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Standard Practice for Maintenance of Airplane Electrical Wiring Systems[1]

This standard is issued under the fixed designation F2799; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 *Definition*—This practice defines acceptable practices and processes for the maintenance, preventative maintenance, and repair of electric systems in general aviation aircraft. This practice does not change or create any additional regulatory requirements nor does it authorize changes in or permit deviations from existing regulatory requirements.

1.2 *Applicability*—The guidance provided in this practice is directed to air carriers, air operators, maintenance providers, repair stations, and anyone performing maintenance or repairs.

1.3 *Protections and Warnings*—This practice provides guidance to minimize contamination and accidental damage to electrical wiring interconnection systems (EWIS) while working on aircraft.

1.4 *"Protect and Clean As You Go" Philosophy*—This philosophy is applied to aircraft wiring through inclusion in operators' maintenance and training programs. This philosophy stresses the importance of protective measures when working on or around wire bundles and connectors. It stresses how important it is to protect EWIS during structural repairs, (STC) installations, or other alterations by ensuring that metal shavings, debris, and contamination resulting from such work are removed.

1.5 *Units*—The values given in inch-pound units are to be regarded as the standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

NOTE 1—When SI units are required, refer to Annex 5 of ICAO.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

F2490 Guide for Aircraft Electrical Load and Power Source Capacity Analysis

F2639 Practice for Design, Alteration, and Certification of Airplane Electrical Wiring Systems

2.2 *ICAO Standard:*

ICAO Annex 5 Units of Measurement to Be Used in Air and Ground Operations[3]

2.3 *JEDEC Standard:*

EIA 471 Symbol and Label for Electrostatic Sensitive Devices[4]

2.4 *NEMA Standard:*

WC 27500 Standards for Aerospace and Industrial Electric Cable[5]

2.5 *RTCA Standard:*

DO-160C Environmental Conditions and Test Procedures for Airborne Equipment[6]

2.6 *SAE Standards:*

AS 4372 Performance Requirements for Wire, Electric, Insulated Copper or Copper Alloy[7]

AS 4373 Test Methods for Insulated Electric Wire[7]

AS 21919 Clamp, Loop Type, Cushioned Support[7]

AS 50881 Wiring Aerospace Vehicle[7]

ARP 1870 Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and Safety[7]

ARP 1928 Torque Recommendations for Attaching Electrical Wiring Devices to Terminal Boards or Blocks, Studs, Posts, Etc.[7]

2.7 *Federal Standards:*

Advisory Circular 20-53A Protection of Aircraft Fuel Systems against Fuel Vapor Ignition due to Lightning

[1] This practice is under the jurisdiction of ASTM Committee F39 on Normal and Utility Category Airplane Electrical Wiring Systems and is the direct responsibility of Subcommittee F39.02 on Inspection, Maintenance, and Repair.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from ICAO, Customer Services Unit, 999 University St., Montreal, Quebec, H3C 5H7, Canada.

[4] Available from the JEDEC Solid State Technology Association, 3103 N. 10th St., Suite 240-S, Arlington, VA 22201.

[5] Available from National Electrical Manufacturers Association (NEMA), 1300 N. 17th St., Suite 1752, Rosslyn, VA 22209, http://www.nema.org.

[6] Available from RTCA, Inc., 1828 L St., NW, Suite 805, Washington, DC 20036.

[7] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

MIL-C-22520/2C Crimping Tools, Terminal, Hand, Wire Termination
MIL-S-8802 Sealing Compound, Temperature-Resistant, Integral Fuel Tanks and Fuel Cell Cavities, High Adhesion
MIL-T-7928 Terminal, Lug Splices, Conductors, Crimp Style, Copper
MIL-T-43435 Tape, Lacing and Tying
MS17821 Specification for Cable and Marker Color Code Numbers
MS17822 Specification for Cable and Marker Color Code Numbers
NAVAIR 01-1A-505 Installation Practices—Aircraft Electric and Electronic Wiring

3. Terminology

3.1 *Definition:*

3.1.1 *maintenance*, *n*—inspection, overhaul, repair, preservation, and the replacement of parts but excludes preventive maintenance.

3.2 *Definition of Term Specific to This Standard:*

3.2.1 *electrical wiring interconnection system (EWIS)*, *n*—as used in this practice, any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy between two or more intended termination points.

3.3 *Acronyms:*

3.3.1 *AC*—alternating current
3.3.2 *CFC*—carbon fiber composite
3.3.3 *DC*—direct current
3.3.4 *EDS*—electronic data system
3.3.5 *EMI*—electromagnetic interference
3.3.6 *ESD*—electrostatic discharge
3.3.7 *EWIS*—electrical wiring interconnection system
3.3.8 *ICAO*—International Civil Aviation Organization
3.3.9 *NiCad*—nickel cadmium
3.3.10 *OEM*—original equipment manufacturer
3.3.11 *PC*—personal computer
3.3.12 *PTFE*—polytetrafluoroethylene
3.3.13 *RF*—radio frequency
3.3.14 *SOC*—state of charge
3.3.15 *STC*—supplemental-type certificate
3.3.16 *SWAMP*—severe wind and moisture problem
3.3.17 *UV*—ultraviolet

4. Significance and Use

4.1 This practice is intended to be used as a standard wiring practice for normal and utility category aircraft when not contrary to standards published by the aircraft original equipment manufacturer (OEM) or regulations. This practice is intended to be used for maintenance and preventive maintenance of electrical wiring interconnection systems (EWIS).

