this document.

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1. SCOPE

Recent field experience has indicated significant problems with some types of wire and cables as routed on aircraft landing gear. This SAE Aerospace Information Report (AIR) is intended to identify environmental concerns the designer should consider, materials that appear to be most suitable for use in these areas, routing, clamping, and other protection techniques that are appropriate in these applications. In recent years aircraft certification regulatory agencies introduced new regulations regarding Electrical Wiring Interconnection Systems (EWIS) to further enhance safety of the associated systems and aircraft overall.

1.1 Purpose

This document is to be used as a general reference for the aerospace community.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS1431	Compound, Solid Runway and Taxiway Deicing/Anti-Icing
AMS1435	Fluid, Generic, Deicing/Anti-Icing Runways and Taxiways
AMS-T-81914	Tubing, Plastic, Flexible, Convoluted, Conduit, General Specification for
ARP914	Glossary of Electrical Connection Terms
AIR1221	Electromagnetic Compatibility (EMC) System Design Checklist
AIR1329	Electrical Connectors and Wiring, Compatibility of
AIR1394	Cabling Guidelines for Electromagnetic Compatibility
ARP1481	Corrosion Control and Electrical Conductivity in Enclosure Design
ARP1870	Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety
ARP1931	Glossary of Terms with Specific Reference to Electrical Wire and Cable
ARP1972	Recommended Measurement Practices and Procedures for EMC Testing
ARP4043	Flight Line Grounding and Bonding of Aircraft
ARP4242	Electromagnetic Compatibility Control Requirements Systems
AS4372	Performance Requirements for Wire, Electric, Insulated Copper or Copper Alloy

AS4373	Test Methods for Insulated Electric Wire
ARP4404	Aircraft Electrical Installations
AIR4567	Composite Electrical Connectors
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP4761	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
AIR4789	Aerospace Information Report on Evaluating Corrosion Testing of Electrical Connectors and Accessories for the Purpose of Qualification
AS4851	Relative Thermal Life and Temperature Index for Insulated Electric Wire
ARP5062	Recommended Test Fluids for Electrical Components Used on Aircraft Exterior or for Ground Support Near Aircraft
ARP5412	Aircraft Lightning Environment and Related Test Waveforms
ARP5413	Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
ARP5414	Aircraft Lightning Zone
ARP5415	User's Manual for Certification of Aircraft Electrical/Electronic Systems for the Indirect Effects of Lightning
ARP5416	Aircraft Lightning Test Methods
AS5419	Cable, Thermocouple Extension, Shielded and Unshielded
ARP5577	Aircraft Lightning Direct Effects Certification
ARP5583	Guide to Certification of Aircraft in a High-Intensity Radiated Field (HIRF) Environment
AIR5919	Alternatives to Cadmium Plating
AS6451	Shields, Protective, Aircraft and Missiles
AS8700	Installation and Test of Electronic Equipment in Aircraft General Specification for
AS21608	Ferrule, Shield Terminating, Crimp Style
AS21919	Clamp, Loop Type, Cushioned Support
AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
AS23190	Wiring, Positioning, and Support Accessories
AS25064	Conduit, Flexible, Radio Frequency Shielding
AS25065	Ferrule, Flexible Conduit, Radio Frequency Shielding
AS25067	Conduit Assembly, Flexible, Radio Frequency Shielding

AS29600 Connectors, Electrical, Circular, Miniature, Composite, High Density, Quick Coupling, Environment Resistant, Removable Crimp Contacts Associated Hardware, General Specification For

AS39029 Contacts, Electrial Connector, General Specification for

ARD50055 Aircraft Electrical Systems

AS50151 Connectors, Electrical, Circular Threaded, AN Type, General Specification For

AS50881 Wiring Aerospace Vehicle

AS81044 Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarlyene Insulated, Copper or Copper Alloy

AS85049 Connector Accessories, Electrical General Specification For

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM F2639-07 Standard Practice for Design, Alteration, and Certification of Airplane Electrical Wiring Systems

ASTM F2696-08 Standard Practice for Inspection of Airplane Electrical Wiring Systems

ASTM F2799-09 Standard Practice for Maintenance of Airplane Electrical Wiring Systems

2.1.3 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

2.1.4 NEMA Publications

Available from National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, VA 22209, Tel: 703-841-3200, www.nema.org.

