



AEROSPACE INFORMATION REPORT

AIR6808™

REV. A

Issued 2020-04
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Superseding AIR6808

Aerospace Vehicle Wiring, Lessons Learned

RATIONALE

The purpose of the update is to synchronize AIR6088 to the latest revision of AS50881, and to provide historical rationale for requirement revisions in the latest revision of AS50881. This update included over 45 paragraphs that changed from the previous revision. Each required a corresponding rationale paragraph to be updated as well. The corresponding rationale paragraph is the purpose of the AIR6088.

INTRODUCTION

AS50881 was developed by the SAE AE-8A System Installation Subcommittee as an industry replacement for MIL-W-5088L. Conformance with the provisions of this document is intended to provide EWIS safety, performance, reliability, maintainability, service life, and lifecycle cost. AS50881 is only applicable to aircraft/air vehicle EWIS. Its scope does not include wiring inside of airborne electronic equipment but does apply to wiring externally attached to such equipment. The information in this document is for air vehicle designers, analysts, quality personnel, and contract officers to better understand AS50881 EWIS requirements. It is written for use by personnel having a basic understanding of EWIS and provides further rationale and explanation of the various EWIS requirements cited in the AS50881 through Revision G. It can also be a useful tool in developing aircraft detailed specification provisions regarding wiring system requirements. SAE AE-8A does not take responsibility or direct the reader to perform any of the cited actions in this document. The contents of this document only provide rationale, historical context, and explanation for AS50881 EWIS requirements.

1. SCOPE

This AIR is limited to the requirements of AS50881 and examines these requirements, providing rationale behind them. AS50881 is only applicable to the aircraft EWIS. Pods and other devices that can be attached to an aircraft are considered as part of the aircraft equipment design. Its scope does not include wiring inside of airborne electronic equipment but does apply to wiring externally attached to such equipment. The AS50881 scope does not include attached devices but does include the interface between the pod/equipment and aircraft wiring. Section 3.3.5 addresses components such as antennas and other similar equipment that were once supplied as Government Furnished Aeronautical/Aerospace Equipment (GFAE).

1.1 Purpose

The purpose of this document is to provide information about how each of the requirements of AS50881 can affect performance, safety, reliability, and maintainability attributes and the potential consequences of their omission.

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<https://www.sae.org/standards/content/AIR6808A/>

Documents

Document Sharing Hub

1.2 Paragraph Organization

The paragraphs listed in [Section 3](#) are the same titles used in AS50881 Revision G Section 3. [Section 3](#) lists the individual EWIS system, process, or performance requirements. Each requirement paragraph from AS50881 is shown in green font. Following each AS50881 green requirement paragraph (green font), when applicable, there is a “rationale” paragraph in black font. The rationale following each requirement paragraph in this AIR provides information regarding the EWIS safety, reliability, historical context, and performance implications.

2. 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 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.

AMS-STD-595	Colors Used in Government Procurement
AIR65	Thermoelectric Circuits and the Performance of Several Aircraft Engine Thermocouples
AIR1329	Electrical Connectors and Wiring, Compatibility of
AIR4465	Design and Handling Guide Radio Frequency Absorptive Type Wire and Cables (Filter Line, AS85485)
AIR4487	Investigation of Silver-Plated Conductor Corrosion (Red Plague)
AIR5558	Ultraviolet (UV) Laser Marking Performance of Aerospace Wire Constructions
AIR5575	Hot Stamp Wire Marking Concerns for Aerospace Vehicle Applications
AIR5919	Alternatives to Cadmium Plating
AIR6151	Torque, Threaded Application, Electrical Connector, Accessory and Terminal Board Installation
AIR6540	Fundamentals in Wire Selection and Sizing for Aerospace Applications
AIR6820	Electrical Wiring Fuel Compatibility
AIR7506	Impact of High Voltage on Wiring
ARP1308	Electrical Connectors for Aerospace, Shipboard, Ground Vehicles and Associated Equipment
ARP1350	Procedure for Installation and Mounting of Single Hole Mount, Cylindrical, Electrical Connectors (For Pressure Differential Applications)
ARP1870	Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety
ARP1897	Clamp Selection and Installation Guide
ARP4404	Aircraft Electrical Installations

ARP5369	Guidelines for Wire Identification Marking Using the Hot Stamp Process
ARP5614	Guidelines for Harness Critical Clamp Locator Marker Installation on Electrical Cable Assemblies
ARP6400	Recommended Practice for Processing and Handling Wire and Cable with Silver Plated Conductors and Shields
ARP6807	Guide for Identification of Terminal Lugs in Electrical Wiring Interconnect Systems (EWIS)
ARP6881	Guidelines for the Use and Installation of Bonded Cable Harness Supports
ARP6903	Guide for Achieving Plating/Finishing Compatibility with Connectors and Accessories used in Electrical Wiring Interconnect Systems (EWIS)
ARP7987	Development, Verification, and Validation of a Thermal Model for Determining Current Derating Design Limits of Aerospace Wires and Wire Bundles
ARP81490	Transmission Lines, Transverse Electromagnetic Mode
AS567	Safety Cable, Safety Wire, Key Washers, and Cotter Pins for Propulsion Systems, General Practices for Use of
AS3509	Cable, Safety, Kit, Nickel Alloy, UNS N0660
AS4372	Performance Requirements for Wire, Electric, Insulated Copper or Copper Alloy
AS4373	Test Methods for Insulated Electric Wire
AS4461	Assembly and Soldering Criteria for High Quality/High Reliability Soldering Wire and Cable Termination in Aerospace Vehicles
AS4536	Safety Cable Kit Procurement Specification and Requirement for Use
AS5117	Clip, Spring Retention - Electrical Cable
AS5419	Cable, Thermocouple Extension, Shielded and Unshielded
AS5768	Tool, Stripper, Electrical Insulation, General Specification For
AS5942	Marking of Electrical Insulating Materials
AS6070	Aerospace Cable, High Speed Data, Copper
AS6136	Conduit, Electrical, Flexible, Shielded, Aluminum Alloy for Aircraft Installations
AS7351	Clamp, Loop Type Bonding
AS7928	Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification For
AS7928/14	Terminal, Electric, Permanent, Crimp Style, Tin-Coated Copper, Insulated, Environment Resistant, Class 1, 150 °C, Heatless Sealing
AS7974	Cable Assemblies and Attachable Plugs, External Electrical Power, Aircraft, General Specification For
AS8700	Installation and Test of Electronic Equipment in Aircraft, General Specification for

AS10380	Coupling Installations, Standard Conduit, Electrical
AS18029	Cover Assembly, Electrical, for MS27212 Terminal Board Assembly
AS21980	Ferrule, Outer, Uninsulated, Shield Terminating, Type I, Two Piece, Class I, for Shielded Cables
AS21981	Ferrule, Inner, Uninsulated, Shield Terminating, Type I, Two Piece, Class I, for Shielded Cables
AS21919	Clamp, Loop Type, Cushioned Support
AS22520	Crimping Tools, Wire Termination, General Specification For
AS22759	Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy
AS22759/14	Wire, Electric, Fluoropolymer-Insulated, FEP-PVF2, Light Weight, Tin-Coated Copper Conductor, 600 Volt, RoHS
AS23053	Insulation Sleeving, Electrical, Heat Shrinkable, General Specification For
AS23053/5	Insulation Sleeving, Electrical, Heat Shrinkable, Polyolefin, Flexible, Crosslinked
AS23053/8	Insulation Sleeving, Electrical, Heat Shrinkable, Polyvinylidene Fluoride, Semi-Rigid, Crosslinked
AS23053/11	Insulation Sleeving, Electrical, Heat-Shrinkable Fluorinated Ethylene Propylene, Non-Crosslinked
AS23053/12	Insulation Sleeving, Electrical, Heat Shrinkable Polytetrafluoroethylene
AS23053/18	Insulation Sleeving, Electrical, Heat Shrinkable, Modified Fluoropolymer, Crosslinked
AS23190	Wiring, Positioning, and Support Accessories
AS25274	Cap, Electrical (Wire End, Crimp Style, Type II, Class 1), for 105 °C Total Conductor Temperature
AS25435	Terminal-Lug, Crimp Style, Straight Type, for Aluminum Aircraft Wire, Class 1
AS25436	Terminal-Lug, Crimp Style, 90° Upright Type, for Aluminum Aircraft Wire, Class 1
AS25438	Terminal-Lug, Crimp Style, Right Angle Type, for Aluminum Aircraft Wire, Class 1
AS25439	Splice-Permanent Crimp Style, 2 Way Type for Aluminum Aircraft Wire, Class 1
AS27212	Terminal Board Assembly, Molded-in-Stud, Electric
AS33481	Contact Bushing, Electric, Wire Barrel
AS33681	Strap, Tiedown, Electrical Components, Identification, Adjustable, Self-Clinching, Plastic, Type II, Class 1
AS33731	Strip, Mounting, Nut Insulating, for AS27212 Terminal Board
AS39029	Contacts, Electrical Connector, General Specification For
AS39029/112	Contact Bushing, Electrical Connector Contact, Wire Barrel
AS50881	Wiring Aerospace Vehicle
AS60491	Sleeve, Protection, for Cable and Harness Protection