4.2 This practice is not intended to supersede or replace any government specification or specific manufacturer's instructions regarding EWIS maintenance or repair.

5. Maintenance

5.1 *Electrical Systems*:

5.1.1 *Maintenance*:

5.1.1.1 Scheduled and unscheduled maintenance activities, if done improperly, may contribute to long-term problems and degradation of wiring. Certain repairs may have limited durability and shall be evaluated to ascertain if rework is necessary. Repairs that conform to manufacturers' recommended maintenance practices are generally considered permanent and should not require rework. Care shall be taken to prevent undue collateral damage to EWIS while performing maintenance on other systems. Metal shavings and debris have been discovered on wire bundles after maintenance, repairs, or modifications have been performed. Care shall be taken to protect wire bundles and connectors during maintenance and repair. Work areas should be cleaned while the work progresses to ensure that all shavings and debris are removed. The work area should be thoroughly cleaned after work is complete, and the area shall be inspected after the final cleaning. Maintenance, repairs, and alterations should be performed using the most effective methods available to protect the surrounding EWIS. Since wire splices are more susceptible to degradation, arcing, and overheating, the recommended method of repairing a wire is with an environmentally sealed splice. (**Warning—**For personal safety and to avoid the possibility of fire, turn off all electrical power before starting an inspection of the aircraft electrical system or performing maintenance.)

5.1.1.2 Repair of any system component that fails an electrical measurement test shall conform to manufacturer's instructions and, in lieu of manufacturer's manuals, Practice F2639 or appropriate regulatory guidance materials.

5.1.1.3 Wire bundles should be routed in accessible areas that are protected from damage from personnel, cargo, and maintenance activity. They should not be routed in areas where they are likely to be used as handholds or as support for personal equipment or where they could become damaged during removal of aircraft equipment.

5.1.1.4 Replacement wires (see Tables 1 and 2) should be clamped so that contact with equipment and structure is avoided. Where this cannot be accomplished, extra protection in the form of grommets, chafe strips, and so forth, should be provided. Protective grommets shall be used wherever wires cannot be clamped in a way that ensures at least a ⅜-in. (9.5-mm) clearance from structure at penetrations.

5.1.1.5 Wire should not have a preload against the corners or edges of chafing strips or grommets. Wiring shall be routed away from high-temperature equipment and lines to prevent deterioration of insulation. Protective flexible conduits should be made of a material and design that eliminates the potential of chafing between their internal wiring and the conduit internal walls.

5.1.1.6 Replacement wires that shall be routed across hinged panels should be routed and clamped so that the bundle will twist, rather than bend, when the panel is moved.

5.1.2 *General*:

5.1.2.1 The term "electrical wiring interconnection system (EWIS)" as used in this practice means any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy between two or more intended termination points.

TABLE 1 Open Wiring

Document	Voltage Rating (Maximum)	Rated Wire Temperature, °C	Insulation Type	Conductor Type
MIL-W-22759/1[A]	600	200	Fluoropolymer-insulated TFE and TFE coated glass	Silver-coated copper
MIL-W-22759/2[A]	600	260	Fluoropolymer-insulated TFE and TFE coated glass	Nickel-coated copper
MIL-W-22759/3[A]	600	260	Fluoropolymer-insulated TFE-glass-TFE	Nickel-coated copper
MIL-W-22759/4[A]	600	200	Fluoropolymer-insulated TFE-glass-FEP	Silver-coated copper
MIL-W-22759/5[A]	600	200	Fluoropolymer-insulated extruded TFE	Silver-coated copper
MIL-W-22759/6[A]	600	260	Fluoropolymer-insulated extruded TFE	Nickel-coated copper
MIL-W-22759/7[A]	600	200	Fluoropolymer-insulated extruded TFE	Silver-coated copper
MIL-W-22759/8[A]	600	260	Fluoropolymer-insulated extruded TFE	Nickel-coated copper
MIL-W-22759/9[A]	1000	200	Fluoropolymer-insulated extruded TFE	Silver-coated copper
MIL-W-22759/10[A]	1000	260	Fluoropolymer-insulated	Nickel-coated copper
MIL-W-22759/13[A]	600	135	Fluoropolymer-insulated FEP PVF2	Tin-coated copper,
MIL-W-22759/16[A]	600	150	Fluoropolymer-insulated extruded ETFE	Tin-coated copper,
MIL-W-22759/17[A]	600	150	Fluoropolymer-insulated extruded ETFE	Silver-coated high-strength copper alloy
MIL-W-22759/20[A]	1000	200	Fluoropolymer-insulated extruded TFE	Silver-coated high-strength copper alloy
MIL-W-22759/21[A]	1000	260	Fluoropolymer-insulated extruded TFE	Nickel-coated high-strength copper alloy
MIL-W-22759/34[A]	600	150	Fluoropolymer-insulated cross-linked modified ETFE	Tin-coated copper
MIL-W-22759/35[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Silver-coated high-strength copper alloy
MIL-W-22759/41[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Nickel-coated copper
MIL-W-22759/42[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Nickel-coated high-strength copper alloy
MIL-W-22759/43[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Silver-coated copper
M1L-W-25038/3/2/	600	260	See specification sheet[B]	See specification sheet[B]
MIL-W-81044/6	600	150	Cross-linked polyalkene	Tin-coated copper
MIL-W-81044/7	600	150	Cross-linked polyalkene	Silver-coated high-strength copper alloy
MIL-W-81044/9	600	150	Cross-linked polyalkene	Tin-coated copper
MIL-W-81044/10	600	150	Cross-linked polyalkene	Silver-coated high-strength copper alloy
MIL-W-81044/12	600	150	Cross-linked polyalkene	Tin-coated copper