WC27500 Standard for Aerospace and Industrial Electrical Cable

2.1.5 AIA Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NAS1713 Clamp, Loop, Cushioned, Center Mounting

2.1.6 U.S. Government Publications

Copies of these documents are available online at http://quicksearch.dla.mil.

MIL-DTL-16878 Wire, Electrical, Insulated, General Specification for

MIL-DTL-25038 Wire, Electrical, High Temperature, Fire Resistant, and Flight Critical

MIL-DTL-26482 Connectors, Electrical (Circular, Miniature, Quick Disconnect, Environment Resisting), Receptacles and Plugs, General Specification for

MIL-DTL-26500	Connectors, General Purpose, Electrical, Miniature, Circular, Environment Resisting, General Specification for
MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification For
MIL-DTL-83413	Connectors and Assemblies, Electrical, Aircraft Grounding, General Specification for
MIL-DTL-83413/8D	Connectors and Assemblies, Electrical, Aircraft Grounding: Type IV Jumper Cable Assembly, Lead, Electrical
MIL-DTL-83454	Terminal, Stud, Blind Plate, For Electrical Bonding and Grounding (Noninsulated)
MIL-DTL-83723	Connectors, Electrical, (Circular, Environment Resisting), Receptacles and Plugs, General Specification for
MIL-HDBK-274	Electrical Grounding for Aircraft Safety
MIL-HDBK-454	General Guidelines for Electronic Equipment
MIL-STD-202	Test Method Standard, Electronic and Electrical Component Parts
MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-464	Electromagnetic Environmental Effects, Requirements for Systems
MIL-STD-470	Department of Defense Handbook, Designing and Developing Maintainable Products and Systems
MIL-STD-704	Aircraft Electrical Power Characteristics
MIL-STD-810	Department of Defense Test Method Standard, Environmental Engineering Considerations and Laboratory Tests
MIL-STD-882	Standard Practice for System Safety
MIL-STD-889	Dissimilar Metals
MIL-STD-1560	Insert Arrangements for MIL-DTL-38999, MIL-DTL-27599 and MIL-C-29600 Series A Electrical Circular Connectors
MIL-STD-7080	Selection and Installation of Aircraft Electric Equipment
MIL-STD-464	Electromagnetic Environmental Effects Requirements for Systems

2.1.7 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

Sections applicable to landing gear wiring:

Part 23	Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes
Part 25	Airworthiness Standards: Transport Category Airplanes

Part 25, subpart H, sections 25.1701 through 25.1733 and sections H25.4 and H25.5 (Appendix H)	
Part 27	Airworthiness Standards: Normal Category Rotorcraft
Part 29	Airworthiness Standards: Transport Category Rotorcraft
AC 20-53	Protection of Aircraft Fuel Systems against Fuel Vapor Ignition due to Lightning
AC 20-136	Protection of Aircraft Electrical / Electronic Systems Against the Indirect Effects of Lightning
AC 20-155	SAE Documents to Support Aircraft Lightning Protection Certification
AC 20-158	The Certification of Aircraft Electrical and Electronic Systems for Operation in the High Intensity Radiated Fields (HIRF) Environments
AC 25-16	Electrical Fault and Fire Prevention Protection
AC 25-26	Development of Standard Wiring Practices Documentation
AC 25-27	Development of Transport Category Airplane Electrical Wiring Interconnection Systems Instructions for Continued Airworthiness Using an Enhanced Zonal Analysis Procedure
AC 25.869-1A	Fire Protection: Systems
AC 25.899-1	Electrical Bonding and Protection Against Static Electricity
AC 25.1353-1A	Electrical Equipment and Installations
AC 25.1357-1A	Circuit Protective Device Accessibility
AC 25.1360-1	Protection Against Injury
AC 25.1362-1	Electrical Supplies for Emergency Conditions
AC 25.1363-1	Electrical System Tests
AC 25.1365-1	Electrical Appliances, Motors, and Transformers
AC 25.1701-1	Certification of Electrical Wiring Interconnection Systems on Transport Category Airplanes
AC 43.13-1B	Acceptable Methods, Techniques, and Practices - Aircraft Inspections and Repair
AC 65-15A	Large Aircraft Airframe and Powerplant Mechanics Handbook
ANM-01-04	System Wiring Policy for Certification of Part 25 Aircraft
PS-ACE100-2004-10023	Final Policy Statement for Flammability of Electrical Wire used in Part 23 Aircraft per 14 CFR, Part 23, §§ 23.853 and 23.1359
PS-ANM100-2002-00070	Electrical Systems and Equipment
PS-ANM111-2002-01-04	System Wiring Policy for Certification of part 25 Airplanes
PS-ANM100-1993-00054	Revision of Multiple Burst Lightning Environment