AS70991	Terminals: Lug and Splice, Crimp Style, Aluminum, for Aluminum Aircraft Wire
AS81044	Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer, or Polyarylene Insulated, Copper or Copper Alloy
AS81714	Terminal Junction System (TJS), Environment Resistant, General Specification For
AS81714/11	Terminal Junction System, Terminal Junction Blocks, Sectional, Wire In-Line Junctions, Single, Series I
AS81714/12	Terminal Junction System, Terminal Junction Blocks, Sectional, Wire In-Line Junctions, Double, Series I
AS81714/21	Terminal Junction System, Terminal Junction Blocks, Sectional, Electronic In-Line Junctions, Diode, Series I
AS81714/23	Terminal Junction System, Terminal Junction Blocks, Electronic, In-Line Junctions, Integral Fuse, Series I
AS81714/27	Terminal Junction System, Terminal Junction Blocks, Sectional, Grounding Modules, Stud Type Mounting, Series I
AS81714/28	Terminal Junction System, Terminal Junction Blocks, Sectional, Grounding Modules, Integral, Bracket Mounting, Series I
AS81714/63	Terminal Junction System, Terminal Junction Blocks, Sectional, Grounding Modules, Stud and Flange Type Mounting, Series II
AS81790	Connectors, Receptacle, External Electric Power, Aircraft, General Specification for
AS81824	Splices, Electric, Permanent, Crimp Style, Copper, Insulated, Environment Resistant
AS81824/1	Splice, In-Line, Electric, Crimp, SN/CU, Environmental, Heat-Shrinkable Sleeve (150 °C), 1 x 1 Sealant Opening
AS81824/6	Splice, Electric, Permanent, Crimp, Nickel Plated Insulated Wires, Environmental Class 1, 175 °C
AS81824/12	Splice, Electric, Permanent, Crimp Style, Tin-Coated Copper, Insulated, Environment Resistant, Class 1, 150 °C, Heatless Sealing
AS81824/13	Splice, Stub, Electrical, Permanent, Crimp Style, Nickel/Copper, Insulated, Environment Resistant, 175 °C Max
AS81824/14	Splice, Electric, Permanent, Crimp Style, Nickel-Coated Copper, Insulated, Environment Resistant, Class 1, 175 °C, Heatless Sealing
AS81914	Tubing, Plastic, Flexible, Convolute, Conduit, General Specification for
AS81969	Installing and Removal Tools, Connector Electrical Contact, General Specification for
AS83519	Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant General Specification for
AS83519/2	Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant With Pre Installed Leads for Cables Having Tin or Silver Plated Shields (Class I)

AS83519/3	Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant With Preinstalled Braid, Class 1, Non-RoHS
AS83519/5	Shield Termination, Solder Style, Insulated, Heat-Shrinkable, Environment Resistant With Preinstalled Braid, Ni Plated, Class 1, RoHS
AS85049	Connector Accessories, Electrical, General Specification For
AS85049/80	Connector Accessories, Electrical, Dummy Contact, Sizes 16, 12, and 8, Category 7 (for MIL-DTL-38999 Connectors)
AS85049/81	Connector Accessories, Electrical, Seal Plug, Size 10, Category 7 (for MIL-DTL-38999 Connectors)
AS85049/82	Connector Accessories, Electrical, Backshell, Straight, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for AS50151 Crimp, MIL-DTL-26482 Series 2, AS81703 Series 3 and MIL-DTL-83723 Series III Connectors)
AS85049/83	Connector Accessories, Electrical, Backshell, 45°, Self Locking, Shield, Band Termination, (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for AS50151 Crimp, AS95234, MIL-DTL-26482 Series 2, AS81703 Series 3 and MIL-DTL-83723 Series III Connectors)
AS85049/84	Connector Accessories, Electrical, Backshell, 90°, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for AS50151 Crimp, AS95234, MIL-DTL-26482 Series 2, AS81703 Series 3, and MIL-DTL-83723 Series III Connectors)
AS85049/85	Connector Accessories, Electrical, Backshell, Straight, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Boot Accommodation, Category 3B (for MIL-DTL-38999 Series I and II Connectors)
AS85049/86	Connector Accessories, Electrical, Backshell, 45°, Self-Locking, Shield Band Termination, (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for MIL-DTL-38999 Series I and II Connectors)
AS85049/87	Connector Accessories, Electrical, Backshell, 90°, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for MIL-DTL-38999 Series I and II Connectors)
AS85049/88	Connector Accessories, Electrical, Backshell, Straight, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Boot Accommodation, Category 3B (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/89	Connector Accessories, Electrical, Backshell, 45°, Self-Locking, Shield Band Termination (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/90	Connector Accessories, Electrical, Backshell, 90°, Self-Locking, Shield Band Termination, (RFI/EMI), Shrink Sleeve Accommodation, Category 3B (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/91	Connector Accessories, Composite, Electrical, Strain Relief, Straight, Self-Locking, Category 4C (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/92	Connector Accessories, Composite, Electrical, Strain Relief, 90°, Self-Locking, Category 4C (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/93	Connector Accessories, Electrical, Termination, Shield Split Support Ring, Composite, Nonenvironmental, Straight, Category 7
AS85049/103	Connectors, Accessories, Composite, RFI/EMI, Electrical, Strain Relief, Straight, Self-Locking, Category 3C (for MIL-DTL-38999 Series III and IV Connectors)

AS85049/104	Connectors, Accessories, Composite, RFI/EMI, Electrical, Strain Relief, 45°, Self-Locking, Category 3C (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/105	Connectors, Accessories, Composite, RFI/EMI, Electrical, Strain Relief, 90°, Self-Locking, Category 3C (for MIL-DTL-38999 Series III and IV Connectors)
AS85049/128	Shield Band, Connector Accessories, Electrical Backshell, Category 7(for AS85049/82 -/90, /93, /109 - /117 Accessories)
AS85049/138	Connector Accessories, Electrical, Cap, Dust, Plastic, Category 9
AS85848	Sleeving, for Identification Marking, Heat Shrinkable, General Specification for
AS85485	Cable, Electric, Filter Line, Radio Frequency Absorptive
AS85485/8	Cable, Electric, Filter Line, Shielded, Jacketed, Radio Frequency Absorptive, 150 °C, 600-Volt
AS85485/12	Cable, Electric, Filter Line, Small Diameter Wire, Shielded, Jacketed, Radio Frequency Absorptive, 150 °C, 600-Volt
AS90387	Wiring Installation Tools for Plastic and Metal Tiedown Straps

2.2 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

2.2.1 Specifications, Standards, and Handbooks

Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Acquisition Streaming and Standardization Information System (ASSIST) specified in the solicitation form a part of this specification to the extent specified herein.

2.2.1.1 Specifications

2.2.1.1.1 Military

MIL-A-46146	Adhesives-Sealants, Silicone, RTV, Noncorrosive (for Use with Sensitive Metals and Equipment)
MIL-DTL-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for
MIL-DTL-3607	Connector, Coaxial, Radio Frequency, Series
MIL-DTL-3650	Connectors, Coaxial, Radio Frequency, Series LC
MIL-DTL-3655	Connector, Plug and Receptacle, Electrical (Coaxial, Series Twin), and Associated Fittings, General Specification for
MIL-DTL-5541	Chemical Conversion Coatings on Aluminum and Aluminum Alloys
MIL-DTL-5846	Chromel and Alumel Thermocouple Electrical Wire
MIL-DTL-24308	Connectors, Electrical, Rectangular, Nonenvironmental, Miniature, Polarized Shell, Rack and Panel, General Specification for
MIL-DTL-25038	Wire, Electrical, High Temperature and Fire Resistant, and Flight Critical, General Specification for
MIL-DTL-25516	Connectors, Electrical, Miniature, Coaxial, Environment-resistant Type, General Specification for