[A] MIL-W-22759 has been replaced by SAE AS 22759.
[B] Inorganic fibers—glass—TFE.

TABLE 2 Protected Wiring

Document	Voltage Rating (Maximum)	Rated Wire Temperature, °C	Insulation Type	Conductor Type
MIL-W-22759/11[A]	600	200	Fluoropolymer-insulated extruded TFE	Silver-coated copper
MIL-W-22759/12[A]	600	260	Fluoropolymer-insulated extruded TFE	Nickel-coated copper
MIL-W-22759/14[A]	600	135	Fluoropolymer-insulated FEP-PVF2	Tin-coated copper
MIL-W-22759/15[A]	600	135	Fluoropolymer-insulated FEP-PVF2	Silver-plated high-strength copper alloy
MIL-W-22759/18[A]	600	150	Fluoropolymer-insulated extruded ETFE	Tin-coated copper
MIL-W-22759/19[A]	600	150	Fluoropolymer-insulated extruded ETFE	Silver-coated high-strength copper alloy
MIL-W-22759/22[A]	600	200	Fluoropolymer-insulated extruded TFE	Silver-coated high-strength copper alloy
MIL-W-22759/23[A]	600	260	Fluoropolymer-insulated extruded TFE	Nickel-coated high-strength copper alloy
MIL-W-22759/32[A]	600	150	Fluoropolymer-insulated cross-linked modified ETFE	Tin-coated copper
MIL-W-22759/33[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Silver-coated high-strength copper alloy
MIL-W-22759/44[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Silver-coated copper
MIL-W-22759/45[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Nickel-coated copper
MIL-W-22759/46[A]	600	200	Fluoropolymer-insulated cross-linked modified ETFE	Nickel-coated high-strength copper alloy
MIL-W-81044/13	600	150	Cross-linked polyalkene – PVF2	Silver-coated high-strength copper alloy
MIL-W-81381/17	600	200	Fluorocarbon polyamide	Silver-coated copper
MIL-W-81381/18	600	200	Fluorocarbon polyamide	Nickel-coated copper
MIL-W-81381/19	600	200	Fluorocarbon polyamide	Silver-coated high-strength copper alloy
MIL-W-81381/20	600	200	Fluorocarbon polyamide	Nickel-coated high-strength copper alloy
MIL-W-81381/21	600	150	Fluorocarbon polyamide	Tin-coated copper

[A] MIL-W-22759 has been replaced by SAE AS 22759.

5.1.2.2 The satisfactory performance of an aircraft is dependent upon the continued reliability of the electrical system. Damaged wiring or equipment in an aircraft, regardless of how minor it may appear to be, cannot be tolerated. Reliability of the system is proportional to the amount of maintenance received and the knowledge of those who perform such maintenance. It is, therefore, important that maintenance be accomplished using the best techniques and practices to minimize the possibility of failure.

5.1.3 *Cleaning and Preservation*:

5.1.3.1 Annual cleaning of electrical equipment to remove dust, dirt, and grime is recommended.

5.1.3.2 If terminals and mating surfaces are corroded or dirty, suitable solvents or fine abrasives that will not score the surface or remove the plating may be used to clean them. Only cleaning agents that do not leave any type of residue shall be used. Avoid using emery cloth to polish commutators or slip rings because particles may cause shorting and burning. Be sure that protective finishes are not scored or damaged when cleaning. Ensure that metal-to-metal electrically bonded surfaces are treated at the interface with a suitable anticorrosive conductive coating and that the joint is sealed around the edges by restoring the original primer and paint finish. Connections that shall withstand a highly corrosive environment may be encapsulated with an approved sealant to prevent corrosion. (**Warning—**Turn power off before cleaning.)

5.1.3.3 *"Protect and Clean As You Go" Philosophy*—It is imperative that the technician performing maintenance and