ASW-2001-01 Certification Guidelines for Compliance to the Requirements for Electro-Magnetic Compatibility (EMC) Testing for “Equipment Known to Have a High Potential for Interference” when Installed on Rotorcraft with Electronic Controls that Provide Critical Functions

2.1.8 EASA Publications

Available from European Aviation Safety Agency, Postfach 10 12 53, D-50452 Cologne, Germany, Tel: +49-221-8999-000, www.easa.eu.int.

CS-23 Certification Specifications for Normal, Utility, Aerobatic, and Commuter Category Aeroplanes

CS-25 Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes

CS-27 Certification Specifications for Small Rotorcraft

CS-29 Certification Specifications for Large Rotorcraft

CS-25 BOOK 1, SUBPART H Electrical Wiring Interconnection System (EWIS) and associated Acceptable Means of Compliance (AMC)

2.2 Definitions

Table 1 - Wire insulation and tubing material acronym list

Acronym	Material
EPDM	Ethylene Propylene Diene Monomer Rubber
ETFE	Ethylene TetraFluoroEthylene
ECTFE	Ethylene ChloroTriFluoroEthylene
FEP	Fluorinated Ethylene Propylene
PFA	Perfluoro Alkoxy Alkene Polymer
PTFE	Polytetrafluoroethylene

3. LANDING GEAR ENVIRONMENT

The landing gear environment is very severe for electrical wire and cable. The designer should keep in mind that the wire and cable routed on landing gear will be subjected to:

a. Wind speeds up to 300 knots - This wind force may cause stretching or vibration (commonly referred to as banjo stringing) of the wire and cable.

b. Moisture due to runway spray and rain.

c. Alkali metal salts used as runway and taxiway deicers.

d. Salt water and ship’s stack gasses in case of ship based aircraft.

d. Aircraft cleaning, including cleaning with chemicals and cleaning with high pressure using water or pressure spray that may or may not be rinsed.

e. Ultraviolet spectrum radiation.

f. Mechanical impact forces due to spin-up/down, high sink rate landing, catapult launches and arrested landings, arresting cable slap, carts loading stores, tie-down chains, debris from failed tires and wheels, tools used to work on the landing gear, and mechanical hand tools, or possible use of the harness as a handhold or step during maintenance.

g. Runway grit, ship deck nonskid abrasives, dirt, sand, and gravel from unpaved landing surfaces - similar debris thrown up by jet exhaust or rotor wash or VSTOL exhaust plumes.

h. Hydraulic fluid, grease, and fuel leaks, including hydrazine, plus carbon dust from carbon brakes.

i. High pressure water cleaning and deicing fluids.

j. Temperature ranges from -67 °F (-55 °C) to maximum temperatures created by brake heat inside a closed wheel cavity.

k. Electromagnetic radiation effects including exposure to radiated electromagnetic fields, direct and indirect lightning, precipitation static, and potential for interference from landing gear electrical components to aircraft radio sensors due to generally unobstructed exposure.

l. Altitude vacuum effects.

m. Lining dust containing iron, copper, graphite, etc., from sintered linings used on steel brakes.

n. Thermal cycling between ambient temperatures while on the ground and temperatures in the air.

o. Severe vibrational environment associated with the landing gear.

p. Fatigue and/or abrasion damage due to landing gear kinematics.

q. Articulation and compression of the landing gear and associated components.