MIL-DTL-32546	Connectors, Electrical, Circular, for High-Speed Data Bus Transmission, Copper Conductor, General Specification for
MIL-DTL-32554	Straps, Tie-Downs, Adjustable, Non-Metallic, Cable Bundling, General Specification for
MIL-DTL-32610	Stripper, Multi-Conductor Electrical Cable, Hand-Operated, General Specification for
MIL-DTL-32633	Connectors, Filter, Electromagnetic Interference (EMI), General Specification for
MIL-DTL-81381	Wire, Electric, Polyimide-Insulated, Copper or Copper Alloy
MIL-DTL-83413/8	Connectors and Assemblies, Electrical, Aircraft Grounding: Type IV Jumper Cable Assembly, Lead, Electrical
MIL-DTL-83517	Connector, Coaxial, Radio Frequency for Coaxial, Strip or Microstrip Transmission Line, General Specification for
MIL-I-631	Insulation, Electrical, Synthetic-Resin Composition, Nonrigid
MIL-I-3190	Insulation Sleeving, Electrical, Flexible, Coated, General Specification for
MIL-M-24041	Molding and Potting Compound, Chemically Cured Polyurethane
MIL-PRF-8516	Sealing Compound, Polysulfide Rubber, Electric Connectors and Electric Systems, Chemically Cured
MIL-PRF-23586	Sealing Compound, Electrical, Silicone Rubber, Accelerator Required
MIL-PRF-29504	Termini, Fiber Optic Connector, Removable, General Specification for
MIL-PRF-39012	Connectors, Coaxial, Radio Frequency, General Specification for
MIL-PRF-46846	Rubber, Synthetic, Heat-Shrinkable
MIL-PRF-49142	Connector, Plug and Receptacle, Electrical, Triaxial, Radio Frequency, General Specification for
MIL-PRF-55339	Adapter, Connector, Coaxial, Radio Frequency, (Between Series and Within Series), General Specification for
MIL-T-81490	Transmission Lines, Transverse Electromagnetic Mode

2.2.1.2 Standards

2.2.1.2.1 Military

MIL-STD-196	Joint Electronics Type Designation System
MIL-STD-464	Department of Defense Interface Standard for Electromagnetic Environmental Effects Requirements for Systems
MIL-STD-681	Identification Coding and Application of Hookup and Lead Wire
MIL-STD-704	Aircraft Electric Power Characteristics
MIL-STD-889	Dissimilar Metals
MIL-STD-1353	Department of Defense Standard Practice Electrical Connectors, Plug-in Sockets, and Associated Hardware

MIL-STD-1678	Fiber Optics Cabling System Requirements and Measurements (Part 1: Design, Installation and Maintenance Requirements) (Part 2: Optical Measurements) (Part 3: Physical, Mechanical, Environmental and Material Measurements) (Part 4: Test Samples Configuration and Fabrication Requirements) (Part 5: Design Phase and Legacy Measurement)
MIL-STD-1553	Digital Time Division Command/Response, Multiplex Data Bus
MIL-STD-7080	Electric Equipment, Aircraft, Selection and Installation of
MIL-STD-7179	Finishes, Coatings, and Sealings for the Protection of Aerospace Weapons Systems, General Specification for
MS3471	Connectors, Receptable, Electrical, Series 2, Crimp Type, Cable Connecting, Bayonet Coupling, Classes A, D, L, T, W and K
MS21919	Clamp, Loop Type, Cushioned, Support
MS27488	Plug, End Seal, Electrical Connector
MS90387	Tool, Hand, Adjustable for Plastic and Metal Tiedown Straps (S/S by SAE-AS90387)
NAVMAT P-4855-2	Design Guidelines for Prevention & Control of Avionic Corrosion

2.2.1.3 Handbooks

2.2.1.3.1 Military

MIL-HDBK-502	Product Support Analysis
MIL-HDBK-516	Airworthiness Certification Criteria
MIL-HDBK-522	Guidelines for Inspection of Aircraft Electrical Wiring Interconnect Systems
MIL-HDBK-525	Electrical Wiring Interconnect System (EWIS) Integrity Program
MIL-HDBK-534	Aircraft Fuel System Service Life Extension
MIL-HDBK-863	Wiring Data and System Schematic Diagrams, Preparation of
MIL-HDBK-1646	Selection of Electrical Contacts, Connectors and Associated Servicing Tools

2.2.1.4 Technical Manuals

Documents can be obtained at the NATEC technical data website, <https://mynatec.navair.navy.mil/natechome.htm>. The link provided is intended for persons with approved access.

NAVAIR 01-1A-505-1, T.O. 1-1A-14, and ARMY TM 1-1500-323-24-1: Installation and Repair Practices Volume I Aircraft Electric and Electronic Wiring

NAVAIR 01-1A-505-2, T.O. 1-1A-14-2, and TM 1-1500-323-24-2: Installation and Repair Practices Volume II Aircraft Circular Electrical Connectors and Accessories

NAVAIR 01-1A-505-3, T.O. 1-1A-14-3, and TM 1-1500-323-24-3: Installation and Repair Practices Volume III Aircraft Rectangular Electrical Connectors and Accessories

NAVAIR 01-1A-505-4, T.O. 1-1A-14-4, and TM 1-1500-323-24-4: Installation and Repair Practices Volume IV Aircraft Fiber Optic Cabling

2.2.1.5 Commercial Item Descriptions (CID)

A-A-52080	Tape, Lacing and Tying, Nylon (Type I), -67 °F (-55 °C) to 250 °F (121 °C)
A-A-52081	Tape, Lacing and Tying, Polyester (Type II), -100 °F (-73 °C) to 280 °F (138 °C)
A-A-52082	Tape, Lacing and Tying, TFE-Fluorocarbon (Type III), -100 °F (-73 °C) to 450 °F (232 °C)
A-A-52083	Tape, Lacing and Tying, Glass (Type IV), -100 °F (-73 °C) to 800 °F (427 °C)
A-A-52084	Tape, Lacing and Tying, Aramid (Nomex), (Type V), -100 °F (-73 °C) to 500 °F (260 °C)
A-A-59163	Insulation Tape, Electrical, Self Adhering Unsupported Silicone Rubber
A-A-59178	Nipple, Electrical Terminal
A-A-59125	Terminal Boards, Molded, Barrier Screw and Stud Types and Associated Accessories
A-A-59474	Insulation Tape, Electrical, High Temperature, Polytetrafluoroethylene, Pressure-sensitive
A-A-59877	Insulating Compound, Electrical, Embedding

2.3 Non-Government Publications

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the ASSIST cited in the solicitation.

Unless otherwise specified, the issues of documents not listed in the ASSIST are the issues of the documents cited in the solicitation.

2.3.1 AIA Publications

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

NAS831	Cap-Protective Electrical Connector
NAS837	Plug - Protective Electrical Connector
NASM3036	Grommet, Rubber Hot-oil and Coolant Resistant
NASM20995	Wire, Safety or Lock
NASM21266	Grommet, Plastic, Edging
NASM22529	Grommet, Edging
NASM22529/1	Grommet, Composite, Edging
NASM22529/2	Grommet, Cushion Composite Edging
NASM25440	Washer, for Use with Aircraft Aluminum Terminals

NASM33540 Safety Wiring and Cotter Pinning, General Practice for

2.3.2 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME Y14.100 Engineering Drawing Practices

ASME Y14.24 Types and Applications of Engineering Drawings

ASME Y14.34M Associated Lists

2.3.3 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 D3032 Standard Test Methods for Hookup Wire Insulation

2.3.4 ECIA Publications

Available from Electronic Components Industry Association, 2214 Rock Hill Road, Suite 265, Herndon, VA 20170, Tel: 571-323-0294, www.ecianow.org.

EIA/ECA-364-26 Salt Spray Test Procedure for Electrical Connectors, Contacts and Sockets

2.3.5 FAA Publications

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

AC 25.1701-1 Certification of Electrical Wiring Interconnection Systems on Transport Category Airplanes

AC 25.981-1D Fuel Tank Ignition Source Prevention Guidelines

AC 43.13-1B Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair

2.3.6 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE Std. 315-1975 Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Letters)

2.3.7 RTCA Publications

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

RTCA DO-160 Environmental Conditions and Test Procedures for Airborne Equipment

3. REQUIREMENTS

3.1 Terminology Interpretation

The term “wiring” wherever used throughout this specification shall be interpreted in accordance with 2.3.26.

Rationale: The term “wiring” is interpreted per the callout from the green text font from AS50881 (H) in 2.3.26 which states: “Wires, electrical/optical cables, groups, harnesses and bundles, and their terminations, associated hardware, and support, installed in the vehicle. When used as a verb it is the act of fabricating and installing these items in the vehicle.”

3.1.1 Deviations

Deviations from this specification desired by the contractor (substitution of equipment, material, or installation) shall be specifically brought to the attention of the procuring activity by letter concurrent with or prior to forwarding the design data for approval. All requests for deviations shall include sufficient engineering information to substantiate the deviations.

3.2 Conflicting Requirements

In case of discrepancies between this specification and the type or detail specification for a particular vehicle part, the type or detail specification shall prevail.

Rationale: The intent is for AS50881 to be tailored for specific applications since every original equipment manufacturer (OEM) has unique design and manufacturing practices. This requirement allows exceptions from AS50881 as defined in the air vehicle type or detail specification for particular reasons such as improved materials and components or vehicle-unique configurations. Any exceptions or deviations should be documented and rationale provided to the procurement and/or airworthiness certification authority.

3.3 Selection of Parts and Materials

Parts and materials covered by documents listed herein are standard and shall be used whenever they are suitable for the purpose. Standard parts and materials shall have qualification inspection and be procured from qualified products list (QPL) that has been issued by the qualifying activity as required by the applicable specification. Nonstandard parts and materials must be equivalent to or better than similar standard parts and materials. When this specification fails to provide an applicable specification or standard, the contractor shall use other established specifications or standards. Parts and materials selected from other than this specification are not standard, and approval must be obtained prior to their use in aerospace vehicles. Each vendor source for a nonstandard part or material requires approval. When a nonstandard part is used where a suitable standard part exists, the contractor shall reference the standard part on the drawing, parts lists, or data package, and the installation shall provide for replacement with the standard part.

Rationale: To provide qualification requirement application and to ensure standard and qualified terms align with SD-6 qualification standard. To clearly define the requirement for use of standard/qualified parts and to outline the contractor role and responsibilities in part selection. Note that MIL-DTL-32610 provides a good part selection process; however, for EWIS components, performance verification testing is required.

3.3.1 Requests for Approval of Nonstandard Parts

The data to be submitted with the request for approval of nonstandard parts shall be in accordance with the terms of the contract. For wire and cable applications, use AS4372 data configuration.

3.3.2 Commercial Utility Parts

Commercial utility parts, such as screws, bolts, nuts, cotter pins, etc., may be used, provided they have suitable properties and are replaceable by standard parts without alteration.

3.3.3 Contractor's Specifications

Wiring and wiring devices conforming to contractor's specifications may be used, provided each contractor's specification is approved by the procuring activity and provided no military specification exists. The contractor shall provide substantiating test data and, when required by the procuring activity, shall provide samples for test. The use of contractor's specifications shall not constitute waiver of procuring activity inspections. Contractor's specifications shall follow the format for military specifications. When a detail or general military specification exists for the class of material required, the contractor's specification shall reference the existing military specification and set forth only the needed new requirements and deviations.

Rationale: To provide qualification requirement application and outline the contractor role and responsibilities in part selection. If a nonstandard or commercial part is to be employed, the contractor's role is defined. The goal is to provide the procuring activity with the requisite components and/or information to make a prudent engineering decision based on data, tests, and/or contractor's specifications.

3.3.4 Commonality

An objective in the selection of parts shall be to maximize commonality and minimize the variety of wiring components and related servicing tools required in the construction, installation, and maintenance of the electrical wiring system.

3.3.5 Government-Furnished Aircraft Equipment (GFAE)

Wiring and wiring devices furnished by the government shall be installed without modification unless otherwise authorized or directed by the procuring activity.

3.3.6 Modification

The contractor shall not alter, rework, or modify wiring or wiring devices built to and meeting government specifications, unless authorized or directed by the procuring activity, and such modification shall be subject to government inspection.

Modified parts shall have the government identifying part number removed and shall be identified by contractor part number.

Rationale: Part selection can be critical for survival of aircraft and occupants for the expected aircraft service life. Aircraft operations in severe environment and field level maintenance affect component life. Using standardized aircraft-qualified parts enhances logistic support, safety, and reliability and supports improved mission availability. Modification of a part makes it nonstandard and should be approved by the procurement authority. As an example, some equipment boxes have had connection pigtails that were modified by the OEM without the design authority to make such changes.

3.4 Service Life

Wiring and associated components used for the wiring installation shall be selected and installed to promote ease of maintenance and high reliability over the entire expected service life of the vehicle. The reliability and maintainability goals for the wiring system shall be determined in the acquisition logistics as delineated in MIL-HDBK-502, as will the expected service life. These goals shall be subject to procuring activity approval.

Rationale: An aircraft's wiring system incorporates many thousands of components and material types, all of which need to function as intended for an extended period in a variety of operational and maintenance environments. Aircraft wiring may be installed in areas not readily accessible for maintenance inspection or replacement. The burden of diagnosing and implementing corrective repairs for an excessive number of failures can be overwhelming to maintenance personnel. Premature or undiagnosed failure modes can risk the safety of occupants and performance of assigned missions. If it is not possible for components to meet the designated service life of the aircraft, a list of life-limited parts should be created and maintained as part of the instructions for continued airworthiness (ICAs). For a more detailed discussion on service life, consult MIL-HDBK-525.

3.5 Smoke and Fire Hazard

The wiring and wiring devices shall be selected and installed in such a manner as to minimize the danger of smoke and fire hazards. Adequate protective means, both physical and electrical, shall be employed to provide reliability and safety commensurate with this requirement. Unless otherwise specified, all wire and cable shall meet the flammability requirements of AS4372.

Rationale: Aircraft electrical systems can experience overload, short circuit failures, or combat damage leading to smoke or fire which can cause injury to crew members or loss of pilot vision. For critical circuits that can directly affect safety of flight, consideration should be given to wire types specified in AS50881 Appendix A as being suitable for use in circuits where electrical integrity is required for a limited time in fire conditions. Physical protective means, such as secondary harness protection and/or physical separation, are potential solutions to meet this requirement. A safety and probability analysis should be developed to fully assess the impact of a failure and the mitigation strategy. Thermal or solid-state circuit breakers are potential devices that could minimize the possibility of smoke/fire.

3.6 Materials

Materials used in the installation of wiring and equipment shall be suitable for the purpose and conform to such government specifications as are specifically applicable under the contract.

Rationale: Aircraft must be able to operate in extreme environments for extended periods. Use of nonstandard materials can lead to premature system failures and issues with traceability and/or maintainability. If contractor-specified materials were freely allowed, the overall safety and reliability of a new aircraft model might not be able to be assessed until the program had progressed beyond the point where corrections could be made within the time and cost constraints allowed for the program.

3.6.1 Metals

Metals used in the installation of wiring shall be corrosion resistant or shall be suitably protected to resist corrosion and electrolytic action during normal service life. Finish and coating shall be in accordance with MIL-STD-7179.

Rationale: Corrosion of wiring system components can interrupt circuit continuity or cause components to be unserviceable for disconnection or functional testing. Such deterioration may not be detectable during inspection or until a system failure has occurred. There is a basic incompatibility between maintaining conductive surfaces and corrosion resistance since protection from corrosion is typically accomplished by passivating surfaces and interrupting electron transport between two galvanically coupled materials. Metals selected for the designed application should be inherently resistant to corrosion or made corrosion resistant by coating and/or plating.

3.6.1.1 Dissimilar Metals

Dissimilar metals used shall conform to the requirements of MIL-STD-889. This standard establishes requirements for the selection and protection of dissimilar metal combinations and other significant corrosion behavior factors.

Rationale: Increased circuit resistance can result from corrosion of conductive materials. Dissimilar metals protection avoids system failures, lightning protection loss, and corrosion damage. Application of protective sealants after final assembly may extend corrosion protection but will typically make unit maintenance more time consuming. Dissimilar metals need to be suitably protected against the various forms of corrosion, which include galvanic, surface oxidation, hydrogen embrittlement, intergranular and stress corrosion, and crevice corrosion. For more detail, consult NAVMAT P 4855-2.

3.6.2 Nonmetals

Nonmetals used, including plastics, fabrics, and protective finishes, shall be moisture and flame resistant, shall not support fungus growth, shall not support combustion, and shall not be adversely affected by weathering, applicable fluids, and propellants, temperature, and ambient conditions encountered during operation of the vehicle. Materials that give off a minimum amount of noxious gases shall be selected. Nonmetals may be treated to conform to this requirement. PVC Insulating materials shall not be used unless no other materials suitable for the application are available.

3.6.2.1 Insulating Materials

Insulating materials shall have an arc resistance capability which will meet the circuit requirements.

3.6.2.1.1 PVC Usage

PVC material shall not be used in U.S. Department of Defense contracts for aerospace applications.

3.6.2.1.2 MIL-DTL-81381 Usage

MIL-DTL-81381 shall not be used in U.S. Department of Defense contracts for aerospace applications.