4. COMPONENTS RECOMMENDED FOR USE ON LANDING GEAR

4.1 General

The materials selected for use, e.g., of wire, cable, tubing, and clamps used on landing gear should possess the following properties:

a. Capable of operation in temperatures from -67 to 250 °F (-55 to 121.1 °C) except in the area around the brake where the operational temperature range may be higher (up to 350 °F (176.7 °C) for 10 minutes); here the materials should not be degraded by whatever local temperatures may be created by brake heat.

b. Good tensile strength and flex properties to sustain wind loads, vibration, and gear operation. Stranded conductors with twisted lay should be used where continuous flexing is going to occur.

c. Resistant to high pH aircraft cleaning solutions, hydraulic oil, greases, carbon dust from carbon brakes, and fuels.

d. Resistance to ultraviolet spectrum radiation.

e. Mechanically tough to resist impact and cut-through, such as chaffing due to interference with landing gear structure).

f. Insulation material properties should not allow solid particle adhesion (i.e., carbon brake dust).

g. Non-degrading with time, ozone and moisture.

h. Reliable and maintainable products.

i. Design practices/materials that can provide protection from the direct effects from lightning.

j. Resistant to corrosive AMS1431 and AMS1435 runway and taxiway deicers.

4.2 Wire and Cable

Choice of wire and cable used in landing gear applications should conform to the following guidelines:

a. Wire size:

- 18 gauge minimum - Single wire.
- 20 gauge minimum - Twisted 2- or 3-wire cable.
- 22 gauge minimum - Twisted, shielded, and jacketed multi-wire cable.
- 24 gauge minimum - Basic wire is suitable with a break strength of 20 pounds minimum and certified for landing gear applications in supportive conduit, semi-breathing harness designs. Size 24 and smaller gage wires should not be installed as a single wire and should be twisted, double shielded and jacketed. Care should be taken to select connectors with appropriate grommet seal sizes.

b. Wire material: High strength copper alloy, nickel, or tin plated wire materials are preferred. Thermocouple wire should be compatible with the thermocouple type used for brake temperature sensing, with sympathetic material contacts for connectors. Flexibility and vibration should be addressed in selection of wire material, in addition to wire material strength properties.

c. Many high strength copper alloy conductors and coaxial cables use silver plating. Contamination of silver plated conductors with glycol (de-icing fluid) can result in electrical fire. Accordingly, you should not use silver plated conductors in areas where de-icing fluid can be present unless suitable protection features are employed. Silver plated conductors and shields can exhibit a corrosive condition (also known as ‘Red Plague’) if the plating is damaged or of poor quality and is exposed to moisture. Designers should be aware of these conditions. See CS-25 Book 2 AMC for subpart H, and I for additional information.

d. In general, thin-wall insulations (classified as hookup wire in AS50881 should not be used unless insulation specification and material properties are suitable for the particular application (i.e., current and voltage ratings).

e. Insulation materials not subject to degradation by humidity, moisture, high pH cleaning solution, aircraft hydraulic fluids, greases and fuels, and sunlight/ultraviolet should be selected; in general, PFA, PTFE, FEP, and ETFE insulation materials will not be affected. flexible homogeneous polytetrafluoroethylene-types are preferred over lightweight, multiwall, stiff, and springy constructions when used with rigid metallic conduits. Dual wall insulations provide improved resistance to cracks and split propagation and it should be considered in flexible areas or where prone to actions resulting in nicks and indentation. Arc tracking should be considered in selection of insulation materials.

f. Resistance to impact and cut-through damage along with good flex life would be added desirable properties for wire and cable insulations.

g. Capable of rated performance from -67 °F (-55 °C) to temperatures created by brake heat inside a closed wheel cavity.

h. Polyimide type insulations (e.g., MIL-DTL-81381) are not suitable for use in this application. Polyimide type insulation used in conjunction with PTFE in composite insulations (e.g., AS22759/182) are permitted.

i. In the event of high voltage (as used in electric brake applications) a "guard" may be required. (A guard is a heavy conductive sheathing that is grounded and found under the outer insulation material. If there is no other barrier, like conduit, then the guard provides safety from cut or burn through to the high voltage (shorting the high voltage).)

j. Selection of materials, to the maximum practicable extent, should account for the direct lightning effects environment.

k. The proper grounding methods of shields should be considered (see ARP1870).

l. Consideration should be given to equipment and criticality of data corruption or failure when exposed to the direct and indirect effects of lightning.

m. Consideration should be given to maintenance (dormant electrical integrity failures) of electrical bonds and value of visual inspections of electrical wiring, insulation and shielding.

n. Adverse effects of corrosion to bonds should be considered in the wiring material selection.

o. Selection of materials should account for the EMI/HIRF environment. Shielded wire may be required, depending on the system safety and aircraft certification requirements. Stainless steel over braid and conduit provide very little protection to electromagnetic effects unless properly grounded. Metal braid can also corrode, especially if it is sheathed in a layer, which could retain water. Nickel plated copper braid is most effective for electrostatic shielding from high frequency signals. However, its mechanical protection is poor, so it requires additional mechanical protection (i.e., ECTFE braid).

p. Continued airworthiness of the installation/wiring protection is required for landing gear electrical systems performing safety critical functions (i.e., braking, WOW indication, etc.) and detailed guidelines are provided in AC 25-26 and AC 25-27.

q. Wire routing should avoid designs with excessive bending radii, to avoid interference with landing gear and structural interface components in tightly packed landing gear bays. However, the minimum bend radius consideration in section 5c should also be considered in parallel.

r. Harness design should provide appropriate separation (i.e., high power and low voltage wiring) to minimize the possibility of hazardous effects upon the airplane or its systems. Whenever possible, the preferred separation is by a physical distance. Alternatively, the separation by a barrier can be used if it provides the same level of protection, but EMI protection must be verified.

4.3 Protective Tubing (Conduit)

Protective tubing (conduit) for wire and cable routing in landing gear area should be used when possible. Typical examples are shown in Figures 1 through 4. The following guidelines are offered for optimum performance:

a. Use rigid metallic conduit for maximum protection.

b. When using flexible conduit, it should have good flex properties from -67 °F (-55 °C) to temperatures created by brake heat inside a closed wheel cavity. Commercially available reinforced convolute is preferred. This provides necessary impact and cut-through resistance from flying debris and loading cart impact. Thin wall convoluted tubing used by itself is inadequate and should not be used.

c. Consider the use of convoluted tubing with an outer wire helix to increase crush resistance or to decrease the minimum bend radius of the tubing without collapsing. However, the possible need to inspect the harness should be considered.

d. Resistance to humidity, moisture, high pH cleaning solutions, aircraft hydraulic fluids and grease, de-icing fluids, sunlight/ultraviolet, nick and cut propagation, and degradation due to aging. Nick and cut propagation resistance is aided by the use of homogenous insulations.

e. Drain holes should be provided in intentionally semi-breathing harnesses where fill factors necessitate a void. They should be located at the bottom of drip loop bends (i.e., backshell adaptors) in both retracted and extended positions of the gear to ensure no dead ends trap fluid and cause freezing of accumulated moisture with subsequent wire breakage. Consideration should be given to alternate approaches, where landing gear harnesses do not utilize drip loops, and the backshells are not necessarily at the bottom (especially in the retracted position). Alternative approaches for landing gear wiring exist that do not require semi-breathing harnesses.

f. Typical wiring schemes run down struts, terminating at weight-on wheel switches, downlock switches, truck position sensors, tire pressure transducers, anti-skid wheel speed sensors, landing lights, taxi lights, carrier approach lights, nose wheel steering system components, towing indication systems, and launch bar sensors. Special attention should be given to the sequence for buildup (production and field repair) of convoluted tubing and switchback/connector shrink tubing. Water running down these wires inside the convoluted tubing should not become trapped at these terminating points. The low point of the convoluted tubing should not be encased by braid, tape, or shrink tubing to ensure that moisture escapes from the convoluted tubing; otherwise, the moisture is channeled down to the connector area (see Figure 4). The benefits of removal of shrink tubing at the top to allow moisture to vent should be weighed against the influx of water from the system thru this entry point. Design should consider design practices that are currently showing acceptable results in service for landing gear wiring schemes relating to water buildup. Consideration should be given to design approaches where the connector backshell sealing methods eliminate condensation paths to the connector.