Rationale: Failure or degradation of nonmetallic materials can lead to loss of insulation properties or fractures resulting in short circuits or extensive corrosion. Deterioration of nonmetals can also result in unanticipated movement of live circuit components causing electrical short circuits. Past experience has shown that test equipment and temporary modifications or repairs can contain materials not designed for aerospace applications (such as PVC) which can outgas toxic or corrosive materials or not meet flammability requirements. There have also been instances where an OEM or maintenance group has used a commercial off-the-shelf (COTS) item without verifying its suitability for aerospace use. It is the responsibility of the EWIS designer and/or certification authority to ensure only aerospace-grade materials are used; when not the case, the materials are evaluated for potential issues and a risk and mitigation strategy is in place. The MIL-DTL-81381 restriction was implemented to prevent employment of wire using polyimide in that configuration. Current wire constructions require arc track testing and passing of all wire constructions containing polyimide insulation. AS4373 cites the dry and wet arc test method 508 and 509. The arc track testing is extended to all materials which may exhibit the characteristic.

3.6.3 Sealing Materials

Only materials that are elastomeric and reversion resistant shall be used. Sealing materials required to seal wire junctions and terminations shall be selected from MIL-PRF-8516, MIL-PRF-23586, MIL-A-46146, or other material specifically approved by the procuring activity. MIL-PRF-8516 is the preferred material. The following temperature limits apply (the upper limit includes ambient plus temperature rise):

MIL-PRF-8516 -51 to 93 °C (-60 to 200 °F)

MIL-PRF-23586 -65 to 232 °C (-85 to 450 °F)

MIL-A-46146 -62 to 200 °C (-80 to 392 °F)

Rationale: Elastic materials can provide the necessary sealing against entry of accumulated condensation and other fluids. Many commercial non-aerospace-grade sealants can outgas acidic acid and revert in hot and humid environments. Reversion causes chemical changes to sealants degrading properties and, in the worst case, liquefy.

3.6.3.1 Process

Sealing materials shall be applied in strict conformance with the manufacturer's instructions. Over-aged material shall not be used. The sealing material shall be held in place by suitable forms during the curing process.

Rationale: All sealants are application-process sensitive and might not perform as intended if not properly applied. Use of materials that have exceeded their storage life, have been improperly stored, or not applied per manufacturer instructions may not seal properly. Unconstrained movement of components prior to complete curing of sealing materials is also likely to compromise environmental protection.

3.6.4 Epoxy Adhesives

Only epoxy adhesives that can withstand sustained use without degradation of mechanical and adhesive properties at the maximum ambient temperatures shall be used for the bonding of fiber optic cables to termini. The time and temperature used for curing of epoxy adhesive used in fiber optic terminations shall be controlled so that a consistent bond is provided under all service conditions. Only epoxies which have inherent resistance to aircraft fluids including, but not limited to, fuel, lubricating oils, and cleaners shall be used. For wiring system applications requiring resistance to petroleum-based fluids, see 3.14.9.

Rationale: Epoxy adhesives have shown superior qualities for performance and longevity in aircraft service conditions. Some epoxies, when subjected to extreme heat, exceed their glass transition temperature (temperature at which the material softens and properties are changed), resulting in loss of adhesion. Curing at stepped temperature levels for specific periods may be required to elevate the glass transition temperature to the necessary level. Verification of cured epoxy properties may not be possible without destructive testing.

Proper surface preparation, such as cleaning, is critical for good epoxy adhesion. Without proper surface preparation, good epoxy adhesion will not be possible and adhesion failure is possible.

3.7 Component Selection and Installation

Components and wiring devices shall be selected for their application and installed in accordance with the requirements of this specification; in addition, selection and installation consideration shall be made relative to vehicle operation and servicing environments to ensure that they are not subjected to conditions exceeding the limits in the applicable wiring component specification.

Rationale: The procuring activity must specify the condition limits the vehicle will experience. The conditions should specify the operational conditions and whether the vehicle will be subjected to field maintenance under less-than-ideal conditions. The maintenance conditions should be specified in order for the contractor's component selection and installation design to meet requirements.

3.7.1 Maintenance Considerations

The maintainability of the wiring system shall be a prime consideration in the design and selection of harnesses, electrical/optical cable assemblies, and wiring system components. All wiring shall be accessible, repairable, and replaceable at the maintenance level specified by the procuring activity. Other specific requirements concerning maintenance are specified in the appropriate paragraph on the subject.

Rationale: The procuring activity needs to specify the limits of conditions that the vehicle will be maintained in and whether it shall be subjected to field maintenance under primitive conditions in order for the contractor's installation design to meet requirements. Unit maintenance under primitive conditions, poor lighting, or by inadequately trained personnel can seriously compromise air vehicle safety and reliability unless allowed for during initial design. Access to wiring without structural disassembly is mandatory at any maintenance level in order to facilitate operations.

3.8 Wiring Selection

Wiring shall be of a type suitable for the application. Wire shall be selected so that the rated maximum conductor temperature is not exceeded for any combination of electrical loading, ambient temperature, and heating effects of bundles, conduit, and other enclosures. Typical factors to be considered in the selection are voltage, arcing, arc propagation, current, ambient temperature, mechanical strength, abrasion, flexure and pressure altitude requirements, and extreme environments such as Severe Wind and Moisture Problems (SWAMP) areas or locations susceptible to significant fluid concentrations. The wire shall be selected in accordance with Appendix A of this specification. Table A1 lists approved wire types for open wiring applications, which have normal, or medium weight insulation. Table A2 lists approved wire types for protected wiring applications, which have thin wall or lightweight insulation. The wire selection shall take into account all requirements of this specification and the following design considerations. For additional information concerning wire selection and sizing, refer to AIR6540.

Rationale: Wiring types specified in AS50881 Appendix A are qualified to provide lower failure rates on wiring system materials and components and support environmental sealing at connectors. These wiring types avoid conductor and insulation failures on critical flight control, armament, systems, etc., and facilitate service in more extreme operational and maintenance environments. Critical systems should be analyzed and designed so that long-term wire material failure modes, of a type that may be undetectable during initial qualification tests, cannot endanger aircraft crew members or maintenance personnel.

3.8.1 Conductor Degradation

Degradation of tin-, nickel-, and silver-plated copper conductors will occur when exposed to continuous operation at temperatures beyond their continuous rating. These effects shall be taken into account in the selection and application of wiring.

Rationale: Degradation in the form of inter-strand bonding, silver and tin migration, and oxidation of the copper strands can occur with continuous operation near, or exceeding rated temperature, resulting in loss of flexibility, increased electrical resistance, and loss of solderability.

3.8.1.1 Tin Plated Conductors

Wire using tin-plated conductors can be rated to 150 °C, dependent upon the insulation. Tin-copper inter-metallic will form in time resulting in an increase in conductor resistance and embrittlement. This increase in resistance is inverse to size, being up to 4% for the smallest gage. Also, the surface of the tin plating becomes oxidized with time, which inhibits solderability (see 3.8.1.3). These potential problems should be considered in the application of tin-plated copper wire.

Rationale: The 150 °C continuous rating of tin-plated conductor wire is based upon insulation heat resistance, as well as conductor rating. Conservative rating procedures can avoid problems with conductor plating. Selection of solder sleeves (e.g., AS83519/2 rated to 150 °C) and other heat processed components must take into consideration the lower temperature rating of the devices to avoid insulation damage when exposed to temperature above the component's rating but below the 150 °C continuous rating of tin-plated conductor wire. As an example, the AS22759/14 wire insulation has a continuous rating of 135 °C.

3.8.1.2 Silver Plated Conductors

Wire using silver-plated conductors can be rated to 200 °C, dependent upon the insulation degradation. Degradation in the form of inter-strand bonding, silver migration, and oxidation of the copper strands can occur with operation near rated temperature, resulting in loss of flexibility. Due to fire hazard, silver-plated conductors shall not be used in areas where they are subject to contamination by ethylene glycol solution. These potential problems should be considered in application of silver-plated copper wire.

Rationale: The 200 °C continuous rating of silver-plated conductor wire is based upon insulation heat resistance, as well as conductor rating. Conservative rating procedures can avoid problems with conductor plating.

Red plague (cupric oxide corrosion of silver-plated copper conductors), another degradation mechanism for silver-plated wires, has also caused millions of dollars in damage to aircraft, particularly during assembly operations. AIR4487 provides additional information on this degradation mechanism.

The 200 °C continuous rating of silver-plated conductor wire is based upon insulation heat resistance, as well as conductor rating. Conservative wire rating procedures can avoid problems with conductor plating. Selection of solder sleeves (e.g., AS83519/2 rated to 150 °C) and other heat-processed components must take into consideration the lower temperature rating of the devices to avoid damage when exposed to temperature above the component's rating but below the 200 °C continuous rating of silver-plated conductor wire.

3.8.1.3 Nickel Plated Conductors

Wire using nickel-plated conductors can be rated up to 260 °C, dependent upon the insulation. Not recommended for soldering applications.

Rationale: The 260 °C continuous rating of nickel-plated conductor wire is based upon insulation heat resistance, as well as conductor rating. Nickel-plated conductor wire is the more commonly used wire in aerospace vehicles because of its lower cost and temperature rating.