g. Tubing minimum radius of bend should not be less than specified by the manufacturer or military specification nor less than the minimum bend radius for the wiring contained inside.

h. To eliminate tubing deformation by clamps, use fiberglass or metal adaptors (fittings) at the clamp area or clamps with convoluted cushions that conform to the tube convolute.

i. Tubing I.D. should consider total wire and cable inside and allow for freedom of movement without binding. The diameter of the wire and cable should not be greater than 80% of the tubing I.D. Fill factors less than 80%, e.g., 60% should be considered in long harnesses with complex routing to allow for removal or replacement of a single wire. Wire ties or lacing should be avoided inside conduits, especially in high vibration or flexing areas. If necessary, it is recommended that PTFE filler-tubing be added to achieve the recommended 80% fill to help dampen wire vibration which can cause damage to wire insulation from adjacent wires or conduit convolutions.

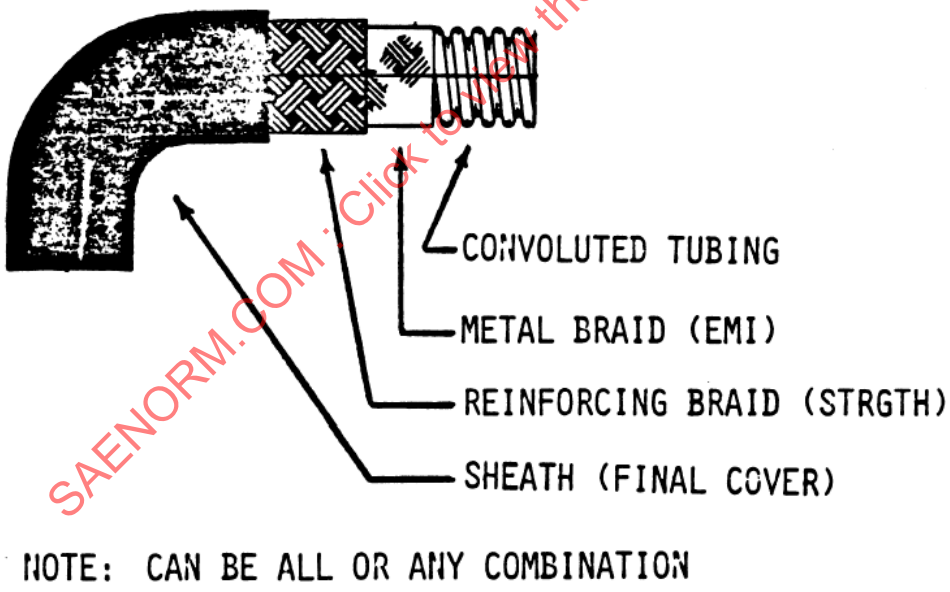

Figure 1 - Typical protective covering

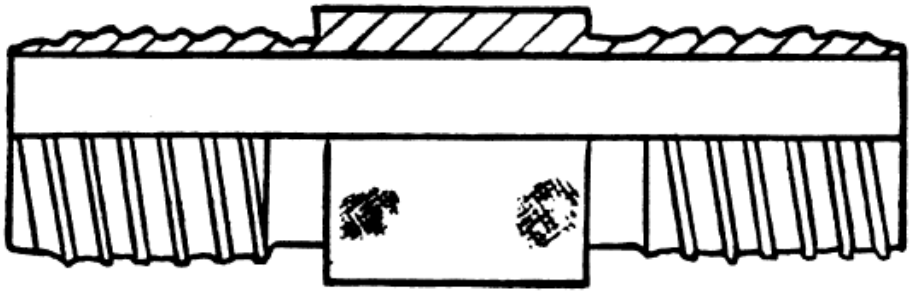

Figure 2 - Typical clamp adaptor

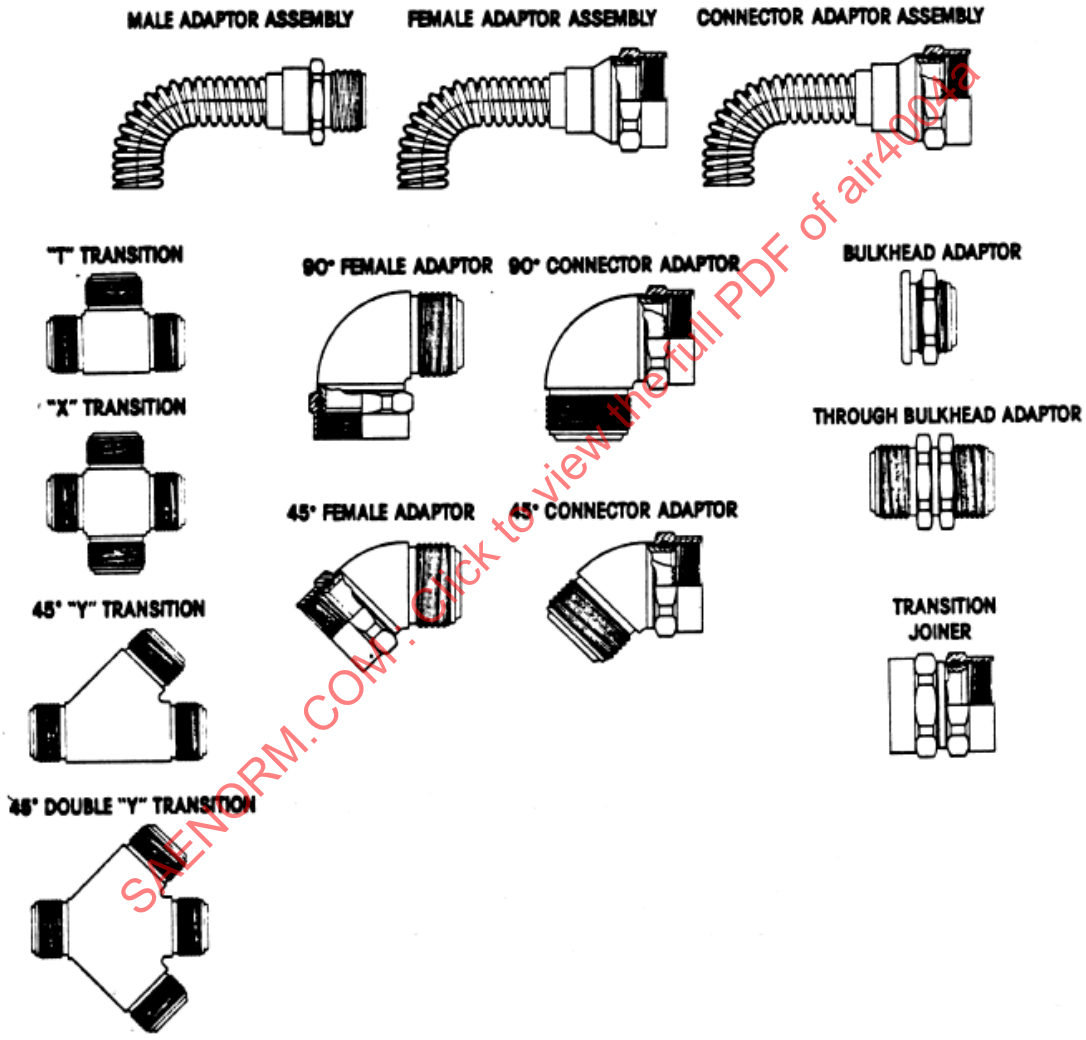

Figure 3 - Typical adaptors and transitions

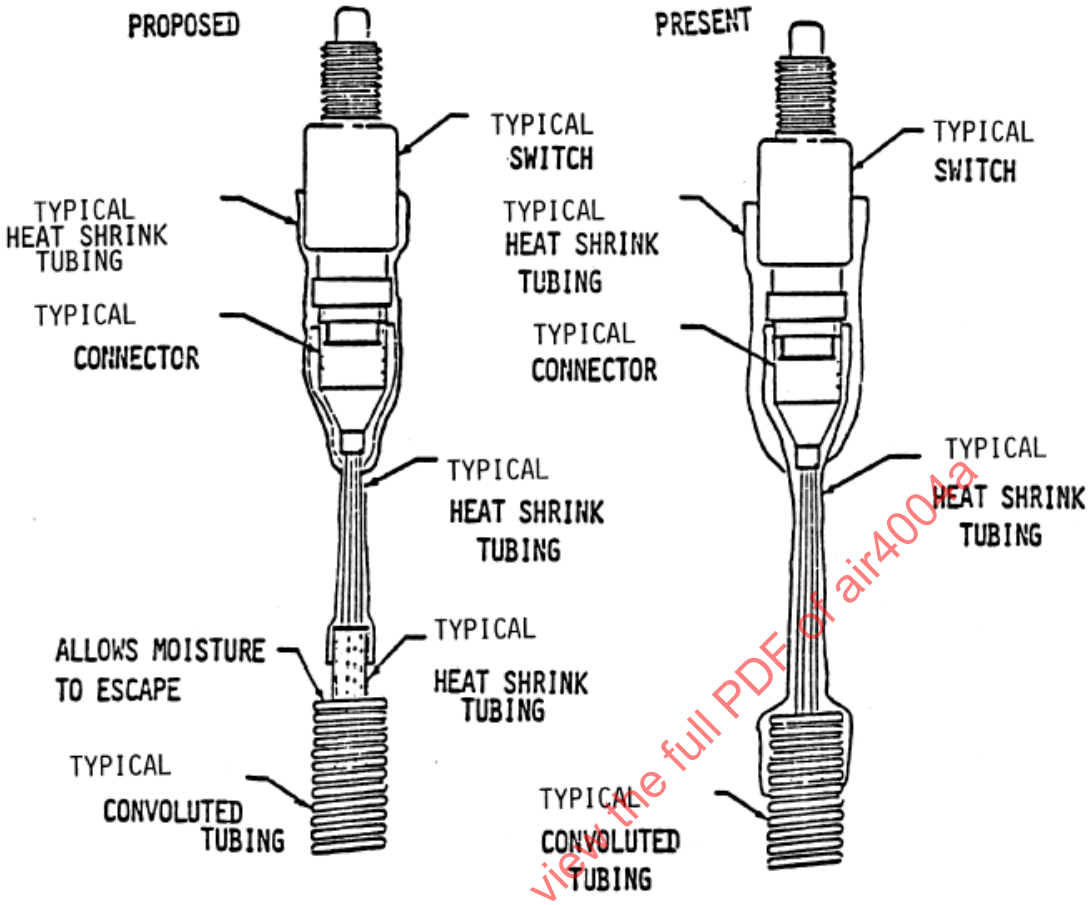

Figure 4 - Example of change to improve service life by elimination of trapped moisture

j. Use of pull-cords or pull-wires is recommended inside of conduits to aid in wire removal or replacement.

k. Typical tubing materials would be PFA, PTFE, FEP, ETFE, Kevlar, aluminum, and stainless steel qualified to salt spray specification requirements in excess of 48 hours and unsusceptible to de-icing fluids.

l. Typical tubing braid material would be plated copper, stainless steel, nickel phosphor bronze, NOMEX©, or Dacron©.

m. Typical sheath coverings would be Hypalon©, neoprene, EPDM, Dacron©, NOMEX©, FEP, ETFE, PFA, and silicone.

n. In commercial applications, typical rigid tubing materials are stainless steel and aluminum.

o. Where tubing termination is at a connector, an adaptor should be used to secure the tubing to the connector backshell. If the connector is strain relieved, the tubing should be terminated at the strain relief clamp. Use a convoluted bushing under the convoluted tubing at the clamp area.

p. Where branches are required, a transition adaptor should be used to accommodate the branch.

q. When EMI protection is required, a metal braided tubing provides improved shielding efficiency depending on whether a single metal braid, double metal braid, or foil is used. The proper bonding methods should be considered (see ARP1870).

r. AMS-T-81914 should be used as an additional guide for selection and use of tubing in landing gear areas.