3.8.1.4 Conductor Solderability

Solderability of tin-plated copper wire degrades significantly within 6 months to a year after production. When significant oxidation occurs, mildly active rosin (RMA) flux is required for proper soldering and depending upon temperature exposure, as well as storage time, an activate rosin (RA) flux may be required. Soldering of tin-plated copper conductors should be avoided, but when required, compensating steps such as re-tinning shall be included in maintenance procedures for re-termination (refer to AS4461).

Rationale: The soldering of nickel-plated wire also presents problems that are not described in this specification. Solder sleeves and other devices intended for silver- or tin-plated wires are not suitable for nickel-plated wire. Generally, most interconnections in the wiring system involve crimped contacts. Soldering issues are more pronounced with relays and other devices that use solder hooks.

3.8.2 Aluminum Wire

The use of aluminum wire requires procuring activity approval. Aluminum wire shall be restricted to size 8 and larger. Aluminum wire shall neither be directly attached to engine mounted accessories nor installed in other areas of severe vibration. It shall not be installed where frequent connections and disconnections are required. All installations of aluminum wire shall be relatively permanent. Aluminum wire shall not be used where the length of run is less than 3 feet, nor in areas where corrosive fumes exist. Aluminum wire shall be terminated only by terminations specifically approved for this application (see 3.20.2 and 6.12).

Rationale: Aluminum wire is used to save weight, but such savings are not justified unless significant weight is saved and all environmental restrictions are observed. Material creepage of aluminum from vibration and stress can result in loosening and high resistance at connections. Fatigue caused by frequent flexure during maintenance can lead to material failure. Restrictions, such as sealed terminations, can prevent potential loss of "gas tight" connection (does not allow potentially corrosive vapor between strands and crimp barrel). Aluminum wire is limited to 150C, whereas copper wire can go to 260C. The higher temperature rating will often provide a better solution with a copper wire.

3.8.3 Fiber Optic Cable Selection

The type, size, construction, and distinct identification for fiber optic cable shall be suitable for the application and shall be approved for use by the procuring activity. Cable shall be of a construction which provides the required optical performance under all service conditions when the overall characteristics of end face polish, cable length, number of connections, installation bend radii, and environmental degradation are taken into account. Cable shall be resistant to environmental degradation and handling damage and shall be of a continuous temperature rating that is compatible with assembly process and installation environment. The fiber optic cable shall be distinguishable from aircraft wire harness assemblies as defined and approved by the procuring activity (refer to MIL-STD-1678).

Rationale: The use of fiber optic cabling provides a number of advantages over its electrical counterpart, including higher data rate transmission, immunity to external interference, e.g., electromagnetic vulnerability (EMV), non-emitting, lighter weight, the ability to support multiple wavelengths along a single fiber, small bend radius when using bend insensitive fiber. A reduction of data strength (light transmission) caused by poor installation (tight bend radius) or terminus end face contamination can lead to increased bit error rate that can affect system operation. MIL-STD-1678 has criteria concerning the selection, usage, and testing of fiber optic cable.

Tested and approved fiber optic cables shall be used. When employing fiber optics into system designs, it is important to remember that assembly, installation, and field servicing require specialized training, tools, and diagnostics.

3.8.3.1 Strength Member

Fiber optic cable shall include a layer of suitable, approved strength member material (e.g., fiberglass, Aramid yarn, or other non-metallic material) that can be mechanically attached to termini assemblies for the purpose of resisting tensile loads (refer to MIL-STD-1678).

Rationale: Attachment of the optical fiber in fiber optic cable terminations and the fiber itself have very limited ability to withstand the tensile loads that can occur on cables during installation and poor installation. Reacting these loads through a properly attached strength member preserves the cable integrity and its optical interface with the termini. MIL-STD-1678 has criteria concerning the usage of a strength member in a fiber optic cable.

3.8.3.2 Jacket

External jacket of fiber optic cable shall be resistant to moisture, mechanical damage, and temperature degradation (refer to MIL-STD-1678).

Rationale: The jacket protects the inner members of such cables against most of the elements, which might otherwise damage or degrade them. MIL-STD-1678 has criteria concerning the selection of an external jacket on a fiber optic cable.

3.8.4 Coaxial Cables

Coaxial cables shall be suitable for the application and shall be selected in accordance with A.3.1.5 of Appendix A.

Rationale: Potential cable degradation can cause communication loss and result in flight hazards. One method of communication degradation can be caused by damage to dielectric layer or termination aging; degradation of either can be difficult to diagnose. The selection guide of approved constructions included in AS50881 Appendix A facilitates predictable system range, operation characteristics, and signal clarity.

For applications above 400 MHz and in critical RF circuits, critical electrical characteristics such as attenuation, capacitance, structural return loss, environmental requirements, short leads, and grounding shall be considered in design. Coaxial cable operating in the transverse electromagnetic mode (TEM) and coaxial cable with tubular metal outer surfaces shall be identified by a violet-colored marker (1-inch nominal width) at intervals not greater than 24 inches of length and within 6 inches of termination. Transmission lines in accordance with MIL-T-81490 need not be identified by colored markers if the color requirements of MIL-T-81490 have been met. For applications above 400 MHz and in critical RF circuits, critical electrical characteristics such as attenuation, capacitance, structural return loss, environmental requirements, short leads, and grounding shall be considered in design. Coaxial cable operating in the transverse electromagnetic mode (TEM) and coaxial cable with tubular metal outer surfaces shall be identified by a violet-colored marker (1-inch nominal width) at intervals not greater than 24 inches of length and within 6 inches of termination. Transmission lines in accordance with ARP81490 need not be identified by colored markers if the color requirements of MIL-T-81490 have been met. ARP81490 is not for U.S. Navy applications.

Rationale: Damage-related degradation of signal carrying properties of coaxial cables may not be apparent by physical inspection nor readily measurable on fielded aircraft without specialized equipment such as a time domain reflectometer (TDR). A very important characteristic of each cable is making such measurements of the cable's known properties.

The requirement of distinctive color markings is to provide an alert that for maintainers that special handling and termination techniques are required.

ARP81490 is not for U.S. Navy applications because MIL-T-81490 contains strict performance requirements which can be employed in contractual requirement documents, unlike ARP81490, which is for guidance only.

3.8.5 Harnesses

Harnesses shall be of either open or protected design. Open harnesses are preferred for maintenance considerations.

Harnesses may be designed to meet mechanical or shielding requirements. The use of protected harnesses shall be avoided unless wiring design considerations dictate their use and is subject to the approval of the procuring activity. The design details of protected harnesses are also subject to the approval of the procuring activity.

Rationale: The benefit of open harness design is that the wiring is easily accessible for maintenance actions, modifications, and replacement. A potential drawback to open harness design is that the wiring can be easily damaged during normal maintenance activities.

Protected harnesses, those with secondary harness protection, provide for limited maintenance actions and normally require replacement if any problems are identified with the harness. When approved for use, protected harnesses allow application of thin-walled wire insulation; the thin-walled wire insulation provide a weight and volume advantage, but this needs to be considered against the additional weight and volume added by the secondary harness protection.

Secondary harness protection can provide the additional benefits of shielding and jacketing and can employ molded terminations to avoid wire/termination breakage and improve environmental/electromagnetic shielding.

Protected and unprotected wire harnesses may be routed together in the same harness. In these instances, special barrier material may be used where protected and unprotected wire bundles are joined together.

UAV Consideration: Closed harness design is not typically used for UAV design. For UAVs, serviceability and risk are lower considerations than space and weight reduction.

3.8.6 Insulation Compatibility with Sealing and Servicing

Wiring terminations in devices where the wiring must be sealed to provide an environment resistant joint shall have insulation compatible with the sealing feature of the device. For wire to connector sealing grommet compatibility, refer to AIR1329. When the diameter of the wire is smaller than the minimum allowable diameter, a length of shrink AS23053/5 Class 1 or 3, AS23053/8, AS23053/11, AS23053/12 Class 3, 4, or 5, or AS23053/18 Class 2 or 3 sleeving shall be installed behind the contact and shall protrude through the environmental seal. Elastomer grommets are generally qualified to seal on wires and electrical/optical cables having smooth extruded insulations. Only one wire/optical cable per grommet hole is permitted. Sealing on tape wrapped, braided, striped, or other than smooth circular insulations shall be specifically tested for compatibility and shall be subject to procuring activity approval, unless compatibility has been demonstrated in the qualification of the terminating device. After installation in the vehicle, the integrity of the sealing features of all such devices shall be intact, and able to perform their function. A device shall be considered as sealed if the outermost sealing feature (web) is in full contact with the device when visually inspected. The wiring shall be installed so that transverse loads will not destroy the integrity of the sealing feature of the wire.

Rationale: Moisture ingress at connector wire entry can cause short circuits and resultant system malfunction or failure. Sealing at the connector avoids pin-to-pin shorts and potential corrosion of wires and contacts. Using the correct size contacts, wire gauge, and wire insulation construction can help to reduce wire breakage, pullout, and ingress of contaminants.

Wire harness routing has an impact on the connector sealing. It is recommended to avoid side loading and sharp bends at the wire exit from the connector as this preserves the sealing capability of the connector's rear grommet.

3.8.6.1 Wire Diameter

The finished wire outside diameter or finished wire diameter plus sleeving (see 3.8.6) shall be within the limits specified for the grommet specified in the appropriate component specification and shall not exceed the capability of contact servicing tools to insert and release contacts.

Rationale: The limits for each connector type and contact size must be observed to allow the successful use of standard contact insertion/extraction tools. Oversized wires (or wires plus sleeving) can become lodged in connectors, and it can be difficult to remove the contact without causing damage to connector contact retention locks.

3.8.6.2 Potting Seal on Wire or Cable

The potting shall be bonded to the outer-most surface of the wire or electrical/optical cable in such a way to ensure an environmental resistant seal.

Rationale: Adherence of potting to the wire surface is dependent upon both the potting material and the wire surface characteristics. It is necessary to follow the manufacturer's recommended preparation and application process to ensure a quality seal and avoid air entrapment during the potting application. Some wire insulation types require surface etching to ensure potting adherence potting to outer wire surface.

3.8.6.3 Insulation Degradation

Wiring shall be handled, stripped, and installed so as not to distort, roughen, or damage the insulation on which sealing is to be affected. Methods of marking and identification shall be applied so as not to provide a track for moisture entry. The impression left on the insulation of shielded and twisted electrical cables can also cause unacceptable degradation of the insulation in relation to the elastomeric seal. Caution shall be used to avoid this condition.

Rationale: Moisture ingress at connectors can cause short circuit system failures or induce interconnection with unrelated systems. When descending from higher altitudes, condensation typically forms on wire bundles in unpressurized zones. This moisture can readily flow along wire surfaces into any available cavity, potentially causing corrosion of conductors or terminations. The absence of a smooth surface at the connector wire grommet entry can affect its ability to provide an environmental seal.

3.8.7 Corona Prevention

In the selection of electrical wiring, considerations shall be given to the prevention of corona discharge. Useful information relating to corona prevention is contained in 6.6 and should be reviewed prior to the selection of all wiring.

Rationale: At very high altitudes and AC voltages exceeding 240 Vrms, electrical discharges can occur on or around thin-walled wire insulation and the surface of any adjacent grounded material. If such conditions are to be encountered, heavier walled wire shall be selected as defined in AS50881 6.6. See [3.19](#).

This is applicable to any voltage difference, including phase-to-phase wiring or interconnections. The "corona-start voltage" from AS50881 Figure 1 is only applicable to AC-waveforms since it is predicated on relative permittivity. To apply Figures 1 and 2 to a given design, the following steps are recommended:

- Determine the phase-to-phase or phase-to-ground RMS voltage.
- Identify the correct altitude and temperature curve.
- Determine the insulation permittivity, taking into consideration the permittivity over the normal and abnormal temperature and frequency ranges.
- Use the provided formula to determine the equivalent thickness of the wire coating/plating, taking into account the insulation thickness of both wires.
- Find the intersection of the altitude curve and the equivalent thickness to find the corona start/inception voltage.
- Use the equivalent thickness to calculate the required thickness for the insulation used.

It is important to consider the largest voltage transient that may be encountered in the system and a safety factor.

3.8.8 Minimum Wire Size

This specification permits the general use of size 22 wire as the minimum wire size for airplanes, helicopters, and lighter-than-air vehicles. Use of size 24 and smaller gage wires in harnesses shall be limited to wires which have break strength of 20 pounds minimum. Size 24 and smaller gage wires shall not be installed as a single wire. Use of size 26 and smaller requires procurement activity approval. This restriction in aerospace vehicle applications is due to maintenance difficulties.

Rationale: Improperly calibrated crimp tools, vibration, flexure, tensile loading, and thermal cycling can all contribute to conductor strand breakage or erratic system operation (caused by the conductor making intermittent contact). Wiring that requires frequent disconnection and utilizes undersized wires are more susceptible to conductor breakage. Most common wire constructions include high-strength copper alloy variations for smaller wire gauges; these may be used to achieve the break strength minimum specified in this requirement. This requirement precludes the use of smaller wire gauges included in cables.

3.8.8.1 Current Carrying Capacity

Wire shall be sized so that all wires distributing current from a circuit protective device have a capacity which is equal to or greater than the rating of the device under all operating conditions. Circuits shall be individually powered with a single operating current interrupt system. Independently operated circuit protection devices shall not be paralleled or ganged together to achieve a required current rating. Power source feeder wires shall be sized for the rated capacity of the power source. A guideline for the continuous current in each wire is shown in Table 1. Table 1 assumes an ambient temperature of 70 °C, a harness or harness branch of 33 or more electrical wires for sizes 26 through 10, and nine electrical wires for size 8 and larger, carrying 20% or less of rated harness or harness branch current and operating at an altitude of 60000 feet. The use of this tabulation shall not eliminate other requirements for wire selection. Data from Figures 3, 4, and 5 may be used for determining wire size for conditions other than those contained in Table 1. The use of Table 1 and Figures 3, 4, and 5 shall not eliminate other requirements for wire selection. Current carrying capacity listed in Table 1 or calculated using Figures 3, 4, and 5 are capable of handling frequencies up to 800 Hz; above 800 Hz, the AC resistance must be corrected for skin and proximity effects. When reducing wire size, unprotected wires connecting power buses or feeders to any circuit protective devices shall be maintained within the same power panel and kept to a minimum length.

Rationale: Wiring must be protected from excess electrical current by circuit protection devices capable of disconnecting the power after a short overload period. Table 1 can simplify some size calculations. The parameters included in AS50881 Table 1 exceed the altitude and ambient conditions encountered during most aircraft operations, but the table does not cover separately routed power feeders, higher altitudes, or high temperature compartments. The tables do not consider cable jackets or overbraiding, which can significantly increase wiring temperatures or wiring near enclosures or structures.

Power source wires connecting bussing within insulated panels are less susceptible to ground faults if the wire length is minimized. Unless protected, current rise-related heating of wire caused by excess loading will break down, insulating materials over time, and can cause wire-to-wire or wire-to-ground shorts.

Most circuit protective devices operate through sensing of heat buildup which is proportional to load current. Their response time is rapid with the highest current overloads but may be protracted when overloads are only slightly greater than current rating. (For example, MS3320 thermal circuit breakers may indefinitely run at 115% current rating without tripping.) Power feeders should be able to carry the maximum power source current. Undersized wires may fail at random intervals due to insulation breakdown, especially in high temperature areas.

Refer to MIL-STD-7080 4.9.1 and 4.9.2. In order to avoid current-related thermal overload damage to wiring and surrounding materials, wires must be protected through coordination of their capacity with that of the associated circuit protective device. Without this rule in AS50881, wires could be sized to suit the running load (typically well below the circuit protector rating) and not be protected by the circuit protection.

Power feeder wiring needs to be sized to the power source capacity to ensure that the current protective features of the power source system can effectively avoid damage to wiring and surrounding materials in the event of overload. It is impossible, during initial design, to anticipate the extent of additional loads that will be applied to a power source during the lifetime of an air vehicle.

The use of paralleling, jumpering multiple circuit protection devices to achieve a higher rated current (e.g., using two 50 A breakers to achieve 100 A protection), does not guarantee uniform current distribution through each device and can allow one device to be overloaded even if total capacity is adequate. Although not specifically prohibited, paralleling circuit breakers is not a recommended practice.

3.8.8.1.1 Wiring in Harnesses

Table 1 current ratings for electrical wires in harnesses are based upon 33 or more electrical wires for sizes 26 through 10 and nine electrical wires for size 8 and larger operating at 60000 feet altitude, and an ambient temperature of 70 °C. The total current carried by the harness shall not be more than 20% of the numerical total obtained by adding the carrying capacities taken from Table 1 (or calculated from Figures 3, 4, and 5 for ambient, altitudes, or harness loading factors differing from those assumed in Table 1), for the appropriate wire construction temperature rating for all the electrical wires in the harness. For example, if a wire harness contains 33 size 20 electrical wires rated at 200 °C, the numerical total is 297 A, 20% of which is 59.4 A and the maximum allowable total current in the harness is 59.4 A and the maximum allowable current for any size 20 wire in the harness is 9 A. An electrical cable in a harness shall be treated as a number of individual electrical wires equal to the number of conductors in the electrical cable, excluding shields.

In smaller harnesses, the allowable percentage of total current may be increased as the harness approaches the single wire configuration. The harness ratings contained in Table 1 were derived from Figures 3, 4, and 5. Single electrical wire in free air ratings for copper wire were determined at T (200 to 70 °C) (for aluminum wire de-rate the free air rating of copper wire by 20%) and de-rated for (a) operation at 60000 feet altitude, (b) harnesses of 33 electrical wires or more, and (c) carrying 20% or less of rated harness current. For conditions other than (a) through (c), see 6.7.

Rationale: Bundle construction and bundle current loading are primary factors affecting the heat rise within a wire harness. The wire bundle heat rise must be accounted for along with the individual current loading of a wire in determining the required wire size. The conventions required for calculation of loading capacity of individual wires and wires in various wire harness sizes have been verified by individual testing and through extensive application in large aircraft fleets that have encountered diverse, and sometimes extreme, operating conditions. Wires carrying current that are not protected by circuit protector may experience insulation failure or fire damage. Protective layers over the wire or bundle, such as overbraid shield or mechanical chafe protection, have been shown to adversely affect the wire insulation of the wires, as the wire/bundle's ability to reject or transfer the heat during high current loading is reduced.

3.8.8.1.2 Wire Terminations

The continuous current ratings of Table 1 were derived only for wire application and cannot be applied directly to associated wire termination devices (e.g., connector contacts, relays, circuit breakers, switches). The current ratings are limited by the design characteristics of the device. Care shall be taken to ensure that the continuous current value chosen for a particular system circuit shall not create hot spots within any circuit element which could lead to premature failure. Acceptable temperature levels of circuit components shall be those defined by the particular circuit component specification.

Rationale: Devices used in wiring systems have various temperature ratings and are dependent upon the conductor material, plating, and insulation materials used. Wire terminations do not normally match that of the associated wire. Conductive sections or insulating material of termination may fail if the current carrying rating or temperature rating limits of specific devices are exceeded. Loss of power source may be at risk. Insulation breakdown of terminating device plating, degradation, or excess voltage drop may occur. This is likely a greater issue when using fully loaded high temperature rated wire (e.g., 260 °C).

3.8.8.2 Ambient Temperature

The contractor shall ensure that the maximum ambient temperature that the wire bundles will be subjected to, plus the temperature rise due to the wire current loads, does not exceed the maximum conductor temperature rating found in Appendix A in Tables A1 and A2. Figures 3, 4, and 5 may be used to determine the appropriate current loads when the following conditions are known: maximum ambient temperature, maximum conductor temperature, maximum altitude, and the number of electrical wires in a bundle. See example in 6.7 for method of calculation.

Rationale: Heat-related insulation breakdowns over extended periods could result in fires caused by short circuits between wires or to adjacent structure, particularly on heavy current power feeders. Wire bundle heat rise calculation must be based on current in all wires, wire resistance ratings, and number of wires carrying current during full loading at maximum ambient temperatures. Temperature surveys of all aircraft sections, including accounting for protective jacketing or insulated enclosures, should be addressed when wire size and insulation construction are selected.

3.8.8.3 Deleted

3.8.8.4 Voltage Drop

For power distribution circuits, the total impedance of supply and return paths shall be such that the voltage at the load equipment terminals is within the limits of MIL-STD-704.

Rationale: Critical equipment may not function properly if the voltage limits are outside of its specified revision of MIL-STD-704. Typical equipment specifications include identification of the applicable MIL-STD-704 revision that specifies voltage levels at which the equipment will function properly. Also note that different revisions of MIL-STD-704 may apply. The voltage drop calculation must include circuit protective devices, wiring, and all terminations to ensure that the voltage drop is within the specified limits.

Under-voltage protection of power sources may cause shutdowns if voltage limits are exceeded. Power generation equipment is also applicable.

Most electrical system components specifications include requirements on voltage drop. Depending on the component type, the voltage drop is specified at ambient and/or at elevated temperatures. This information can be used as a starting point for voltage drop calculations.

3.8.9 Maintainability

Wire selection shall be affected by considerations of the types and frequency of maintenance action.

Rationale: Maintenance induced damage is frequently among the leading causes for wiring failure. The wire selection and secondary harness protection should consider the potential impact of normal maintenance activities.

For harnesses routed subject to repeat flexure or attached to equipment requiring frequent removal, wires with a greater number of conductor strands should be considered as they tend to have better flex life endurance and extend service life. Harnesses routed in areas subject to frequent maintenance action should consider abrasion resistant secondary harness protection or wires/cable with greater abrasion resistance properties.

The difficulty of wiring component repair should be considered prior to design implementation. The cost-benefit of using EWIS components requiring specialized tool and/or training should also be a selection factor. Components that require specialized tooling and/or have not been approved by the procuring activity have caused significant issues on several platforms.

3.8.10 Wiring Selection for Special Applications

The general-purpose electrical wires listed in Appendix A do not perform equally in all applications. The detail characteristics of the specific wire types shall be considered for the following special applications.

Rationale: Wire failure in areas of severe environment can cause safety issues with engine operation, wing folding, and landing gear folding. Critical armament and fly-by-wire circuits should receive special attention. Some insulation types do not provide reliable service under severe high temperature, high vibration, flexure, and fluid exposure. Severe heat, wind, and moisture areas need certain environment-resistance properties. Engine compartments, landing gear, wing fold areas, and high wattage lighting, etc., may need special wire types. Fire detection and extinguishing systems require fire zone wire (wires selected from AS50881 Appendix A that retain integrity for a limited period during a fire) so as to be able to continue functioning during a fire.

The use of fire zone wire in a combat aircraft for flight critical wires should be considered. Many combat aircraft (and some civil aircraft) have experienced fires or arcing damage that could cause short circuits. The fire zone wire in Table A1 in AS50881, MIL-DTL-25038 has been used traditionally in applications where fire detection, fire suppression, or fuel shutoff devices are located within engine fire zones. This type of wire can be considered for the most safety-critical circuits, particularly in congested areas where channel separation is minimal. In some helicopters, the multiple channels are each above the other around the main gear box, connecting to the flight control actuators. The combination of ballistic damage and/or ignited fuel or oil could easily expose all channels to fire.

3.8.10.1 Severe Wind and Moisture Problems (SWAMP)

Suitable wire types in accordance with AS22759, listed in Appendix A, are preferred for SWAMP areas or both. Applications include wheel wells, near wing flaps, wing folds, and pylons.

Rationale: Wires having a fluoropolymer insulating jacket, when properly rated, have demonstrated excellent ability to withstand SWAMP area conditions. Other wire types have occasionally succumbed to extended wind and moisture exposure by delaminating or experiencing other forms of degradation.

Long-term humidity exposure and/or force hydrolysis testing should be considered for components located in SWAMP areas. The suitable wire types identified in AS50881 Appendix A should be considered for use in SWAMP zones.

3.8.10.2 Frequency Flexure

Wire types in accordance with AS22759, listed in Appendix A, shall be used for areas that require repeated bending and flexing of the wiring.

Rationale: Wires having a fluoropolymer insulating jacket have demonstrated excellent ability to withstand repeated flexure conditions even when subjected to moisture, other fluids, and handling conditions. Specialized wire types which achieve the correct cross-sectional area by having smaller diameter strands in greater numbers have displayed excellent flexure characteristics in specialized applications.

The frequency of flex and the bend severity (tightness of bend) should be considered when selecting wires for these applications. A smaller harness bend radius will result in a shorter fault-free service life. Tests methods such as AS4373 Method 704 (flex life) can be considered for determining comparative flex life performance. The test is a performance comparison versus a long-term reliability test.

3.8.10.3 Electromagnetic Interference (EMI) and Electromagnetic Vulnerability (EMV) Sensitive Areas

AS85485 cable is preferred for use in EMI and EMV sensitive areas. For complete installation guidance, refer to AIR4465. The following precautions must be taken when routing and installing AS85485/8 or /12 shielded and jacketed filter line wire. The black jacket is conductive and should be routed and clamped or protected to ensure clearance to all exposed (uninsulated) power distribution points. The use of discrete filters or other suitable means should also be considered in instances where more effective attenuation of interference can be provided at specific frequency ranges or where replacement of existing wiring is impracticable. Qualified examples of such devices include active components integrated in terminal junctions (refer to AS81714).

Rationale: The reliable performance of EMI/EMV sensitive wiring can only be assured when adequate shield construction and proper shield grounding are employed. Available means to reduce the impact of EMI/EMV include:

- Filter line cable has excellent attenuation characteristics for high frequency interference but does not attenuate as well at lower frequencies.
- Additional separation and/or ferrous metal shielding are more effective at lower frequencies.
- Discrete filters within sensitive equipment units may be required.